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A Comparative Scrutinization on Diversified Needle Bandanna Segmentation Methodologies

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Abstract

As there has been a prevalence of innumerable harmful diseases concerned with the internal and external structure of the spinal cord, a well predetermined examination may lead evading this problem. MRI scanning is of course a perfect choice due to its non-existence of side effects to humans. Therefore, a comparative study is forged on the four research papers that explore multiple marvelous methodologies given in the assessment of the different parts of spine tissue manifestation and an analytical study of its corresponding symptotic diseases. The methodologies applied are machine learning approach, a deep learning convolutional neural network, a combined MRI-US spine tissue segmentation and an atlas free method. A succinct brief out is given on its performance, severity of the disease in each spinal area, and the segmentations carried out. Each implementation is unique and efficient in its own way with possible future enhancements to be carried over.

Keywords: Initial Filtration; Magnetic Resonance Imaging; Spine Tissue; Tissue Segmentation

1 Introduction

MRI is found to be a wonderful choice for receiving much more in depth detail robust images of the spine tissues [9] compared to any other developed models [19]. In machine learning approach, an attempt is made to elucidate on a proper detection of spine tissue persisting on the lumbar spine area using MRI. Before stepping up in to this discrete methodology, many pre-processing and ensembled techniques are taken into consideration [11]. The hypothetical study involves:

1) Initial Filtration;
2) Preliminary Vertebra Recognition;
3) Tissue Segmentation;

4) Shape Interpolation;

5) Evaluation Measures.

The other research deal with the segmentation of axon and myelin sheaths of the spinal cord of the various species using the SEM (Scanned Electron Microscope) and TEM (Transmission Electron Microscope). This novel method can be considered as in held study in the MRI segmentation. The process allows segmenting both the sheaths in the same network. No post and pre-processing is done here therefore prohibits high speed.

Axon and Myelin Segmentation of the nervous tissue will furnish with very deep and intense information of any type of spinal cord [6]. These images can further be integrated with the MRI spine tissue morphometric detection of cells to even have a clear visibility of the multifarious nervous systems. The cell network is one of the popular application CNNs with U-Net architecture [7]. The methodology uses Convolutional Neural Network architecture in the frame of deep-learning approach, two-read-to-use models for the segmentation and a pertinent implementation of the training sets to come up with newer modalities along with the availability of anytime used program codes referred as "AxonDeepSeg" [16].

Although UltraSound images is the marvelous option of identifying images, it is weaker in coming out with proper structure visibility [18]. The US lags in muscle boundary mapping and emanates with indifferent shapes and texture with the target output beyond the limit. MRI thus rules out this case [15]. The MRI-US association procedure inculcates a full-fledged segmentation of the cervical muscles affected with back pain or injury, myothesis, neurothesis and cervical dystonia with the invoked shape and contour information with less error. This paper composement is vitally for the recognition cervical dystonia caused due to the dreadful sudden muscle spasticity [3]. The segmentation of five bilateral muscle are carried out under a novel multi-model regression frame 10. The method can be used to determine any deep muscle region through Ultrasound images combined with MRI.

Here is a cervical spinal cord approach carried over without the Atlas free method for the MRI images. With a combined containment of Expectation Maximization (EM) and Dynamic Programming (DP) algorithms and Region Growing, a computer-aided diagnosis of the spinal diseases are recognized [6]. The atlas free method provides information etiology of canal stenosis, degree of cord compression and pathological changes within the cord [2].The severity of the cervical myelopathy are considered here to assess its impact in MRI with the proceedings of canal stenosis, degree of cord compression and its changes. All these have led to the development of Atlas-free cervical spinal cord segmentation.

2 Input Data

1) DICOM MRI Input Images:
   As an initiative study, we must have a manifestation that the forthcoming processes to be discussed were done manually. The data relates to 50 MRI examination of the patients who are been affected with low back pain. These were taken from 5 physicians who have done this manually. The patients underwent the MRI treatment with SIEMENS MAGNETOM 3T MR Device [9]. For the requirement of the peak contrastness and the brightness of the typical vertebral body recognition, the researchers used the T1TSE Sagittal Sequences of the image datasets with an Echo Time (ET) of 903ms and the Repetition Time (RT) between 550ms and 700ms. The term Sagittal refers to the image to be viewed. The MRI Echo time is meant for the production of radio pulse signals from the location scanned in the prescribed time. The MRI Repetition Time (RT) infers the proper arrangements of the flow of electrons in the supervised area. They acquired the image sets with the slice thickness of 4mm and 4.8 mm slice distance with a pixel resolution of 384×384.

Table 1: The four types of species considered

Samples	Axon Labels	Myelin
TEM	Identified by its region filling	Inner and the outer contours are manually segmented with GIMP
SEM	Inner region fill-ups after initial thresholding	Intensity thresholding.

The DICOM (Digital Imaging Communication in Medicine) images, an international standard exclusively meant for storing, transferring images and its information between MRI and the system were acquired.

2) SEM and TEM Images in PNG Form:
SEM and TEM image gathered with a variable isotopic pixel resolution ranging from 0.05 to .018 μm (SEM) and 0.002 to 0.009 μm (TEM). The SEM samples were used with the presence of 2% osmium, built in epoxy and the construction was with the same system (JEOL 7600F). The adjustments of the same were made if necessary. Finally, the ground truth label consists of a single PNG image[6]. Table 1 shows the four types of species considered. For the initial step, the ground-truth labeling of axon (nerve density) and the myelin (inner and the outer boundaries of the axon) were manually segmented as given in the Table 1.

Table 2: The ground-truth labeling of axon and the myelin

Species	Image Type	Training/Validation	Testing
Rat	SEM	Spinal Cord (Cervical)	Spinal Cord (Cervical)
Human	SEM	-	Spinal Cord (Cervical)
Macaque	TEM	-	Brain (Corpus Collosum)
Mice	TEM	Brain(Splenium)	Brain (Splenium)

3) MRI-US Input Images:
The MRI and the US data for the next study were collected from 22 participants (age: 29.0 $\pm$ 6.6). Male found to be 12 and the female to 10. The T-Shaped probe that is perfectly suited for the skin taping and for the movement with the 2-cod liver oil capsules identified the cervical muscle image plane [11]. The person then undergone MRI scan to find the cervical muscle region helping to get a perfect resolution, shape, texture of the US image with the dependency of MRI. It also includes:

   a. Image Annotation;
   b. Texture and Shape Model;
   c. Dictionary Segmentation;
   d. Refined‘ Fitting with Visualization Features.

4) MRI Images in JPEG Format:
The patients met with the treatment on SIEMNENS MAGNETOM AVANTO 105 Tesla MRI Scanner [6]. The T2- Weighted Scan for the cervical cord had a turbo spin echo sequence with

TR= 3300ms and TE = 95 ms, flip angle=150 degree, bandwidth = 223 Hz/voxel and a sagittal slice of 3mm. A saturation band is placed over the anterior and the inferior aspect having a total of 13 gray scale images with 320*320 pixel in size with a resolution of 0.6875 mm/pixel.

3 Initial Filtration

3.1 Data Preprocessing in Machine Learning Technique

The low quality data is overcome by eliminating: Resolution; Intensity Inhomogeneity(IIH); and High noise.

1) Resolution and IIH:
A high resolution cubic spine interpolation is made use of, where the incoming images are resampled to a fixed size [17]. The IIH correction is attained by maintain the smoothness which may be eliminated when the deep intense images are taken. By re-arranging the local intensities to a global exponential function, the intensity inhomogeneity is obtained.

2) High Noise:
A full-fledged noise reduction is done by using the same global exponential function which is applied in non-linear selective Gaussian Bur. It involves the process of blurring the image typically to diminish the noise.

3) Data Preparation:
The SEM and TEM sample is adjusted to a pixel resolution (512×512) and integrated to 8 patches, with each patch having 75 to 100 axons in it.

4) Histogram Pre-Processing:
A traditional histogram pre-processing is applied on these split-up patches and assigned with axon and myelin labels with the background having its own labels. Finally identifies the dataset alotted for training and validation. Now the SEM and TEM models are ready to train the incoming new images.

3.2 Initial Stage

Prior to the segmentation, the research methodology here inhibits the following preprocessing task:

1) Image Annotation:
The MRI images were explicitly used to observe in keen the various positions of cervical muscle area. Each of the ensemble data are noted so that none of the prominent information are evaded. Based upon it, many annotation points were created that are inter related to the US images involving rotations and transitions [11]. The soft tissue deformation was also appended by optimizing the parameters of the contour squashing function. Thus a matched fit and equivalent data that satisfies both the MRI and US image were obtained.

2) Shape Model:
A Statistical ASM(Active Shape Model) is used to find the shape and contours from the MRI annotations for the 22 datasets and an intrinsic asymmetric is attained with the outcome of 44 annotated images. The images were cross-verified with already exhibited 50 annotations for the individual muscle. Based on this observation, a database of around 70,619 shapes was generated by adopting Principle Component Analysis. Elbow method was used to select only the most descriptive components for the following process [11].

3) Texture Model:
The texture determination is reasonable as there is a probability of muscle location in varied places. As a preliminary step, the fourth order polynomial is applied to evaluate each shape to mean shape [11]. An association of pixel shape locations to mean texture is done through which the shapes are transformed to a mean texture. This process is repeated till the overall mapping is done which in turn relates to the mean texture using bilinear interpolation. Hence we get the texture-to-shape dictionary.

3.3 Symmetry Based Selection of Midsagittal Images

The selection of two T2-weighted midsagittal images is chosen and its symmetric variation between them is evaluated to select one input image from them. To do so, as the spinal cord and the vertebral column are bilaterally symmetrical, the estimation of the intact MidSagittal Plane (iMSP) length of it is done. Now the kMSP value is pretended that tells the sagittal position closest to the iMSP . One that satisfies this assumption is accepted as the input image. Among the assumption of the kMSP [6] values between the 1 and 13, the value 7 is taken as the apt location. There is a manifestation that gray level pixel differences give the anticipated input image.

4 Preliminary Vertebra Recognition

4.1 Cascade of Boosted Classifiers

The identification of whole vertebra is carried out using Cascade of Boosted Classifiers using extended set Haar like features [18]. From the 50 MRI examinations, there is necessity of discriminating the positive and negative samples. From the 1000 vertebra images, 10,000 positive samples were extracted using Thin Plate Splines [3]. The Thin Plate Spline is the geometric design of a two-dimensional to a one-dimension. The mean of the data points are connected together for the shape representation scaling thus diminishing the cost of bending energy. The negative samples are generated by utilizing the same 1000 vertebra images for the background image estimation through Image Impainting. Haar-based features are meant for marking the perfect image in a sequence of rectangular bounding box. Finally, the false positive hits are removed for the additional size constraints. The process is designed in AdaBoost algorithm under OpenCV library [4].

4.2 Learning

This stage contains the actual implementation required for training and validating the ground truth values. The built-in process is constructed under CNN architecture. The model is helpful whenever the new incoming SEM and TEM for the segmentation. The overall implementation of AxonDeepSeg tool is done using Python programming that can be adapted in any platform of Linux and MacOSX systems.

4.3 Pre-Segmentation Process

1) Dictionary Segmentation:
The search process initiates here in the dictionary once a new sample image is fed in. the index is maintained here that holds all the exact and approximate texture matches found using the Sum of Absolute Difference(SAD) metric [11]. Once it is evaluated for all the textures, the SAD with the lowest value have the best texture is used for further segmentation.

2) Refined Fitting Segmentation:
Here we consider the warped texture that is also generated in the previous step for refining segmentation. Using the contour profile intensities of the warped image, computation of sum of squared differences is done by finding the intensity values of the test image and the image profile in the dictionary. The procedure is established to get the overall structure.

4.4 Spinal Cord Detection using EM and DP

1) Region of Interest Location:
A categorization of anterior, posterior, superior and inferior edges of the cord, canal, vertebral column, disks are to be identified in future based on the above spinal cord region detection [11]. The foremost step explores the outline detection while the later study implies the detection in deep.

2) Signal Intensity Determination:
To carry over the first step, a predetermination of signal intensities is made. A normalized histogram Gaussian approach is used under EM algorithm with gray level pixel oriented or signal intensity approach [1].The gribbs artifact technique is involved to overcome the probability of the inhomogeneity arisal in the radio-frequency field, saturation bands and MR frequency adjustments. Thus the grey level values ranging between 60 and 100 isotense values denote the spinal cord.

3) Vertebral and Intervertebral Disk Detection:
By using the previous signal intensity values [3], the former comprises of

- The hypointense → Cortical Bone;
- The isointense → Bone Marrow;
- The hypointense → Endplate.

The histogram is constructed to segregate these groups according to their pixel wise regions. The labeling is marked based on location, height, depth and area using the region growing to find the intervertebral disks.

5 Segmentation

5.1 Tissue Segmentation

1) Active Appearance Model(AAM):
The actual segmentation is done using AAM [2] combined with Principle Component Analysis [1] and Gray level appearance. As an initiative, the 16 characteristic features prepared and labeled by the 5 physicians are taken for training. These are then applied to the already detected vertebra images. T-he method is used to extract only the desired location than the entire vertebra. To implement this, we categorize the function into Appearance Detection Model and the Shape Detection Model.

2) Appearance Detection using PCM:
Here the matched 16 features are extracted using the similar way of positive and negative samples with the details of exact regularized shape, eigenvector and the eigenvalues assessment using the Shape model. The implementation here is done using the Point Distribution Model (PCM) in the Principle Component Analysis. The individual point extracted shows the feature. The whole

implementation is so called "Active Appearance Model". This ready to use trained method starts with a initial guess with the ground truth value. The implementation is on Lucas-Kanade Optimization method with Wiberg Inverse Compositional Algorithm. All the feature points generated are integrated together as a whole to form a closed geometrical shape connecting only control points using Catmull-Rom Splines [2].

5.2 The Training and Prediction Model

1) Training:
The original segmentation is done for a new microscopy image by invoking the training and the validation model. The evaluation procedure receives the image from the prediction stage, sends it to the training model for the segmentation of axon and myelin labels. The result is send to the validation part to check for any wrong assumptions and re-transmits for the resampling in the prediction phase with the proper labeling of axon, myelin and the background [1].

2) Prediction:
The images are once again re-sorted back in to the original pixel size for the display.

5.3 Visualization and Real-Time Analysis of the Muscle Features

The cervical muscles after proper segmentation are made to visualize on the screen. The extrapolated boundary images far apart from the image plane are adjusted by itself to enter into the level automatically without having any executional part. A normalized statistical measure is used in the form of bar chart to have display of overall cervical muscle structure.

5.4 Spinal Cord Border Detection using Atlas Free Method

Once all the four edges are determined, the actual spinal cord detection occur using Median Filtering for to come out with the problem of Atlas free method as the signal intensities are not known in this process. The calculation of the median gray level spinal canal is performed for a range of hypointense pixels and the isointense pixels. The Compound Fitness Function is employed to gradually increase the contrastness of the spinal cord edges through DP algorithm with the involvement of four components and weight assumptions:

- Median and Grey level Similarity;
- Heterogeneity between the adjacent pixels;
- Contrast between the cord and non-cord pixels;
- Penalty for passing through non-cord pixels.

6 Evaluation Measures

6.1 Machine Learning Procedure Evaluation

Three numerical evaluation measures were used for the comparison between the manual and the automatic segmentation process [8]. The implementation was done on Menpo Framework using the five different optimization algorithms:

- Wiberg Inverse Compositional Algorithm (WIC);

- Simultaneous Inverse Compositional Algorithm (SIC);
- Project-Out Inverse Compositional Algorithm (POIC);
- Alternating Inverse Compositional Algorithm (AIC);
- Modified Alternating Inverse Compositional Algorithm (MAIC).

The reliability testing was evaluated on the above algorithms by comparing the mean values of True Positive Fraction (TPF), False Negative Fraction (FNF) and the False Fraction (FF) between the computer and the expert [2]. Due to the low standard deviation and a good stability WIC was chosen for the further optimization. Finally FF was seemingly high with best results as shown in Table 3. The intra class correlation coefficient that tells the consistency of the vertebral spine tissue segmentation between manual and automatic segmentation was found to be acceptable. 10-fold cross validation is also determined by splitting 1000 vertebral images in to equal individual parts and applied for training on 90% of the images and tested on 10% of it. FF value was 90.19±1.01%. The test convergence algorithm was performed with the comparison of TPF, FF, FNF and mean. The automatic segmentation result was good having r-= 0.8336 for single measurements and r-= 0.9068 for the average measurements with p = 0.05[1].

Table 3: Comparison of all the modalities used in each process

Process Deployment	Machine Learning Approach	CNN	Integrated MRI-US Technique	Atlas-Free Method
Input data	DICOM Images	PNG image	Not Specified	JPEG Image
Pre-Processing Techniques	IIH, Gaussian Blurring and Cubic Spline	Histograms	SoftTissue Deformation, Contour Squashing Function, ASM and Texture Model	Determination of kMSP and iMSP
Actual Tissue Segmentation	AAM with PDM	Prediction and Resampling	Extrapolation under Statistical Methods	Median Filtering
Spinal Muscle Segmented	Lumbosacral Spine Tissue	Spinal Cord Slice	Cervical Muscles	Cervical Spinal Cord
Disease Predicted	Low Back Pain	Neuro Degenerative Disease	Cervical Dystonia	Cervical Spondylotic Myelopathy
Tools Applied	OpenCV Library, Menpo Framework.	Python Programming	C++ Programming	Unspecified
Segmentation Performance Measure	90.19%	SEM=85%(Rat), 81%(Human) TEM=95%(Mice), 85%(Macaque)	86%	85%

6.2 Axon Myelin Segmentation Evaluation

The data augmentation strategies for the various forms of input patches related to shifting, rotation, rescaling, flipping and elastic deformation A proper labeling of axon and myelin were measured using Dice metrics for each species. The segmentation metrics is used to measure its quality. The result was appreciable with 83% for all except for the human species. The result of the axon dice is better than the myelin dice. The pixel wise accuracy was found to be between 81% and 82% of optical microscopy data.

6.3 MRI-US Evaluation

The whole process is developed using C++ language. The performance is measured using Jaccard Indices, Hausdroff distance and the Dice similarity coefficient. Jaccard indices are used to measure the absolute cross-sectional area of the muscle which is with the efficiency of 99%. The detection of proper muscle contour is estimated by the Hausdroff distance and the performance arrives nearly to 17mm. the dice similarity coefficient is used to evaluate the time taken to segment a single image which delivered 97% approximately [11].

6.4 Atlas Free Method Measurement

The outcome was successful for 67 (85%) MRI studies from 79. The performance of the spinal cord detection is cross valuated between the manual and automatic segmentation. Jaccard index is evaluated to assess the efficiency if overlapping between the cord and regions for the various observers by considering TP, FP and FN pixels. The result was between 0.937 and 1 with the mean of 0.980±0.014. The accuracy of the maximum distance between the two curves of the spinal cord edges is determined using the Hausdroff distance and obtained to be 1.0±0.5mm for automatic segmentation. Table 3shows a comparison of all the modalities used in each process.

7 Conclusion

This innovative approach can be further upgraded to detect Grey Scale or 2D spine images with more efficient integration of region split and merge segmentation to clearly reach the part of the image that we have to view for. In addition to the process, Blind Deconvolution algorithm can be appended to accurately snap out the minute region of the spine image without having the prior information of the blur kernel. We can also explore the shape, size and the adjacent vertebral bodies in addition to motion recognition using the same. Here, the computation time can be improved. Further, the development can be done by considering even the weakly affected tissues and put a step forward in handling excessive set of data and having all the process as an automated one and adopted on any muscle area segmentation.

References

[1] H. Abdi and L. J. Williams, "Principal component analysis," *Wiley Interdisciplinary Reviews: Computational Statistics*, vol. 2, no. 4, pp. 433-459, 2010.

[2] J. Alabort-I-Medina, E. Antonakos, J. Booth, P. Snape, and S. Zafeiriou, "Menpo: A comprehensive platform for parametric image alignment and visual deformablemodels," in *Proceedings of the 2014 ACM Conference on Multimedia (MM'14)*, pp. 679- 682, ACM, New York, Nov. 2014.

[3] F. L. Bookstein, "Principal warps: Thin-plate splines and the decomposition of deformations," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 11, no. 6, pp. 567-585, 1989.
[4] G. Bradski, "The opencv library," *Doctor Dobbs Journal*, vol. 25, no. 11, pp. 120-126, 2000.
[5] L. C. Chen, G. Papandreou, F. Schroff, H. Adam, "Rethinking atrous convolution for semantic image segmentation," arXiv: 1706.05587, 2017.
[6] R. J. Cunningham, P. J. Harding, and I. D. Loram, *et al.*, "Real-time ultrasound segmentation, analysis and visualisation of deep cervical muscle structure," *IEEE Transactions on Medical Imaging*, vol. 36, no. 2, Feb. 2017.
[7] S. S. Eun, H.-Y. Lee, S.-H. Lee, K. H. Kim, andW. C. Liu, "MRI versus CT for the diagnosis of lumbar spinal stenosis," *Journal of Neuroradiology*, vol. 39, no. 2, pp. 104-109, 2012.
[8] A. Fenster and B. Chiu, "Evaluation of segmentation algorithms for medical imaging," in *Proceedings of the 2005 IEEE 27th Annual Conference Engineering in Medicine and Biology*, pp. 7186-7189, Shanghai, Jan. 2006.
[9] D. Gawel, P. Glowka, T. Kotwicki, M. Nowak, *et al.*, "Automatic spine tissue segmentation from MRI data based on cascade of boosted classifiers and active appearance model," *Hindawi BioMed Research International*, vol. 2018, Article ID 7952946, 13 pages.
[10] A. Karpathy, G. Toderici, S. Shetty, T. Leung, "Large-scale video classification with convolutional neural networks," in *IEEE Conference on Computer Vision and Pattern Recognition*, 2014.
[11] C. C. Liao, H. W. Ting, F. Xiao, *et al.*, "Atlas-free cervical spinal cord segmentation on midsagittal T2-weighted magnetic resonance images," *Hindawi Journal of Healthcare Engineering*, vol. 2017, Arcticle ID 8691505, 12 pages.
[12] C. D. Malon, E. Cosatto, "Classification of mitotic figures with convolutional neural networks and seeded blob features," *Journal of Pathol. Inform.*, vol. 4, no. 9, 2013.
[13] T. Naito, *et al.*, "Identification and segmentation of myelinated nerve fibers in a cross-sectional optical microscopic image using a deep learning model," *Journal of Neurosci. Methods*, vol. 291, pp. 141-149, 2017.
[14] S. Onun, X. Chen, S. Lai, S. Hart, *et al.*, "Automatic vertebra segmentation on dynamic magnetic resonance imaging," *Journal of Medical Imaging*, vol. 4, no. 1, 2017.
[15] J. A. Parker, R. V. Kenyon, and D. E. Troxel, "Comparison of interpolating methods for image resampling," *IEEE Transactions on Medical Imaging*, vol. 2, no. 1, pp. 31-39, 1983.
[16] L. Ros, J. Mota, A. Guedea, and D. Bidgood, "Quantitative measurements of the spinal cord and canal byMR imaging and myelography," *European Radiology*, vol. 8, no. 6, pp. 966-970, 1998.
[17] M. Singla, M. S. Ansari, K. S. Rabvi, S. Khare, "Morphometric analysis of axis and its clinical significance-an anatomical study of indian human axis vertebrae," *Journal of Clinical and Diagnostic Research*, vol. 9, no. 5, pp. AC04-AC09, 2015.
[18] P. Viola and M. Jones, "Rapid object detection using a boosted cascade of simple features," in *Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, pp. I511-I518, Dec. 2001.
[19] A. Zaimi, M. Wabartha, V. Herman, *et al.*, "AxonDeepSeg: Automatic Axon and Myelin segmentation from microscopy data using convolutional neural networks," *Scientific Reports*, 2018: 3816, DOI:10.1038, s41598-018-22181-4.

Biography

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A Brief Survey on Text Summarization Techniques

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Abstract

Today there are a massive amount of document available over the internet so the process of getting the information fast and efficiently becomes difficult. This show up the significance of Automatic Text Summarization .text summarization is a process of compressed the text of a given document to provide useful information to users. Automatic document summarization is a wide research area related with different fields such as computer science, multimedia, statistics, beside cognitive Psychology. For human it is very difficult to manually summarize great amount of documents. In this paper, a brief Survey of Extractive and abstractive Text Summarization techniques are represented. The process of extractive summarization Techniques depends on selecting the valuable sentences, from the original document and combined them into shorter form. The abstractive summarization method depends on understanding the entire document and formulate it.

Keywords: Abstractive Summarization Technique; Automatic Document Summarization; Extractive Summarization Technique

1 Introduction

Automatic document summarization makes revolution in recent years and solve the problem of the information overload. Document summarization facilitates the process of searching and finding required document by providing summary of each document for user from a huge number of document .so that it plays and important and certain role in information retrieval (IR). The main goals of a summary are introducing the main ideas of document in less space. And reducing the time of reading. We must differentiate between document summarization and multi-document summarization. First document summarization is the task of creating a reduced text of useful and required information to user from original text automatically. While the summarization of multi documents is creating a summary which include plurality of information content about an explicit main topic or implicit one of a large set of documents. Researches about text summarization field started from 1950's until now. Here the Text is used in general, however it could refer to multimedia documents, speech, hypertext, etc. So many researchers provide different definitions to summary. One of these definition is "A summary can be loosely defined as a text that is produced from one or more texts that conveys important information in the original text(s), and that is no longer than half of the original text(s) and usually significantly

less than that". Despite all of researches in this area but there is no system that can generate accurate summaries than professionals or human's expert which called gold summary [25].

The main challenge in summarization is determining the informative sections .while information content in documents appears in A series of gunshots, some of these content are more informative and other are less informative .so differentiating between these informative sections and rest of document is very important because if all content are have the same importance this lead to less effective summary .classification of Automatic Text Summarization technique are abstractive and extractive summarization. Extractive approaches are utilized by many and most summarization systems which cut and stitch together segments of the text to create a strengthen and intensify version. While, abstractive summarization tries to produce a summary, which seems not included as part of the main document. The meaning of Abstractive summarization is Understanding of the basic concepts of document and then presenting a summary in new form based on this concept.

There are two groups of text summarization: first is Indicative summarization which represents only the basic concept of the text to the user. The ideal length of this type is 5 %to 10% of the original text. In contrast, the informative summarization systems give abstract information of original text. The ideal length of informative summary is 20% to 30 % of them original text [2]. The task of Summarization task categorized into generic or query-based. A query-based summary provides the information that match to given queries. This can be achieved by expansion of traditional information retrieval technologies. Depending on the user's query, searching in the documents that matches with the query that contain the sentences and the summary is created quickly the election of sentences based on their ranking, with respect to a query, on other hand a generic summary presents general meaning of content of the document as shown in Figure 1 [2].

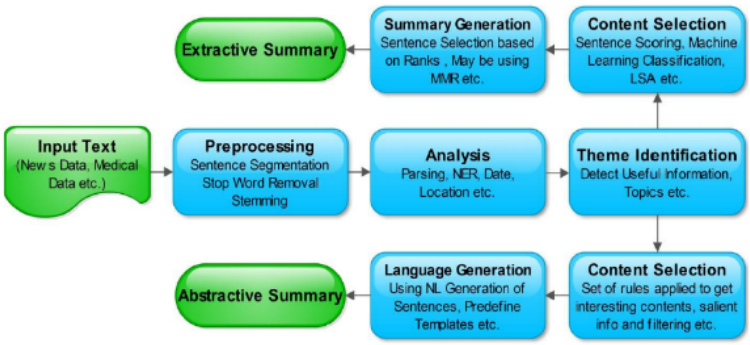

Figure 1: Generic Automatic Text Summarization Process

The techniques of summarization can be assorted into two kinds: the technique which depends on the pre-existing document- summary pairs called supervised techniques, while the unsupervised techniques, depend on characteristic and heuristics obtain from the document. The techniques of Supervised extractive summarization consider the job of summarization are two groups the positive one is the summary sentences while the non- summary sentence are the negative one. The rest of the paper is arranged as follows: In Section 2 the basic concept of extractive summarization method is presented; Section 3 describes basic concept of abstractive summarization method. Section 4 shows the related works of previous work on recent abstractive and the extractive summarization techniques; Finally, Section 6 represents Conclusion and future work Section, we provide an insight into the possible areas that can be explored in terms of summarization.

2 Related Work

In [25] proposed Automatic Text Summarization domain independent framework which can used in both abstractive and extractive methods. This framework has two Process, first clustering the original text and secondly it implements the respective optimal set of rules or method of that categories. In this framework classification process of document is implemented first, then summarization process is implemented based on the specific label or class. The Stemming process is applied using Porter's Stemming Algorithms. The main advantage of this framework is availability to be used for both extractive and abstractive text summarizations. In [26] a novel approach is proposed to build an abstractive summary using a rich semantic graph reducing technique for a single document.it apply the reduction heuristic rules on the rich semantic graph from the original text. It presents also, a simulated case study which prove that the original text was minimized to fifty percent.

In [11] a graph based technique is proposed to produce summaries of redundant opinions. It merges statements using the sentiment analysis. This result an abstractive summary which are well generated to confirm the text essence. The dataset used to be evaluated is DUC 2002 dataset18. There are 10 outperforms described by the dataset. Algorithms of abstractive summarization presented by [30, 36]. In [31] abstractive sentence summarization fully data-driven approach proposed. This approach Use a local attention-based model that put condition on original text to generate each word of the summary. Despite simplicity of structure of model, it can be trained easily and scales to a large volume of training data. The model evaluates its result on the DUC-2004 shared task. In [28] an abstractive text summarization model proposed using Attentional Encoder- Decoder Recurrent Neural Networks, this model notify summarization problems that are not modeled by the basic architecture, for example forming key-words, collect structure of sentence-to-word, and revival words that are rarely seen at training time. This proposed model depends on multi-sentence dataset. In [10] a proposed summarization model using the latent semantic analysis was built. This model use LSA to collect those semantic contents in sentences using sentence extraction method to generate perfect summary. This model shows how to upgrade the quality of summary using latent semantic analysis and sentence feature extracted by fuzzy logic system. In [2] propose continue sentence -clustering Based extractive summarization model of the generic document which is based on clustering of sentence. It presents, summarization result depends on both optimized function, and a similarity measure. This results use benchmark datasets from DUC01 and DUC02. The proposed model ensures improving of the performance when compared to state-of-the-art summarization approaches.

In [20] proposed text summarization approach Using fuzzy logic and word-net, this model retrieve the relevant sentences using fuzzy from an original document to find the worthiest sentences. The results of this approach ensure that extracted sentences more relevant when compared to other text summarizers approaches. In [36]. Proposed an approach based on machine learning techniques. While the text summarization is considering a supervised classification learning problem .so it uses of Genetic Algorithm (GA) to improve performance of classification to solve problem of automatic text summarization task. Dataset are document base crated by news retrieved from benchmark of The Wall Street Journal of the TIPSTER. In [14] proposed co-ranking approach for word-sentence called corank, it merge the relationship between word-sentence and the unsupervised graph-based ranking model, a preventable redundancy technique is used as completed step to corank, this help improve efficiency of text summarization. Dataset contain about 600 documents which ensure efficiency proposed model.

In [34] presents hybrid model for automatic summarization for summarizing articles. This model combines neural network and rhetorical structure theory (RST). It used back propagation technique in step of training network to learn the sentence's relevant characteristics. After training neural network, the feature fusion and pruning step is implemented to determine the relevant characteristics of sentences which must appear in summary to provide meaningful summary.

3 Basic Concept of Extractive Summarization Method

Text summarization Extractive method [27] could be, categorized, into two phases [15]: First phase is Pre Processing which is the primary exemplification of the main document. It commonly comprises:

1) Sentences boundary identification. That specified with existence of dot at the sentence ending.
2) Stop-Word Elimination Common words that doesn't has semantics that do not gather related information to the job take place often such as a, an, the etc.
3) Stemming means obtaining the origin of each term, which confirm its semantics.

Second phase is processing, features which impress the cognation of the sentences are settled, counted after that weight learning method is used to assign weights to the selected features and the Feature-weight equation used to determine ultimate score for each sentence. Sentences with Higher ranked are chosen for conclusive summary.

3.1 Extractive Summarization Problems

Although extraction summarization methods have set of problems but most researcher prefer:

1) Consuming space where some parts of unimportant segments included in the summary.
2) The Extractive summarize cannot hold significant information which is usually extend across sentences, except if the summarize is sufficient long to keep all these sentences.
3) The Conflicted information might not be presented precisely it may be spread across the whole text.
4) Clear extraction many times drive to issues in inclusive consistency of the summary Sentences that that oftentimes include pronouns when reproduced out of context miss out their referents.

Multi-document case takes the large space in These problems, when using different source for extraction. Post-processing extracts is basic process to addressing these issues, for example, substitute pronouns with their predecessor, Replacing close temporal term with actual dates, etc. To build good extractive summary we must know set of features which ought to be included in a sentence in eventual summary some of these features [15]:

1) Content word (Keyword) feature
2) Title word feature.
3) Sentence location feature.
4) Sentence Length feature.
5) Proper Noun feature.
6) Upper-case word feature.
7) Cue-Phrase Feature.
8) Biased Word Feature.
9) Font based feature.

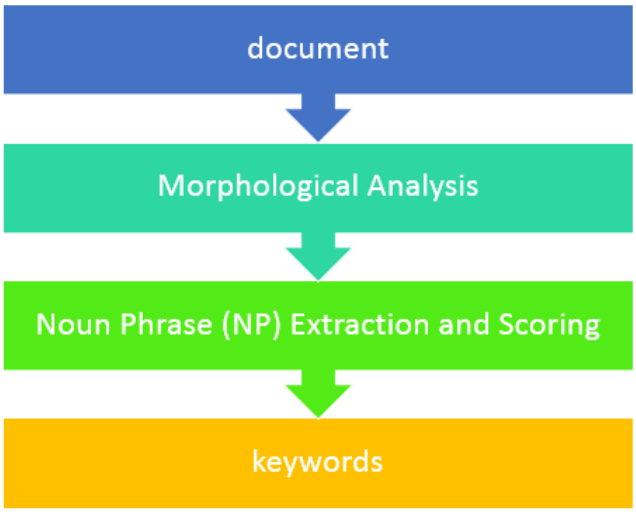

Figure 2: Keyword extraction methods

3.2 Extractive Summarization Methods

Extractive summarizers [13, 25, 32] aim at selecting the most important sentences in the document but Also preserving a low redundancy in the summary. Some of these methods are.

3.2.1 Term Frequency-Inverse Document Frequency (TF-IDF) Method

Model of large collection of words is constructed at the sentence level, with the regular pattern weighted term-frequency and inverse sentence frequency where the sentence frequency defined as number of sentences of the document which involve these terms refer to sentence-frequency. The vectors of sentence are compared with the query to be scored. The sentences with highest score are taken to be of the conclusive sentences for summary. The availability of adjustion of the summary to be generic as defined later, but usually it is query-specific The general method in order to produce a generic summary, words that symbolize the subject of the document, they generate generic summaries the non-stop-words are taken as query words that take place most frequently in the document(s) 0 or 1 is used as Term frequencies assigned to sentences—when the same term does not manifest more than once in a particular sentence. If users construct query words the manner they make for information retrieval, consequently the query based summary generation would become generic summarization.

3.2.2 Machine Learning Approach

For a Given set of extractive summaries and their training document, the process of summarization process explained as a classification problem: the classification of Sentences is based on the features that they own as sentences taken into summary and sentences not included in summary. By the training data, using Bayes' rule lead to learn the classification probabilities statistically as follows [30]:

$$P(s \in < S|F_1, F_2, \cdots, F_N) = P(F_1, F_2, \cdots, F_N|s \in S)^*$$
$$P(s \in S)/P(F_1, F_2, \cdots, F_N).$$

S refers to the document's collection's a sentence, $F_1, F_2, \cdots, F_N$ are classification features. S is the produced summary and $P(s \in < S|F_1, F_2, \cdots, F_N)$ is the probability that sentence s will be selected to generate the summary based on features $F_1, F_2, \cdots, F_N$.

3.2.3 Cluster Based Method

Usually document is written in a coordinated way where they classify various subjects one after one. Normally these document split up into segments either in explicit way or implicit one. This organized approach stratify also on summaries of documents. It is self-evident to believe that summaries ought to address several subjects seems in the documents.to produce a significative summary then document clustering is needed. if the set of documents for such a summary is being produced is of quite distinct themes, several summarizers combine such side through clustering. Term frequency inverse Document frequency (TF-IDF) applied to symbolize scores of words in Documents [2]. However, Term frequency is the average number of occurrences of document sentences over the cluster.

The IDF amount was calculated depend on the integral text. The summarizer accepts the input from the previously clustered documents. While every cluster is defined as a theme. The theme is shown by top ranking term frequency of words, with the scores of inverse document frequency (TF-IDF) in such cluster. Selection of Sentence depends on sentence's similarity of the subject of the cluster Ci. the location of the sentence in the document (L_i) is the other factor which should be consider when making sentence selection. In the context of newswire articles, the higher the sentence, the greater the weight to be included in the summary. Similarity to the first sentence in the document to which it belongs (F_i) Is The last factor that rises the score of a sentence The total score (S_i) of a sentence i is a weighted sum of the above three factors:

$$S_i = W_1 \times C_i + W_2 \times F_i + W_3 \times L_i.$$

Where S_i is the score of sentence C_i, F_i are the scores of the sentence i depend on the similarity to theme of cluster and first sentence of the document it belongs to, respectively. L_i is the score of the sentence based on its location in the document. W_1, W_2 and W_3 are the weights for linear combination of the three scores.

3.2.4 Text Summarization with Neural Networks

training the neural networks is a main task to find the different kinds of sentences which should be concerned in the final summary. This is done by training of neural network with sentences in various test paragraphs. each sentence is specified as it should be included in the summary or not. The human reader performs this task. Figure 3 shows the Neural Network [21] after Training.

Once the neural network has learned the features that would be concerned in the final summary, appear the necessity of detecting the drift and relevance within the features. This task is achieved by the feature fusion phase, that composed of two steps:

1) Removing unusual features; and

2) Breaking down the impact of common features and removing unusual features from the network [21] as shown in Figure 4.

The Neural Network after feature fusion is shown in Figure 5.

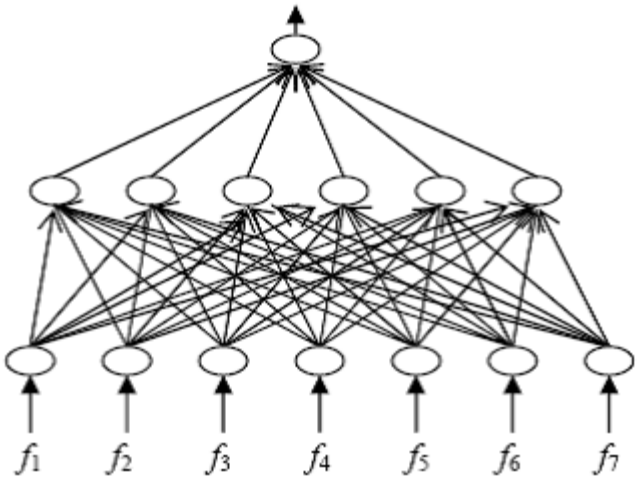

Figure 3: Neural Network after Training

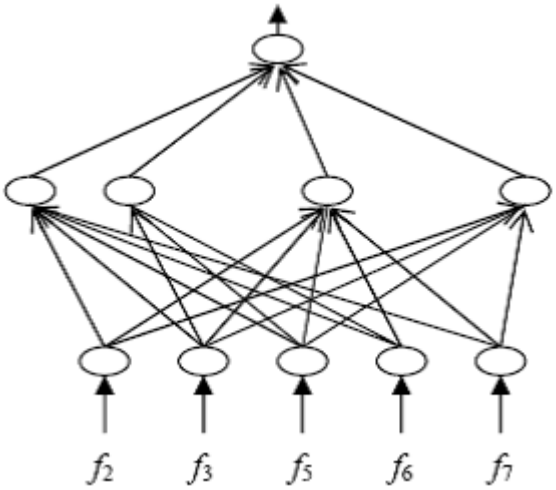

Figure 4: Removing Unusual Features From The Network

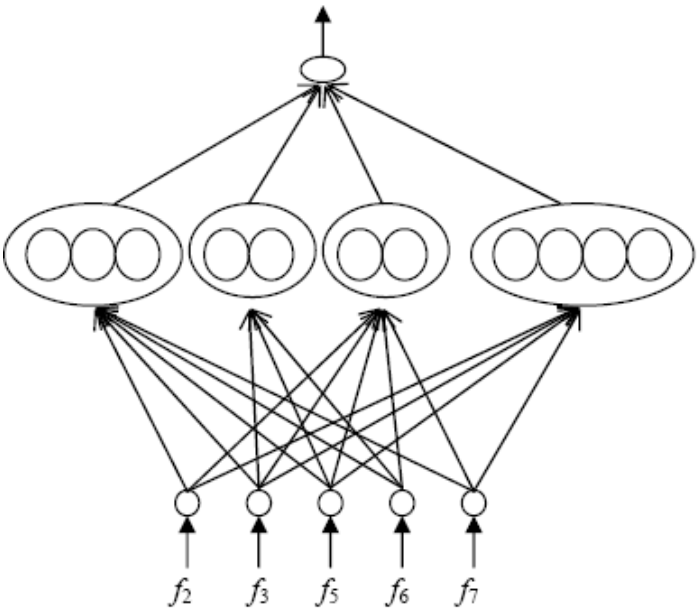

Figure 5: The Neural Network after feature fusion

3.2.5 Latent Semantic Analysis

This mechanism has emerged in the treatment of natural languages to analyze the relationships between the documents and the terminology contained in those documents by producing related concepts [10]. LSA assumes that terms which are adjacent in sense will take place in similar pieces of text A matrix containing word counts per paragraph (rows represent unique words and columns represent each paragraph) is structure from a great piece of text and a mathematical technique called singular value decomposition (SVD) is used to minimize the number of rows while maintaining the similarity structure among columns. Words are then compared by taking the cosine of the angle between the two vectors (or the dot product between the normalizations of the two vectors) formed by any two rows. Values that are closer to 1 represent very similar words while Values that are closer to 0 represent very dissimilar words. There are three main steps in LSA These steps are as follows:

1) Input Matrix Creation.

2) Singular Value Decomposition.

3) Sentence Selection.

3.2.6 Automatic Text Summarization Based on Fuzzy Logic

This mechanism depends on the input of fuzzy system the text properties such as length of sentence, little similarity, similarity with the keyword and so on. Then, all the principles required for summarization is entered in the knowledge base of system, For each sentences in the output takes the values from zero to one based on the sentences characteristics and the obtainable rules in the knowledge base. The stage of the magnitude of the sentence in the ultimate summary determined by The acquired value in the

output. for each feature The input membership function is divided into three membership functions which are composed of unimportant values low (L), very low (VL), medium (M), important values High (h) and very high (VH). The fundamental sentences are extracted According to the feature criteria using IF-THEN rules. Text summarization based on fuzzy logic system architecture is shown in Figure 6. The design of Fuzzy logic system usually includes selecting fuzzy rules membership function. This selection directly impacts the performance of the fuzzy logic system that composed of four components:

1) Fuzzifier;

2) Inference Engine;

3) Defuzzifier;

4) Fuzzy Knowledge Base.

Firstly, In the fuzzifier, membership function is used to translate the crisp inputs into linguistic values After fuzzification, the inference engine refers to the rule base containing fuzzy IF THEN rules to derive the linguistic values. In the last step, defuzzifier converts the output linguistic variables into the final crisp values using membership function to represent the final sentence score.

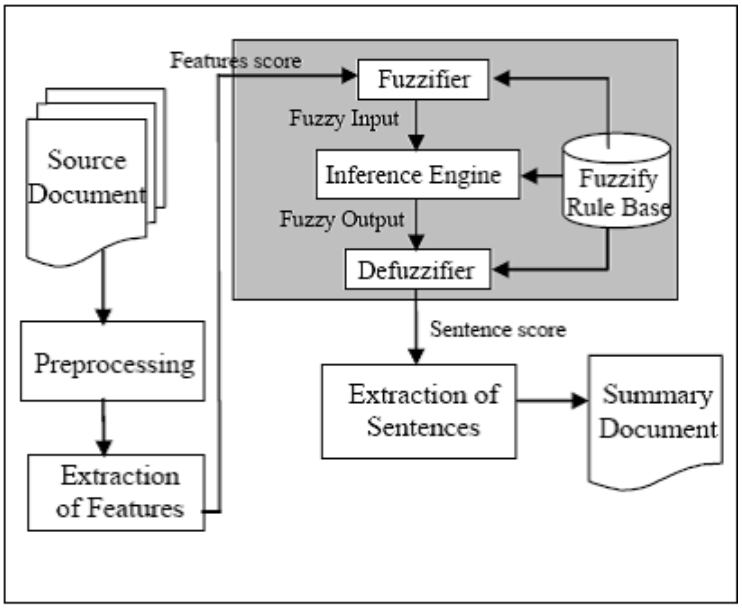

Figure 6: Text summarization based on fuzzy logic system architecture

3.2.7 Multi-document Extractive Summarization

The method of Multi document extractive summarization work with the extracted information around the same subject from various documents. The produced summary report permits users, also professional consumers of information, in order to fastly make it usual with information included in a massive cluster of documents. Multi-document summarization makes reports about information that are advantaging with both brief and inclusive. With varied views for each topic is described from different

opinion in an individual document. NEATS [27] is a multi-document summarization system which seek to extract related parts from a group of documents about different topics then present them in solid order. It is an extraction-based multi document summarization system. Given an input of a combination of sets of newspaper articles, NEATS produces summaries in three stages: content selection, filtering, and presentation.

3.2.8 Query Based Extractive Text Summarization

In This manner, for a given document scoring of the sentences rely on the frequency counts of terms. The sentences that contains the query phrases takes higher scores than the ones that contains single query words. Then, the sentences with highest scores are taken into the final summary with their structural context. Some Parts of text extracted from different sections or subsections. The produced summary consists of the association of that extracts. The number of sentences extracted and the extent to which their concept is presented count on the summary frame size of the output screen without scrolling. For the extraction algorithm, when a new sentence is selected for the summary implication, in that context the selection of some of the headings happens.

4 Basic Concept of Abstractive Summarization Method

An abstractive method depends on understanding the original text using linguistic method to clarify and elucidate the text. It needs a deeper analysis of the text understanding the whole text and retelling it in a fewer word. The main reason which makes the abstractive method more complex is it difficult for computers to combine and integrate important sentences and generate consistent and succinct summaries after selecting the most substantial sentence from the document.

The importance for a high quality summary becomes numerous demands especially for the summarization of a text document, or multimedia content Despite there has been a lot of work done in the field of extractive summarization and complexity of abstractive summarization but it has been demonstrated that abstractive summaries perform well than extractive summaries because the abstractive summaries are less size and provide more useful information and doesn't contain more word than necessary (Carenini et al.). Abstractive summaries are compact and present the useful information and are not long-wided. But, generating Abstract summary is a strong task than generation of extract summary. Besides that, it should be known that single document summarization is not same as multi document summaries, while single documents contain lesser data. So, a more efficient way is required to generate abstractive summaries in case of single documents. Abstractive Summarization Techniques are classified into two categories: Structured based approach and Semantic based approach.

4.1 Structured Based Approach

Structured Based Approach encodes the most important information from the document through cognitive schemas such as templates, extraction rules and other structures such as tree, ontology, lead and body phrase structure.

4.1.1 Tree Based Method

The Tree based method represent the contents of a document using a dependency tree. There are many Different algorithms are used for text selection for summary such as algorithm that uses local alignment across pair of parsed sentences or theme intersection algorithm. The technique uses either an algorithm or language generator for generation of summary. The weakness of this method is that it needs a complete model which should include an abstract representation for the content selection.

4.1.2 Template Based Method

This technique uses a template for representing the whole document. Extraction rules or Linguistic patterns are matched to identify the text scrap that will be mapped into the template slots. These text scrap are considered as the index of the contents of the summary. The templates are filled with important text scrap extracted by the Information Extraction systems. A considerable advantage of this approach is that the generated summary is highly cohesive because it depends on related information identified by IE system. This approach works only if the summary sentences are already present in the source documents. While It cannot handle the task if multi document summarization requires information about similarities and differences across multiple documents.

4.1.3 Ontology Based Method

Researchers have attempt to use ontology which is defined as the knowledge base to develop the process of summarization. Generality documents on the web are domain related because they discuss the same subject or event. For Each domain its own knowledge structure and that can be better represented by ontology. The main utility of this method is that it utilizes fuzzy ontology to handle uncertain data that simple domain ontology cannot. But the main defect that this approach is only limited to Chinese news only.

4.1.4 Lead and Body Phrase Method

This method depends on the operations of phrases such as insertion and substitution that have same syntactic head chunk in the lead and body sentences in order to rewrite the lead sentence. The power of this method is that it found semantically suitable revisions for revising a lead sentence. While the weaknesses of this method are Firstly, it focuses on rewriting techniques, and lacks a complete model which would include an abstract representation for content selection Secondly, parsing errors degrade sentential completeness such as repetition and grammaticality.

4.1.5 Rule Based Method

In this method, the candidate documents that will be summarized are represented in terms of categories and a list of aspects. Firstly, Content selection module selects the best candidate among the ones generated by information extraction rules to answer one or more aspects of a category. Finally, generation patterns are used for generation of summary sentences. The potential side of Rule based method is that it has a potential for creating summaries with greater information concentration than current state of art. The difficulty of this methodology is that all the rules and patterns are manually written, which is tedious task and time consuming.

4.2 Semantic Based Approach

In Semantic based method, semantic representation of Document is used to feed into natural language generation (NLG) system. This method focusses on identifying noun phrases and verb phrases by processing linguistic data.

4.2.1 Multimodal Semantic Model

In Multimodal semantic model, a semantic model, is built to represent the contents of multimodal documents that captures concepts and relationship among these concepts, the major concepts are evaluated based on some measures then the selected concepts are expressed as sentences to form the

final summary. The strength of this framework is that it produces abstract summary, whose coverage is excellent because it includes graphical content and distinguished textual from the whole document. The shortness of this framework is that it is manually evaluated by humans. An automatic evaluation of the framework is desirable.

4.2.2 Information Item Based Method

In this method, the summary contents are generated from abstract representation of source documents, rather than from sentences of source documents. The abstract representation is Information Item, which is the smallest element of coherent information in a text. The major strength of this approach is that it produces short, coherent, information rich and less redundant summary. This approach has several limitations. Firstly, linguistic quality of summaries is very low due to incorrect parses. Secondly, many important information items are rejected due to the difficulty of creating meaningful and grammatical sentences from them.

4.2.3 Semantic Graph Based Method

The Semantic Graph Based Method uses Rich Graph (RSG) that creates semantic graphs for the major document to summarize the documents and reducing the generated semantic graph. After that it generates the final abstractive summary from the reduced semantic graph. The Strength of this method is that it produces brief, consistent and less grammatically correct and redundant sentences. However, this method is limited to single document abstractive summarization.

5 Conclusion

This survey paper presents comprehensive overview of automatic text summarization methods and their techniques.it provide giant explanation of abstractive and extractive summarization methods as well as their recent and novel approaches used to improve summary of one document or multi-document. The basic goal of text summarization is to provide best and more meaningful summary for a specific user either the original text is structured, semi structured or unstructured. The software used for text summarization must produce meaningful summary with less redundancy and time. Summaries must be evaluated using one of both measures. Firstly, intrinsic method measures quality of summary by human experience. Secondly extrinsic method measure based on a set performance measure [3].

References

[1] R. M. Alguliev, R. M. Aliguliyev, and N. R. Isazade, "Multiple documents summarization based on evolutionary optimization algorithm," *Expert Systems with Applications*, vol. 5, pp. 1675-1689, 2013.

[2] R. M. Aliguliyev, "A new sentence similarity measure and sentence based extractive technique for automatic text summarization," *Expert Systems With Applications*, pp. 7764-7772, 2009.

[3] M. Allahyari and K. Kochut, "Automatic topic labeling using ontology-based topic models," in *IEEE 14th International Conference on Machine Learning and Applications*, pp. 259-264, 2015.

[4] M. Allahyari and K. Kochut, "Discovering coherent topics with entity topic models," in *IEEE/WIC/ACM International Conference on Web Intelligence*, pp. 26-33, 2016.

[5] M. Allahyari and K. Kochut, "Semantic context-aware recommendation via topic models leveraging linked open data," in *International Conference on Web Information Systems Engineering*, pp. 263-277, 2016.

[6] M. Allahyari and K. Kochut, "Semantic tagging using topic models exploiting wikipedia category network," in *IEEE Tenth International Conference on Semantic Computing (ICSC'16)*, pp. 63-70, 2016.
[7] M. Allahyari, S. Pouriyehy, M. Assefiy, S. Safaeiy, E. D. Trippez, J. B. Gutierrezz, K. Kochuty, "Text summarization techniques: A brief survey," *International Journal of Advanced Computer Science and Applications*, vol. 8, pp. 397-405, 2017.
[8] M. Allahyari, S. Pouriyeh, M. Assefiy, S. Safaeiy, E. D. Trippez, J. B. Gutierrezz, and K. Kochuty, "A brief survey of text mining: Classification, clustering and extraction techniques," *ArXiv e-prints arXiv:1707.02919*, 2017.
[9] E. Baralis, L. Cagliero, S. Jabeen, A. Fiori, and S. Shah, "Multi-document summarization based on the Yago ontology," *Expert Systems With Applications*, vol. 17, pp. 6976-6984, 2013.
[10] S. A. Babar and P. D. Patil, "Improving performance of text summarization," in *International Conference on Information and Communication Technologies*, pp. 354-363, 2015.
[11] R. Bhargava, Y. Sharma and G. Sharma, "Abstractive text summarization using sentiment infusion," in *Twelfth International Multi-Conference on Information Processing*, pp. 404-411, 2016.
[12] S. Divya, P. C. Reghuraj, "Eigenvector based approach for sentence ranking in news summarization," *International Journal of Computational Linguistics and Natural Language Processing*, vol. 3, pp. 521-526, 2014.
[13] Sh. Elfayoumy, J. Thoppil, "A survey of unstructured text summarization techniques," *International Journal of Advanced Computer Science and Applications*, vol. 5, pp. 149-154, 2014.
[14] C. Fanga, D. Mua, Z. Denga, Z. Wub, "Word-sentence co-ranking for automatic extractive text summarization," *Expert Systems with Applications*, vol. 72, pp. 189-195, 2017.
[15] V. Gupta and G. S. Lehal, "A survey of text summarization extractive techniques," *Journal of Emerging Technologies in Web Intelligence*, vol. 2, pp. 258-268, 2010.
[16] V. Gupta, G. S. Lehal, "A survey of text mining techniques and applications," *Journal of Emerging Technologies in Web Intelligence*, vol. 1, pp. 60-76, 2009.
[17] B. Hachey, "Multi-document summarization using generic relation extraction," in *Proceedings of the ACL Conference on Empirical Methods in Natural Language Processing*, vol. 1, pp. 420-429, 2009.
[18] R. A. G. Herandez and Y. Ledeneva, "Word sequence models for single text summarization," in *2009 Second International Conferences on Advances in Computer-Human Interactions*, IEEE, pp. 44-48, 2009.
[19] F. Jin, M. Huang and X. Zhu, "A query specific opinion summarization system," in *Proceedings of 8th IEEE International Conference on Cognitive Informatics*, pp. 428-433, 2009.
[20] F. Kiyoumarsi, E. Eslami, A. Tajoddin, "Optimizing text summarization based on fuzzy logic," *Iranian Journal of Fuzzy Systems*, vol. 7, pp. 15-32, 2010.
[21] F. Kyoomarsi, H. Khosravi, E. Eslami and P. K. Dehkordy, "Optimizing text summarization based on fuzzy logic," in *Proceedings of Seventh IEEE/ACIS International Conference on Computer and Information Science*, IEEE, pp. 347-352, 2009.
[22] C. Y. Lin and E. Hovy, "From single to multidocument summarization: A prototype system and its evaluation," in *Proceedings of the ACL Conference*, pp. 457-464, 2002.
[23] A. F. Martins, *A Survey on Automatic Textsummarization*, Literature Survey for the Language and Statistics II Course at CMU, vol. 4, pp. 192-195, 2007.
[24] Y. K. Meenaa, D. Gopalanib, "Evolutionary algorithms for extractive automatic text summarization," in *International Conference on Intelligent Computing, Communication & Convergence*, pp. 244-249, 2015.
[25] Y. K. Meenaa, D. Gopalanib, "Domain independent framework for automatic text summarization," in *International Conference on Intelligent Computing, Communication & Convergence*, pp. 722-727, 2015.

[26] I. F. Moawad, M. Aref, "Semantic graph reduction approach for abstractive text summarization," in *Seventh International Conference on Computer Engineering & Systems*, pp. 132-138, 2012.
[27] N. K. Nagwani, Sh. Verma, "A frequent term and semantic similarity based single document text summarization algorithm," *International Journal of Computer Applications*, vol. 17, pp. 36-40, 2011.
[28] R. Nallapati, B. Zhou, C. D. Santos, B. Xiang, "Abstractive text summarization using sequence-to-sequence rnns and beyond," *arxiv: 1602.06023v5*, 2016.
[29] A. Nenkova, K. Mckeown, *A survey of text summarization techniques*, Chapter 3, C.C. Aggarwal and C.X. Zhai (eds.), Mining Text Data, pp 43-76, 2012.
[30] D. P. Pallavi, N. J. Kulkarni, "Text summarization using fuzzy logic," *International Journal of Innovative Research in Advanced Engineering*, vol. 1, pp. 42-45, 2014.
[31] A. M. Rush, S. Chopra and J. Weston, "A neural attention model for abstractive sentence summarization," *arxiv: 1509.00685v2*, 2015.
[32] H. Saggion and T. Poibeau, "Automatic text summarization: Past, present and future," in *Multi-source, Multilingual Information Extraction and Summarization*, Springer, pp. 3-21, 2013.
[33] C. S. Saranyamol, L. Sindhu, "A survey on automatic text summarization," *International Journal of Computer Science and Information Technologies*, vol. 5, pp. 7889-7893, 2014.
[34] A. T. Sarda, A. R. Kulkarni, "Text summarization using neural networks and rhetorical structure theory," *International Journal of Advanced Research in Computer and Communication Engineering*, vol. 4, pp. 49-52, 2015.
[35] Sh. Shimpikar, Sh. Govilkar, "A survey of text summarization techniques for indian regional languages," *International Journal of Computer Applications*, vol. 165, pp. 29-33, 2017.
[36] C. N. Silla Jr., G. L. Pappa, A. A. Freitas, C. A. A. Kaestner, "Automatic text summarization with genetic algorithm-based attribute selection," in *Ibero-American Conference on Artificial Intelligence (IBERAMIA'04)*, pp. 305-314, 2004.
[37] C. Sreejith, M. P. Sruthimol, P. C. Reghuraj, "Box item generation from news articles based paragraph ranking using vector space model," *International Journal of Scientific Research in Computer Science Applications and Management Studies*, vol. 3, 2014.
[38] L. Suanmali, N. Salim and M. S. Binwahlan, "Fuzzy logic based method for improving text summarization," *International Journal of Computer Science and Information Security*, vol. 2, 2009.

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Summing/Differencing Circuit Using EXCCCII for Sub-1GHz and Beyond Applications

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Abstract

This brief article presents a new circuit for summing and differencing of electronic signals by a single extra-X current controlled current conveyor (EXCCCII). The proposed circuit is verified by simulation results and offers sub-1GHz and beyond frequency applications. The proposed circuit advances the existing knowledge on the subject of analog circuit design.

Keywords: Analog Circuits; Current Conveyors; EXCCCII

1 Introduction

This brief article is on a commonly used electronic function in analog signal processing. Analog signals are continuously varying signals encountered in day to day real life situations. Most of the naturally occurring signals are analog in nature, which are converted to electrical/electronic equivalent, so that these can be processed and transmitted for design of any electronic gadget or communication equipment. Such signals vary continuously with time and assume an infinite number of possible values, be it the voltage or current. A commonly encountered function on such signals is summing and differencing of these electronic signals. This function is often needed in many communication and instrumentation applications. As far as possible signals are concerned, dc and ac are broadly classified types, out of which ac signals are of special interest. These signals may further be classified into several types, one of these being periodic and non-periodic signals, which are often of interest to scientific community. An excellent example of a periodic signal is sine (sinusoidal) wave, which is one of the standard test signals used by physicists and engineers. Although, most of the naturally occurring signals may be of different nature and often not periodic either.

However, need arises to obtain sum and difference of two signals for the design of an electronic / communication equipment. Summing and differencing of voltages may sound simple, by the reasoning of series connections, with appropriate polarity, in case of standard dc and ac sources. However, this is not the case when naturally occurring signals' electronic equivalents are to be processed. It requires extra hardware in form of circuits, which can produce sum and difference of two such signals, and amplify the signals as well for any practical usage. Thus, when the two signals to be processed are

also to be amplified with different gains, dedicated summing/difference amplifiers are employed for the purpose [3,4]. Recently, a new current mode building block is getting popular for circuit design, and it is called extra-X current conveyor or extra-X current controlled conveyor [5,6]. It is to be employed in this work.

Rest of the paper is organized in subsequent sections, with the following Section 2 elaborating the importance of summing/differencing operation in communication systems. Section 3 is devoted to the actual circuit proposal, followed by the brief Section 4 on bandwidth analysis. Section 5 presents some sample results for verification of the proposed idea. The paper conclusion is given in Section 6.

2 Summing/Differencing as an Inevitable Block

The importance of the topic to the electronics and communication systems is deliberated herein. The summing and differencing circuit is one of the standard basic blocks in the realization of various active filters and in the design of digital to analog converters. The differencing circuit with gain is often termed as instrumentation amplifier and forms another inevitable block for pre-processing of weak analog signals at front end. These circuits find numerous applications in communication systems as well.

The generation of quadrature phase shift keying (QPSK) and quadrature amplitude modulation (QAM) requires amplitude combinations, where summing/differencing circuits are employed. Orthogonal frequency division multiplexing (OFDM) with multiple carriers demand their usage. A double-quadrature downconverter receiver decomposes the received signal into two components, before applying quadrature down-conversion on each component, and adds/subtracts the results to obtain net quadrature IF outputs. Single sideband mixers also require summing/differencing blocks. Thus, the summing/differencing unit becomes an important basic building block in all these applications [7].

3 Circuit Description

In order to cater to the growing demands of high performance electronic and communication systems, with accurate processing of signals over a wide range of frequencies, standard building blocks have been developed, which enable processing of signals, when used appropriately with external network, comprising of passive components. Such standard building block was named as an Extra-X Current Controlled Current Conveyor, and referred to as EX-CCCII [5,6]. Like the various devices, namely transistors, opamps etc. have well defined properties, this block can also be treated as a simple device, exhibiting following characteristics:

$$\begin{aligned} V_{x_i} &= V_y + i_{x_i} R_{x_i}, \quad \text{where } i = 1, 2; \\ i_{z_1+} &= i_{x_1}; \\ i_{z_2\pm} &= \pm i_{x_2}; \\ i_y &= 0. \end{aligned}$$

It may be noted that this block allows any voltage applied at 'Y' to replicate at X_1 and X_2, whereas, any current inserted at X_1 is conveyed to Z_1, and the current inserted at X_2 is conveyed to Z_2, with appropriated polarity ($\pm$).

Furthermore, the 'Y' terminal does not sink any current, and is called a high impedance terminal, which is good only for voltage signal inputting, while, the X_1 and X_2 are good for current signal inputting. Interested readers may refer to [3–6], for further reading on the topic. On the other hand, current mode circuits have become quite popular for their advantages over voltage mode building

blocks [8–11]. However, the traditional voltage opamp. based applications do find most recent space in open literature [1].

The function of summing/differencing can be easily accomplished using EXCCCII. The new proposed circuit is given as Figure 1, with the output voltage as

$$V_o = -R_L(V_1/R_{x_1} \pm V_2/R_{x_2}).$$

It is clear from the expression that the circuit provides inverting summing/differencing of two signals This is attributed to the '-' sign associated with the expression, which implies a phase reversal or phase inversion at the output. The choice of Z_2 stage as " $\pm$ " results in summing/difference operation. It may be noted that R_{x_1} and R_{x_2} are the intrinsic (inherent, hence not visible!) X-terminal resistances and are controlled through the bias current Io, which is a dc current source controlling the value of intrinsic resistances. Such a control is referred to as electronic control, which allows a circuit parameter (here, R_{x_1} and R_{x_2}) to vary in response to the variation in 'Io'. Now, how can the gain with which the two signals are processed be controlled? The simple answer is to vary Io, which controls the invisible resistances (R_{x_1} and R_{x_2}). Therefore, the two signals can be easily added or subtracted with certain gain factor as well.

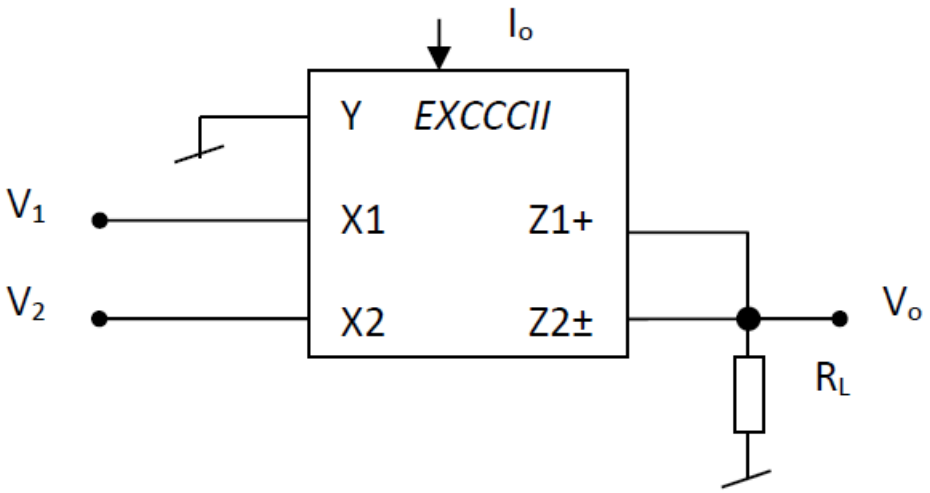

Figure 1: Electronically tunable summing/difference amplifier

4 Bandwidth Analysis

The proposed circuit is next analyzed for bandwidth, by considering the parasitics of EXCCCII. The Z-terminals exhibit high, yet finite resistances, modelled as R_{z_1} and R_{z_2}; low parasitic capacitances, modelled as C_{z_1} and C_{z_2} at Z_1 and Z_2 terminals respectively. The circuit analysis incorporating these parasitics result in the low frequency gain factor of "$-R'_L/R_x$", where, $R'_L = R_L//R_z$ and $R_z = R_{z_1}//R_{z_2}$. Moreover the bandwidth is found as $\omega_{-3dB} = 1/R'_L C_p$. Here, $C_p = C_{z_1} + C_{z_2}$, thus, the bandwidth depends strongly on the parasitic capacitances at Z terminals. Now, using the reported values of the parasitics of EXCCCII, the bandwidth is found for 1 KΩ load as 4 GHz. It may be noted

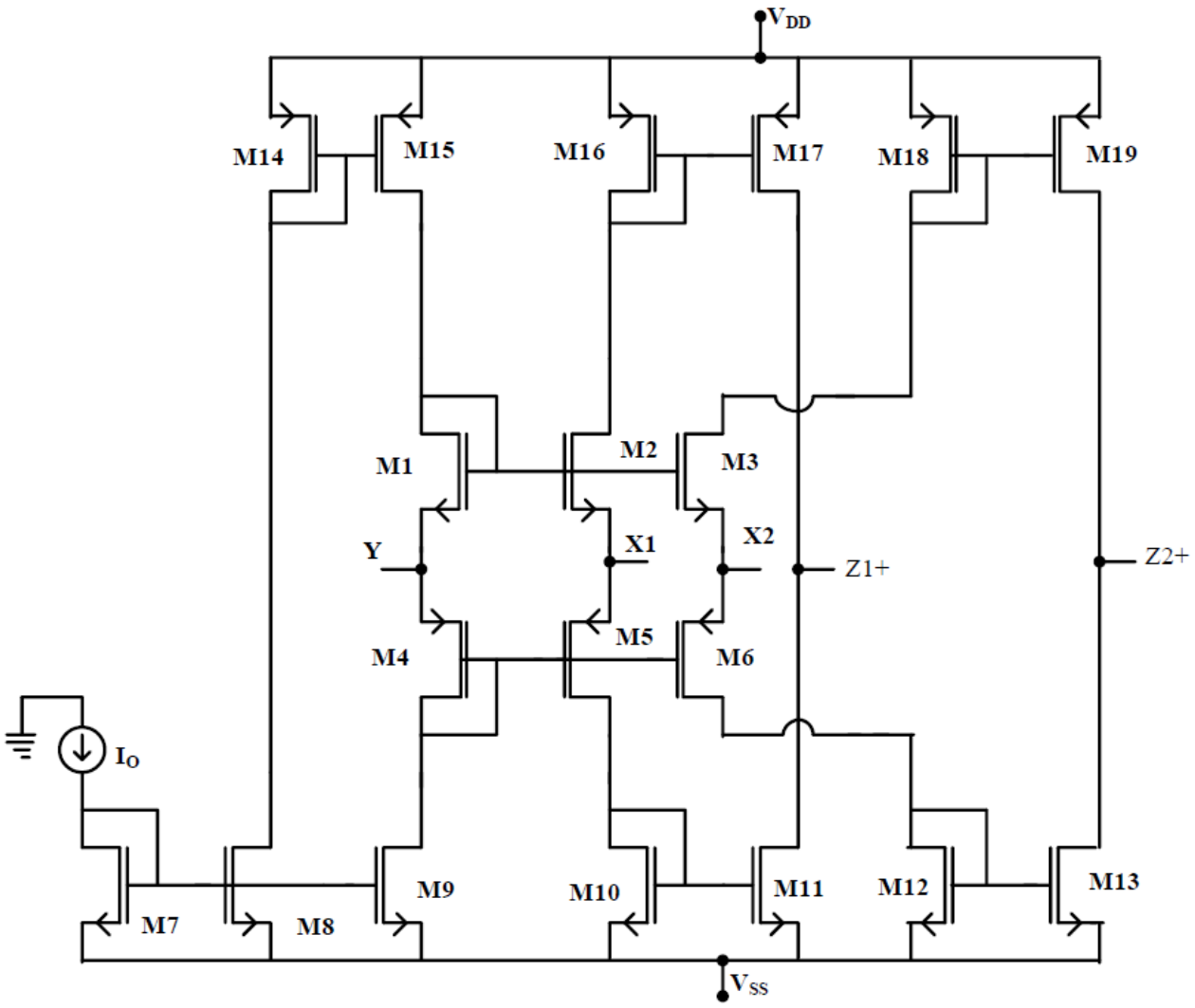

Figure 2: CMOS implementation of EX-CCCII [5]

that the C_z and R_z are 20 fF and 2 MΩ respectively [5]. These values would be justified through simulation studies that follow in the results section.

5 Verification Results

An example of the circuit performing the said operation is also given, where, two input sine waves v(1) and v(2) are such that v(2) used is phase inverted with respect to v(1). It may be noted that CMOS circuitry for EXCCCII as shown in Figure 2 is used for verification of results [5], although the circuit of Figure 2 shows only Z_2+ output stage. The EXCCCII is simulated using 0.25 μm CMOS parameters with supply voltage of ± 1.25 V [2,5,6].

The negative stage, namely Z_2- is implemented by employing cross-inverted current mirrors. The differencing output is obtained as v(3), which is phase inverted with respect to v(1), due to a '-' sign with the expression of output, as mentioned previously. The frequency of signals used is 100 MHz. This result is seen in Figure 3. Another result is further shown in Figure 4, for differencing operation, with v(1) and v(2) are at 100 MHz frequency and of same phase, and the output v(3) is the direct difference of the two inputs.

It is to be concluded that the new EXCCCII based circuit provides a simpler summing/differencing of signals for electronic and communication equipment. The bandwidth of the proposed circuit is found as 3.9 GHz, as evident from the magnitude response shown in Figure 5. The high frequency operation (sub-1 GHz and beyond) is also further verified by inputting 1 GHz signal for the differencing operation, which are shown in Figure 6. The output spectrum as shown in Figure 7 is found to show -40 dB suppression of harmonics, which proves the utility of the circuit for high frequencies as well.

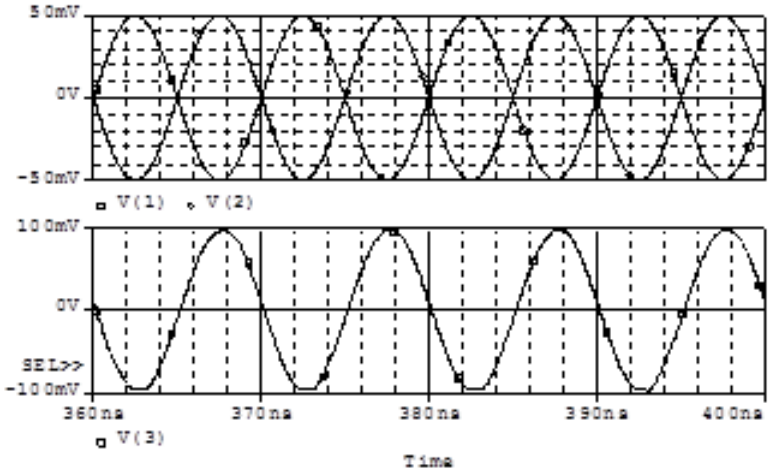

Figure 3: Differencing of two signals, where v(1) and v(2) are inputs, v(3) is output

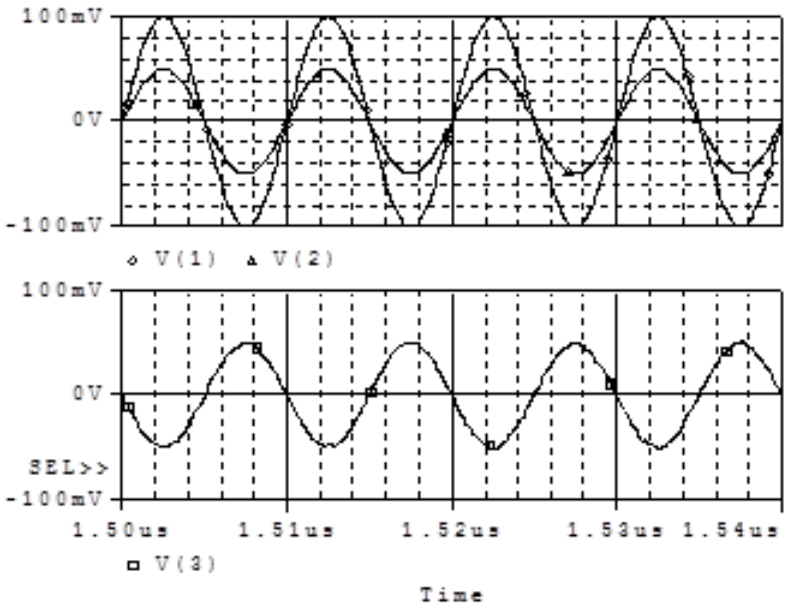

Figure 4: Another set of results showing differencing operation on signals

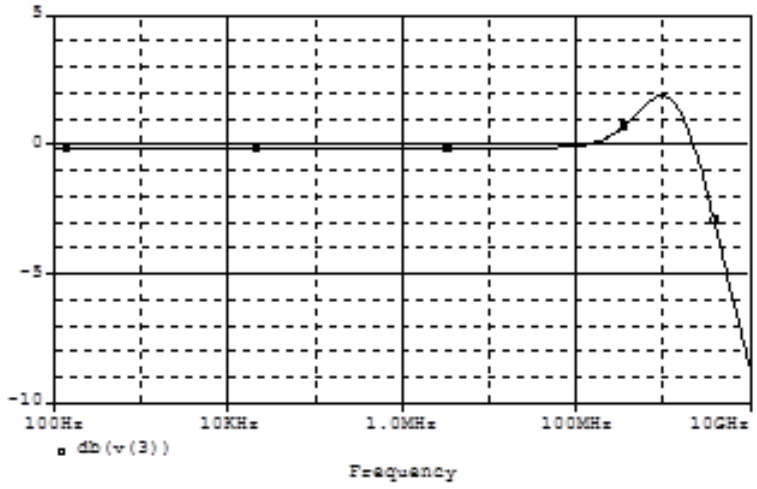

Figure 5: Magnitude response of proposed circuit with 3.9 GHz bandwidth at 100 μA bias current

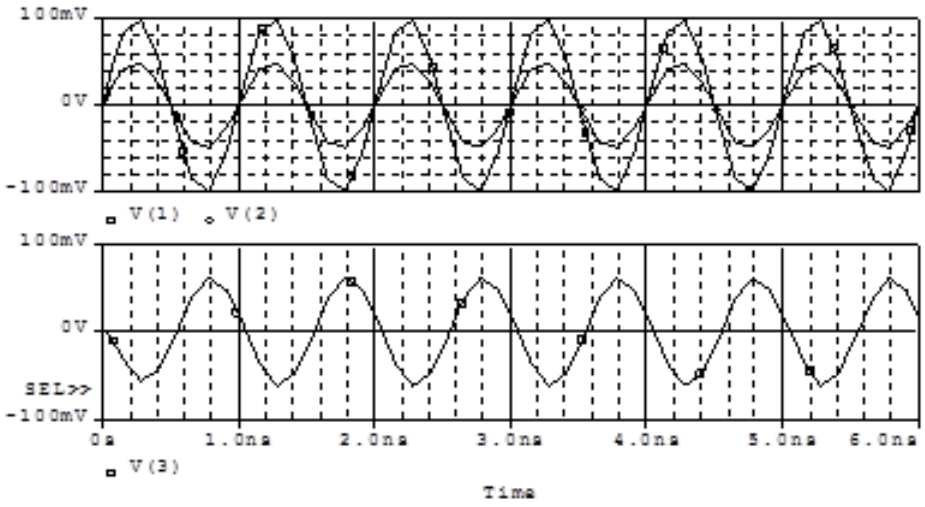

Figure 6: Another set of results inputs: V(1) and V(2); output: V(3) for differencing operation at 1 GHz

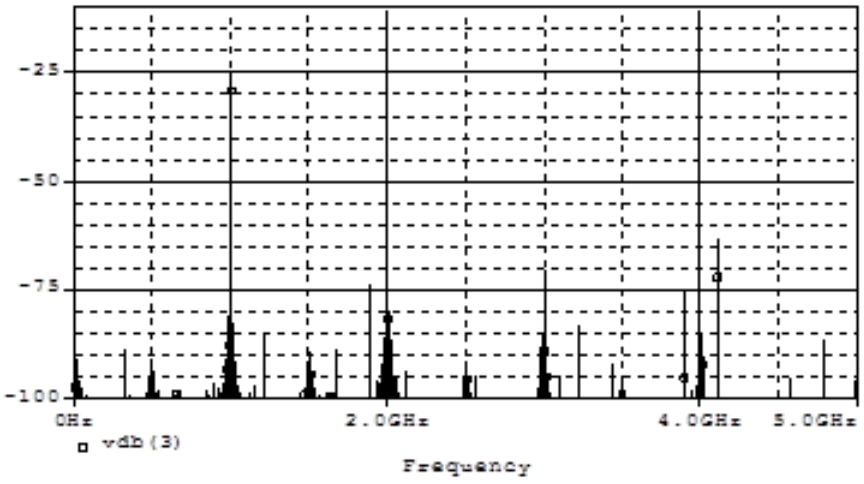

Figure 7: Output Spectrum for 1 GHz signals with -40 dB suppression of harmonics

6 Conclusion

Simple summing/differencing circuit employing an EXCCCII is presented, which finds useful application in communication and instrumentation systems. Some results are included to support the theory, and the proposed circuit is found useful for sub-1 GHz frequency applications as well. This brief article adds to the existing circuits and advance the knowledge on the design and application of EXCCCII based analog circuits.

References

[1] K. Maheshwari, "A New Sinusoidal Quadrature Oscillator for Electronics Engineering," *International Journal of Electronics and Information Engineering*, vol. 10, no. 1, pp. 45-50, Mar. 2019.
[2] S. Maheshwari, "Mode Conversion, Topology Preservation and Symmetry of Filter Circuit and New Tunable Circuit Example," *International Journal of Electronics and Information Engineering*, vol. 10, no. 1, pp. 1-7, Mar. 2019.
[3] S. Maheshwari, "Active-Only Current Controlled Summing/Difference Amplifiers Using CCCIIs," *Active and Passive Electronic Components*, vol. 26, no. 4, Jan. 2003.
[4] S. Maheshwari, "Additional Summing/Difference Amplifiers Using CCCIIs," *Journal of Active and Passive Devices*, vol. 1, no. 2, pp. 159-162, Dec. 2005.
[5] S. Maheshwari, D. Agrawal, "High Performance Voltage-Mode Tunable All-Pass Section," *Journal of Circuits, Systems and Computers*, vol. 24, no. 6, Mar. 2015.
[6] S. Maheshwari, "Analog circuit design using a single EXCCCII," *International Journal of Electronics and Information Engineering*, vol. 9, no. 2, pp. 61-69, Dec. 2018.
[7] B. Razavi, *RF Microelectronics*, Second Edition, Pearson, 2012.
[8] A. S. Sedra, K. C. Smith, "A second-generation current conveyor and its applications," *IEEE Transactions on Circuit Theory*, vol. 17, no. 1, pp. 132-134, 1970.
[9] C. Toumazou, F. J. Lidgey, D. G. Haigh, "Analogue IC Design: The current mode approach," *IEE Press*, 1993.
[10] T. Tsukutani, Y. Kunugasa, N. Yabuki, "CCII-Based Inverse Active Filters with Grounded Passive Components," *Journal of Electrical Engineering*, vol. 6, no. 4, pp. 212-215, July 2018.
[11] B. Wilson, "Recent developments in current conveyors and current-mode circuits," *IEE Proceedings - Circuits, Devices and Systems*, vol. 137, no. 2, pp. 63-77, Apr. 1990.

Biography

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A Note on One Protocol for Subset Sum Problem

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Abstract

In computer sciences the subset sum problem which is closely related to knapsack problem has many applications. Recently, Nederlof has presented a protocol [*Information Processing Letters*, 118 (2017), 15-16] for constructing a proof that the number of subsets summing to a particular integer equals a claimed quantity. In this note we show that the protocol is flawed because: 1) its consistence is not kept; 2) the proposed recurrence formula is incorrect.

Keywords: Dynamic Programming; Recurrence Formula; Subset Sum Problem

1 Introduction

In computer science the subset sum problem is that: given a set (or multiset) of integers, is there a non-empty subset whose sum is equal to a given integer? It is closely related to knapsack problem and has many applications. We refer to the latest publications [4,5,7,8,11–13] for the relevant discussions.

The subset sum problem is a classical NP-complete one [1]. In 1955, Gupta ever proved that [6].

Theorem 1. *Let $P(A,t)$ denote the number of partitions of t into members of the set $A = \{a_0, a_1, a_2, \cdots, a_n\}$ (a_i distinct positive integers), $a_0 = 1$. Then*

$$\binom{t+n}{n} \le P(A,t) \prod_{j=1}^{n} a_j \le \binom{t+\sum_{j=1}^{n} a_j}{n}.$$

In 1956, Bateman and Erdős proved that [3].

Theorem 2. *If A is any non-empty set of positive integers, then the number of partitions of n into members of the set A, $P(A,n)$, is a non-decreasing function of n for large n, if and only if A either:*

1) Contains the element 1 or

2) A contains more than one element and, if we remove any single element from A, the remaining elements have greatest common divisor 1.

In complexity theory, a proof system for subset sum is referred to as a Merlin-Arthur protocol. Babai and Moran [2] ever discussed the Arthur-Merlin games and a hierarchy of complexity classes. In 2016, Williams [14] pointed out the relation between strong ETH and Merlin-Arthur proof system. Austrin *et al.* [1] stressed that a special case of subset sum may be the hardest. In 2017, Nederlof [10] proposed a Merlin-Arthur protocol for subset sum. In this note, we show that the Nederlof's protocol is flawed.

2 Review of Nederlof's Protocol

The subset sum problem discussed by Nederlof [10] is that: given positive integers $w_1, \cdots, w_n$ along with a target integer t, the task is to determine whether there exists a subset $X \subset \{1, \ldots, n\}$ such that

$$w(X) := \sum_{i \in X} w_i = t. \tag{1}$$

Such an X is referred to as a solution. The Nederlof's system (Algorithm 1) aims to construct a proof that the number of solutions of $(w_1, \cdots, w_n; t)$ is c_t. To do so, the prover and the verifier execute the following algorithms, respectively.

Algorithm 1: Nederlof's proof system for subset sum

Algorithm P$(w_1, \cdots, w_n; t)$. Prove that the number of solutions is c_t.
Output: Prime $p = \Theta(\sqrt{nt}), c_i : |\{X \subset [n] : w(X) = i\}|$ for $i \leq nt : i \equiv_p t$.

1: Initiate $T[0,0] = 1$ and $T[0,i] = 0$ for $0 < i \leq nt$.
2: **for** $j = 1 \to n$ **do**
3: **for** $i = 1 \to nt$ **do**
4: **if** $i < w_j$ **then**
5: $T[j,i] \leftarrow T[j-1,i]$
6: **else**
7: $T[j,i] \leftarrow T[j-1,i] + T[j-1, i-w_j]$
8: Pick the smallest prime p such that $2\sqrt{nt} < p < 4\sqrt{nt}$.
9: **for** $i \leq nt$ such that $i \equiv_p t$ **do**
10: $c_i \leftarrow T[n,i]$.
11: **return** $(p, \{c_i\})$.

Algorithm V$(w_1, \cdots, w_n; t; p, \{c_i\})$. Verify the proof for number of solutions.
Output: c_t, if the proof is as output by P, NO with 1/2 probability otherwise.

12: Pick a prime q satisfying $2^n t < q < 2^{n+1}t$ and a random $r \in \mathbb{Z}_q$.
13: Initiate $T'[0,0] = 1$ and $T'[0,i] = 0$ for $0 < i < p$.
14: **for** $j = 1 \to n$ **do**
15: **for** $i = 1 \to p$ **do**
16: $T'[j,i] \leftarrow (T'[j-1,i] + r^{w_j} \cdot T'[j-1, (i-w_j) \,\%\, p]) \,\%\, q$.
($x \% p$ denotes the remainder of x divided by p)
17: Compute $\sum_i c_i r^i \% q$.
18: **if** $\sum_i c_i r^i \equiv_q T'[n, t \,\%\, p]$ **then return** c_t **else return** NO.

---

3 Analysis

3.1 Inconsistency

The correctness of Nederlof's protocol was not explained explicitly. For example, the choice of the prime p and the correctness of the recurrence formula

$$T'[j,i] = (T'[j-1,i] + r^{w_j} \cdot T'[j-1,(i-w_j)\,\%\,p])\,\%\,q.$$

are not explained. Besides, *the initial values* $T[1,0], T[2,0], \cdots, T'[1,0], T'[2,0], \cdots$, *are not specified at all*. We also find its consistency is not kept. To see this flaw, it suffices to investigate the following example.

Example 1. *Suppose that* $w_1 = 1, w_2 = 2, w_3 = 3, w_4 = 4; t = 17$. *Then* $n = 4, nt = 68, c_{17} = 0, 2\sqrt{nt} = 2\sqrt{68} \approx 16.492$ *and* $p = 17$. *By Nederlof's protocol, we have*

$$T[j,i] = \begin{cases} T[j-1,i], & i < w_j \\ T[j-1,i] + T[j-1,i-w_j], & i \geq w_j \end{cases} \quad (2)$$

for $i = 1, \cdots, 68; j = 1,2,3,4$. *Hence,*

$$\begin{aligned} T[0,0] &= 1; \\ T[1,1] &= T[0,1] + T[0,0] = 1; \\ T[2,2] &= T[1,2] + T[1,0] = T[0,2] + T[0,1] + T[1,0] = T[1,0], \cdots \\ c_{17} &= T[4,17] = T[3,17] + T[3,13] = \cdots = 0; \\ c_{34} &= c_{51} = c_{68} = 0. \end{aligned}$$

The prover's output is $p = 17, c_{17} = 0, c_{34} = 0, c_{51} = 0, c_{68} = 0$. *Suppose that the verifier picks* $q = 277, r = 7$. *Then* $\sum_i c_i r^i = 0$.

By the recurrence formula

$$T'[j,i] = (T'[j-1,i] + r^{w_j} \cdot T'[j-1,(i-w_j)\,\%\,p])\,\%\,q \quad (3).$$

We have

$$\begin{aligned} T'[n,t\,\%\,p]\,\%\,277 &= T'[4,17\%17]\,\%\,277 \\ &= T'[4,0]\,\%\,277 \\ &= (T'[3,0] + 7^4 T'[3,(0-4)\,\%\,17])\,\%\,331 \\ &= (T'[3,0] + 7^4 T'[3,13])\,\%\,277 \\ &= (T'[2,0] + 7^3 T'[2,14] + 7^4 T'[2,13] + 7^7 T'[2,10])\,\%\,277 \\ &= \cdots \\ &= T'[0,0]\,\%\,277. \end{aligned}$$

To ensure $\sum_i c_i r^i \equiv_q T'[n,t\,\%\,p]$, *it has to specify* $T'[0,0] = 0$. *This leads to a contradiction which means its consistency is not kept.*

3.2 The Correct Recurrence Formula

Suppose that $A = \{w_1, w_2, \cdots, w_n\}$, and all members are positive integers. Let

$$A_j = \{w_1, w_2, \cdots, w_j\}, \;\; 1 \leq j \leq n.$$

Denote the number of partitions of i into members of the set A_j by $T[A_j, i]$. Then the following recurrence formula

$$T[A_j, i] = \begin{cases} T[A_{j-1}, i], & i < w_j \\ T[A_{j-1}, i] + T[A_{j-1}, i - w_j], & i \geq w_j \end{cases} \tag{4}$$

holds, where $T[A_{j-1}, i]$ is the number of solutions which do not contain the element w_j and $T[A_{j-1}, i - w_j]$ is the number of solutions which contain w_j. Apparently, Ref. [10] confused Equation (2) with Equation (4).

4 Further Discussions

By the correct recurrence formula Equation (4), we have the following case:

$$\begin{aligned} T[A_n, t] &\xrightarrow{t>w_n} T[A_{n-1}, t] + T[A_{n-1}, t - w_n] \\ &\xrightarrow{t-w_n>w_{n-1}} T[A_{n-2}, t] + T[A_{n-2}, t - w_{n-1}] \\ &\quad + T[A_{n-2}, t - w_n] + T[A_{n-2}, t - w_n - w_{n-1}] \\ &\xrightarrow{t-w_n-w_{n-1}>w_{n-2}} T[A_{n-3}, t] + T[A_{n-3}, t - w_{n-2}] \\ &\quad + T[A_{n-3}, t - w_{n-1}] + T[A_{n-3}, t - w_{n-1} - w_{n-2}] \\ &\quad + T[A_{n-3}, t - w_n] + T[A_{n-3}, t - w_n - w_{n-2}] \\ &\quad + T[A_{n-3}, t - w_n - w_{n-1}] + T[A_{n-3}, t - w_n - w_{n-1} - w_{n-2}] \\ &\longrightarrow \cdots . \end{aligned}$$

In the worst case, it has to perform $2^n - 1$ additions with the complexity $O(2^n)$, which equals to that of the general exhaust search method [9]. We would like to stress that this recurrence method can only compute the number of solutions instead of generating all concrete solutions.

5 Conclusion

We analyze the Nederlof's protocol for constructing a proof that the number of subsets summing to an integer is a claimed quantity. We also remark that it is somewhat difficult to theoretically compute the number of partitions of an positive integer into members of a finite set if its cardinal is large enough.

Acknowledgements

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References

[1] P. Austrin and *et al.*, "Dense sub-set sum may be the hardest," in *Proceedings of 33rd Symposium on Theoretical Aspects of Computer Science (STACS 2016)*, pp. 13:1–13:14, Orleans, France, Feb. 2016.

[2] L. Babai and S. Moran, "Arthur-merlin games: a randomized proof system, and a hierarchy of complexity classes," *J. Comput. Syst. Sci.*, vol. 36, no. 2, pp. 254–276, 1988.

[3] P. Bateman and P. Erdős, "Monotonicity of partition functions," *Mathematika*, no. 3, pp. 1–14, 1956.

[4] V. V. Curtis and C. A. A. Sanches, "A low-space algorithm for the subset-sum problem on gpu," *Computers and Operations Research*, vol. 83, pp. 120–124, 2017.
[5] L. Gourves, J. Monnot, and L. Tlilane, "Subset sum problems with digraph constraints," *Journal of Combinatorial Optimization*, vol. 36, no. 3, pp. 937–964, 2018.
[6] H. Gupta, "Partitions in general," *Research Bull. Panjab Univ.*, no. 67, pp. 31–38, 1955.
[7] R. M. Kolpakov, M. Posypkin, and S. T. T. Sin, "Complexity of solving the subset sum problem with the branch-and-bound method with domination and cardinality filtering," *Automation and Remote Control*, vol. 78, no. 3, pp. 463–474, 2017.
[8] M. S. Lee, "Sparse subset sum problem from gentry-halevi's fully homomorphic encryption," *IET Information Security*, vol. 11, no. 1, pp. 34–37, 2017.
[9] L. H. Liu, L. L. Wang, Z. J. Cao, and X. Q. Wang, "Algorithms for subset sum problem," *International Journal of Electronics and Information Engineering*, vol. 9, no. 2, pp. 106–114, 2018.
[10] J. Nederlof, "A short note on merlin-arthur protocols for subset sum," *Information Processing Letters*, no. 118, pp. 15–16, 2017.
[11] A. Nikolaev and A. Ushakov, "Subset sum problem in polycyclic groups," *Journal of Symbolic Computation*, vol. 84, pp. 84–94, 2018.
[12] U. Pferschy, G. Nicosia, and A. Pacifici, "On a stackelberg subset sum game," *Electronic Notes in Discrete Mathematics*, vol. 69, pp. 133–140, 2018.
[13] W. Q. Wang and J. Nguyen, "The k-subset sum problem over finite fields," *Finite Fields and Their Applications*, vol. 51, pp. 204–217, 2018.
[14] R. Williams, "Strong eth breaks with merlin and arthur: short non-interactive proofs of batch evaluation," in *Proceedings of 31st Conference on Computational Complexity (CCC 2016)*, pp. 2:1–2:17, Tokyo, Japan, May 2016.

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A Novel Protocol for Vehicle Cluster Formation and Vehicle Head Selection in Vehicular Ad-hoc Networks

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Abstract

Vehicular Ad-hoc Network (VANET) is a special kind of mobile ad-hoc network where network nodes are represented by actual moving vehicles. Due to the mobility of vehicles, VANET is a highly dynamic structure that requires the type of sophisticated control that can be provided by an efficient clustering algorithm. The clustering solution provides the degree of performance necessary to handle the message flooding in the network, hence decreases the protocol overhead happening within the network. The controlling instance in the cluster is known as a vehicle head. The vehicle head handles the messaging communication between both individual vehicles and the clusters themselves. The selection of an optimal vehicle head within a cluster is an open issue. In this work we proposed a novel approach of vehicle cluster formation and vehicle head selection in VANET. Our protocol design centers around the application of K-means and Floyd-Warshall algorithms, to form vehicle clusters and then select the vehicle head based on the optimum route to the nearest vehicle. The optimum vehicle head is that vehicle which occupies a central position nearest to the rest of the vehicles in a cluster. The K-means algorithm is applied to divide vehicles into three different clusters considering uniform speed of the vehicles. The task of Floyd-Warshall algorithm is to actually compute that which vehicle occupies the centralized position thereby selecting the cluster's vehicle head. The designed protocol cluster stability comparison with the existing protocols shows that it produces significant improvements over other approaches. Moreover, the practical implementation and evaluation shows that our centralize cluster based routing protocol is highly adapted to a congested environment. The protocol is programmed in C language and simulated in Code-Blocks integrated development environment (IDE).

Keywords: Cluster Based Routing; Floyd–Warshall Algorithm; K-Means Algorithm; Mobile Ad-hoc Networks; Vehicle Ad-hoc Networks

1 Introduction

Vehicular ad-hoc Network (VANET) is a distinct kind of Mobile Ad-hoc Network where intelligent vehicles are used in place of mobile nodes. Vehicles are highly mobile in VANET due to which rapid changes occur in the topology of network. This highly dynamic nature of VANETs brings many issues for the stability of the network. VANET has some special characteristics that distinguish it from other mobile ad hoc networks; the most important characteristics that differentiate VANETs from MANETs are: high mobility, self-organization, distributed communication, road pattern restrictions, and no restrictions of network size. All these characteristics made VANETs environment a very challenging task for developing efficient routing protocols [4].

The VANET is an assortment of vehicular nodes that act as mobile hosts establish a transient network without the assistance of any centralized administration or any established infrastructure. Therefore, it is called autonomous & self-configured network [10]. In VANET, two vehicles remain under direct range of communication on an average of about one minute. Vehicles have limited communication ranges. The reason behind excessive concentration of researchers on VANET's is that, this area has a lot of fruitful applications [2]. These applications are related to safety management, traffic management and internet usage etc. There are different modes of communication in VANET's as shown in Figure 1.

There are different modes of vehicular ad-hoc networks. It consists of Inter-Vehicle Communication System (IVC), Vehicle to Roadside Unit Communication and Hybrid Communication System. In case of inter-vehicle communication, the communication take place between vehicles in the network while in case of vehicle to roadside unit communication, the communication take place between vehicles to the roadside units

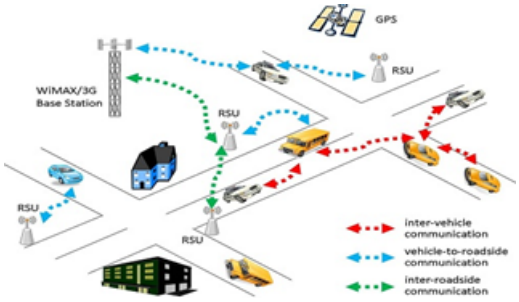

Figure 1: Modes of VANET communication system

In third case the different roadside units can also communicate with each other for some necessary actions. The IVC mode is the most important part of vehicle ad-hoc networks and our proposed protocol is designed for IVC network. In VANET, the tracking of vehicles can be done, based on the transmission of vehicles during the communication between each other and with roadside units. In VANET every vehicle acts as router or mobile node which allows vehicles approximately 100 to 300 meters (depends on the signal strength) distance of each other to connect and form a network. Figure 2 shows a sample of vehicular ad-hoc network.

When vehicles fall out of the signal range and network, new cars join the same network so that mobile Internet can be formed. It is projected that the first system that will integrate and benefit from this technology are the safety system e.g. police and fire vehicles to communicate with each other. Mainly there are two types of communication in VANETs. First the communication is done between the vehicles which are purely ad-hoc and there is no stable infrastructure required. Secondly the communication takes place between the road side infrastructure and movable vehicles [7]. The roadside units are the

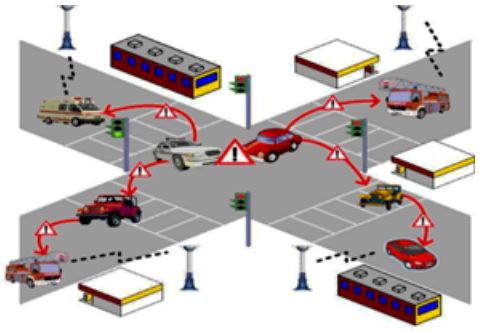

Figure 2: An example of a vehicular ad-hoc networks

established infrastructure. In VANETS, there are two types of units in each node. One is onboard unit (OBU) and the other is application unit (AU). The onboard unit has the capability of communication while the application unit is responsible for the execution of instructions. To avail Internet services a roadside unit can also be connected further to the wired network. Figure 3 depicts the above mentioned concept.

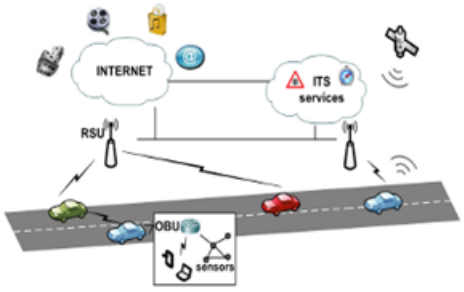

Figure 3: An example of onboard unit and application unit

2 Background Research

In VANET, high mobility of vehicles leads to the constant break down of links, but using the clustering this can be fixed easily. Dividing the network into clusters can help to achieve the efficient transmission of data packets as data transmission becomes limited within the clusters. Data to other clusters can be sent via CH and GN nodes that increases the scalability of the network. Every method discussed in this paper, researchers have tried to improve the cluster based technique for better efficiency using different approaches. Clustering in vehicular ad-hoc network denotes to the virtual partition of highway vehicles into groups. A special node selected on specific standards responsible for routing inside the cluster and outside as well. The clustering algorithm has been implemented distributed over all nodes of the vehicular ad-hoc network. The formation of clusters depends upon the dynamic and mobile nature of vehicles. The highly mobile vehicles are grouped into one cluster while low mobile vehicles are collected in other cluster.

Furthermore, the vehicle heads are selected by using multi metric approach. Cluster based location routing (CBLR) works on the transfer of HELLO messages between vehicles. If there is any vehicle that joins a network, these messages will be broadcast to other vehicles in the cluster and it will wait for a defined time. If the entering vehicle receives any reply in the specified time then it will become a member of the said cluster. If it does not receive any response from the other vehicles in the cluster then it will broadcast itself as a vehicle head of the cluster. The management of mobile nature of vehicles in VANET is done by keeping a table which consists of the neighbor list. The vehicle can communicate directly to its neighbors by using this neighboring table. There is another famous protocol for VANET, known as Distributed Weighted Cluster Based Routing Protocol where the Lowest ID of MANETs is used with modification.

In wireless sensor networks, there is a protocol knows as application specific protocol, where clustering approach is combined with media access and creation of cluster is completed in distributed way. Each cluster has its own cluster head for the transformation of data to the stable infrastructure. For each round, the selection of cluster head is performed randomly by selecting a number between 0 and 1. Any node can be selected as candidate for cluster head, provided its value is less than threshold. In the same architecture of Wireless Micro-sensor Networks (WMSN), the centralized routing is done where first energy levels are computed for all nodes by a Base Station and after the calculation of all energy levels, the cluster head is selected which will have the high energy level than average. The approach is also related to centralize clustering approach, in which road side units (RSU) computes the centralized and less irregular velocity Table 1 Comparison of Cluster Based Routing Protocol as a cluster head. The comparison between different cluster based routing protocol is given in Table 1.

The reason that cluster based routing protocols are used in vehicular ad-hoc networks, is to stabilize the dynamicity of vehicles, by the formation of group of vehicles known as clusters. Cluster based routing in VANET is particularly useful for applications that require better routing and scalability to hundreds or thousands of vehicles. Clustering is one of the control schemes used to make VANET global topology less dynamic. However there is an important issue with clustering technique, which is the selection of an optimal cluster head. The selection of cluster head is an open issue and much solution has been proposed. In our thesis we have proposed a new approach to form stable clusters and then select an optimal vehicle by using Floyd-Warshall algorithm which results in the formation of stable vehicle clusters. Hence, network topology will be more stable in vehicular ad-hoc network. The stability of the cluster is important for Cluster Based Routing Protocols [3, 6].

In [9] the author introduced, an efficient Cluster Based Routing Protocol with Adaptive Transmission Power in VANET where the transmission power is adapted. This adaptation is based on the distance between vehicles and cluster head. Therefore, VANET cluster schemes should take into consideration and parameters to produce relatively stable clustering structure. To achieve better performance, the used algorithm also considers the uncertainty of vehicle mobility. Also this work shows better throughput and lower transmission delay and enhances the overall performance. In [11] the author proposed a novel cluster-based network topology discovery approach for VANET by taking into account both vehicle connectivity and vehicle mobility. It is a fast convergent approach with load balancing to significantly improve the scalability of VANET. In [11] the author introduced, the cluster-based topology discovery scheme proposed in this paper has the following significances. First, it utilizes the advantage of a k-hop cluster architecture to improve the network topology scalability. Second, it takes into account the inter-cluster link expiration time to improve network topology stability with a capability to tolerate false routes and balance traffic loads. Third, it considers the factor of vehicle mobility to reduce the overhead and the caused by route path recovery.

The clustering based protocol actually partitions the network into small clusters and each cluster is examined and controlled by a single node called Cluster Head (CH). In [1] the author proposed a solution to enhance the network life time. The proposed solution is the enhanced algorithm for

Low Energy Adaptive Clustering Hierarchy-Mobile (LEACH-M) protocol called ECBR-MWSN which is Enhanced cluster based routing protocol for mobile nodes in wireless sensor network. ECBR-MWSN protocol selects the CHs using the parameters of highest residual energy, lowest Mobility and least Distance from the Base Station. In [8] the authors introduced a clustering algorithm that executes distributed over the whole VANET's nodes. The cluster formation criteria depends on the mobility of the vehicles, high mobility vehicles are clustered in one group and the low mobility vehicles are gathered in other group. Cluster head are further selected by the multi-metric method. On the other hand, we introduced a novel approach for cluster formation and vehicle head (VH) selection by using modified K-Means and Floyd-Warshall algorithm respectively. In [9], authors introduced a scheme where cluster head constantly advertises cluster information and includes its position within the advertisement. The cluster member can then calculate the distance to cluster head and update the transmission range. When distance is observed the transmission power is adjusted according to the distance and hence clustering routing takes place with enhances performance [6].

Table 1: The comparison between different cluster based routing protocol

Routing protocol	Forwarding strategies	Recovery strategies	Scenario	Mobility model	Propagation model	Delivery	Delay
CBLR	Multi-hop	Flooding	City	RWP	Road blocking	Guaranteed	Less
TIBCRPA	Greedy	Flooding	City	Free way	Road blocking	Guaranteed	More
COIN	Greedy	Flooding	Highway	Unknown	Unknown	Guaranteed	Less
LORA_CBF	Multi-hop	Flooding	Highway	RWP	Road blocking	Guaranteed	More
CBDRP	Multi-hop	Store & Forward	City	RWP	Road blocking	Guaranteed	More

3 The Novel Protocol for Vehicle Cluster Formation and Vehicle Head Selection in Vehicular Ad-hoc Networks

The nature of dynamicity of vehicles in Vehicular Ad-hoc Networks brings many challenges to form a stable network. The dynamic nature of vehicle causes link failures due to which rapid changes occur in the network topology. The routing protocol communication overhead increases by sending the frequent messages to re-establish links. Clustering technique is able to control this dynamic and mobile nature of vehicles by the formation of different clusters but the challenge is to select an optimal vehicle head for each vehicle cluster so that the stability time is increased. To tackle this challenge we have designed a novel protocol, where three different vehicle clusters are formed and optimal selection of vehicle head is performed for each vehicle cluster. Furthermore this vehicle head has further the responsibilities of managing other vehicles inside cluster and other activities to perform with in a cluster or between the clusters. The vehicle clusters are formed by the K-Means theorem. The Floyd-Warshall algorithm is used to select an optimal vehicle head in each cluster. The protocol is divided into three different parts i.e. Vehicle Dispersion and Division Points, Vehicle Cluster Formation and Vehicle Head Selection. In this section we have discussed in detail the different parts of the designed protocol.

3.1 Vehicle Distribution and Division Points Calculation

The first step of the proposed solution is the distribution of vehicles provided along a specific transmission region. The algorithm allows providing number of vehicles in a VANET. In the simulation, the transmission region is considered as 200×1000. In our simulation, we have given 40 numbers of vehicles. These vehicles are randomly distributed along the given region. Further to the random distribution of vehicles the algorithm also calculates and stores all the possible distances between vehicles. The first step of the algorithm also finds three different division points known cluster division points. The algorithm execution can be seen in Figure 4.

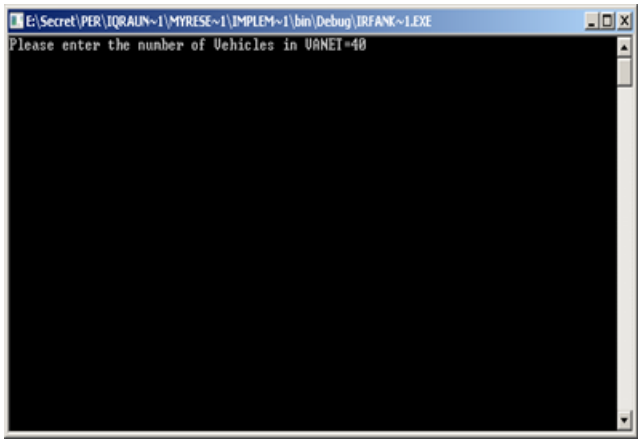

Figure 4: Algorithm execution: providing number of vehicles in VANET

3.2 Vehicle Cluster Formation

The second important step of the proposed solution is the formation of stable vehicle clusters. The proposed method is applied across highway vehicles, where each vehicle acts as a graph vertex and distances between vehicles represent edges. The vehicle cluster formation is performed by using K-Means mechanism. The main idea of K-Means is to find three different stable vehicle clusters. In the first step of the proposed solution the three division points have already been calculated according to the transmission region of road side units (RSU). Each division point defines an individual vehicle cluster. The K-Means theorem is executed which classified vehicle into three clusters C1, C2 and C3. The output of the second step vehicle cluster formation of the proposed solution is given in Figure 5.

3.3 Vehicle Head (VH) Selection

In cluster based approach, an optimal responsible node should be selected within each cluster to administrate its group. The selection of cluster head (vehicle head) is a critical and challenging task. The reason is the randomize nature of vehicular ad-hoc network due to the fast moving vehicles. Each vehicle exchange HELLO message with each other in every cluster, these HELLO messages consist of different parameters vehicle information such as speed, location and direction. However, in the proposed solution we are considering uniform speed of vehicles for each cluster.

In the third step of the designed algorithm the selection of an optimal and centralized vehicle head for each vehicle cluster is performed by using a dynamic programming algorithm known as Floyd-Warshall

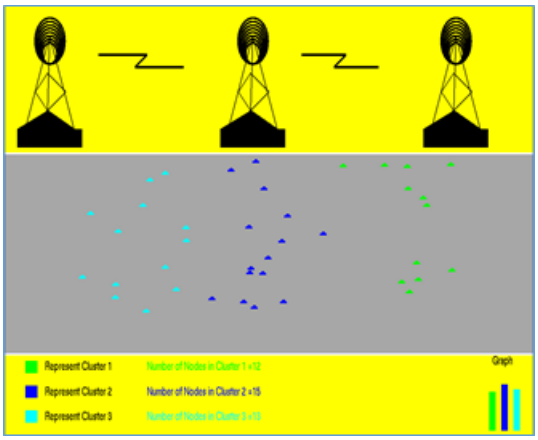

Figure 5: Three vehicle clusters formation by using K-Means theorem

algorithm. Floyd Warshall algorithm belongs to all pair shortest path category of graph theory which calculates shortest distances of all vehicles. Hence in this step the Floyd-Warshall algorithm calculates all the shortest path distances between the vehicles in each cluster and we get three different metrics. The algorithm also finds the average distance values for each vehicle in every cluster. The vehicle having the lowest distance values is selected as the vehicle head. In similar way we get three different vehicle head VH1, VH2 and VH3 for three different clusters C1, C2, C3 respectively. These vehicle heads have the centralize position in each cluster comparative to all other vehicles in each cluster. The third algorithm step execution can be seen by Figure 6.

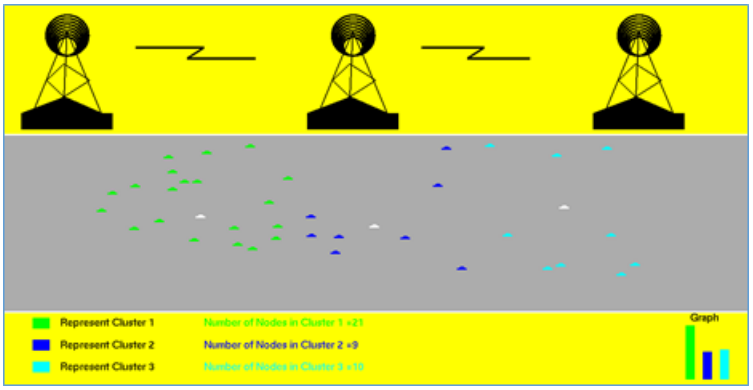

Figure 6: An optimal vehicle head selection by using Floyd-Warshall algorithm

3.4 Novelty of the Designed Protocol

In our designed protocol we have used a novel approach to select an optimal vehicle head for each cluster in the vehicular ad-hoc networks. In the designed protocol, we have used the Floyd-Warshall algorithm for the first time in the selection of a vehicle head within a vehicle cluster, where stable vehicle clusters

have already been created by the application of K-Means theorem. The K-Means forms stable vehicle clusters and within that stable clusters we have used the Floyd-Warshall algorithm for the first time to select the most appropriate and centralize vehicle head. The adaptation of the modified K-Means theorem and the Floyd-Warshall algorithm is the novelty of our designed protocol that produces more stable vehicle clusters and eventually the network performance improves significantly.

4 Case Study of the Proposed Solution

The designed protocol is applied across highway vehicles, where each vehicle acts as a graph vertex and distances between vehicles represent edges. In this section we have discussed a complete CASE of a sample highway vehicular ad-hoc network. The proposed solution for vehicle cluster formation and vehicle head selection is applied to get stable vehicle clusters (See Figure 7).

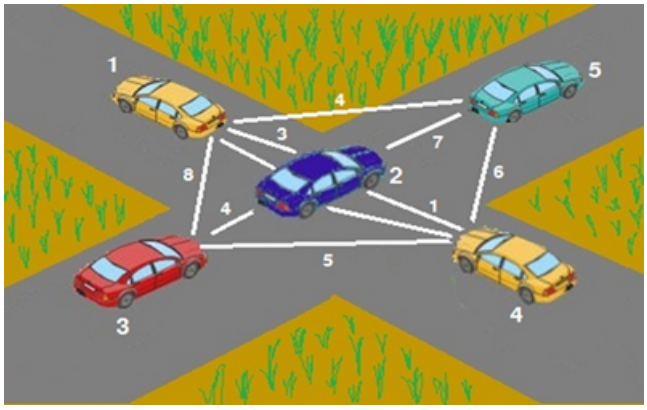

Figure 7: CASE study of the proposed solution

In the above case study, if we consider the idea of graph theory we can see that a specific undirected graph will be formed where every vehicle is an edge of the graph. The coordinates of the vehicles can be identified and weight of the distance can be calculated by the following formula below.

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_2)^2}$$

The distance weight is represented by "W" and (x, y) are the co-ordinates of the vehicles.
The distance weight "W"is measurement for blue and green vehicles below:

$$\begin{aligned} W(Blue) &= \sqrt{(14\text{–}6)^2 + (8\text{–}8)^2} = 8m; \\ W(Green) &= \sqrt{(6\text{–}14)^2 + (4\text{–}4)^2} = 8m. \end{aligned}$$

The distance weights "W" are calculated for all vehicles in Figure 8. In similar way distance weights are calculated for all of the vehicles. The Floyd-Warshall algorithm is executed on each vehicle of the cluster. The Floyd-Warshall algorithm results all pair shortest distances for each vehicle. The algorithm works such that it elect every vehicle as a center vehicle and uses this vehicle to calculate all its possible distances with other vehicles. The said algorithm works on the given formula.

$$W_{ij}(n) \leftarrow \min(W_{ij}(n-1), W_{ik}(n-1) + W_{kj}(n-1)). \quad (1)$$

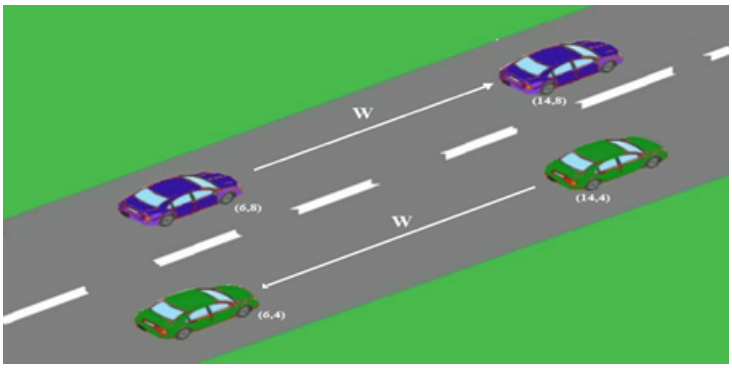

Figure 8: Distance weight calculations

All vehicles are selected as middle vehicles at the end of every iteration of the algorithm. Average weight of the each vehicle is calculated after the execution of the algorithm. That vehicle will be selected as vehicle head which will have the lowest average weight. Here we have calculated different average weights as you can see the following:

Average Weight of V1 = -2/5;

Average Weight of V2 = -1/5;

Average Weight of V3 =19/5;

Average Weight of V4 = 4;

Average Weight of V5 = -6/5.

In this case "V5" has the lowest distance weight so it is the best choice to be selected as VH and it is selected as VH. In this way in our proposed solution, forms three different vehicle clusters and then select an optimal vehicle head for each cluster that eventually increases the lifetime and stability of each cluster.

5 Performance Measurement of the Designed Protocol

5.1 Vehicle Density and Time Estimation

The performance of our proposed protocol is measured in terms of time. It means that how much time a given set of vehicles will take in the formation of vehicle cluster and vehicle cluster head selection. This section represents the relationship of time and vehicle density. The aim is to show that how time gets affected with increasing the number of vehicles for vehicle cluster formation and vehicle head selection. Following are the experiments that show the time taken for the formation of vehicle cluster and vehicle head selection in terms of vehicle density.

1) Number of vehicles = 10 (See Figure 9).

   The output of the algorithm shows that if the number of vehicles is 10, the total time taken to execute the algorithm will be 0.00400 seconds and vehicles are grouped into three different clusters.

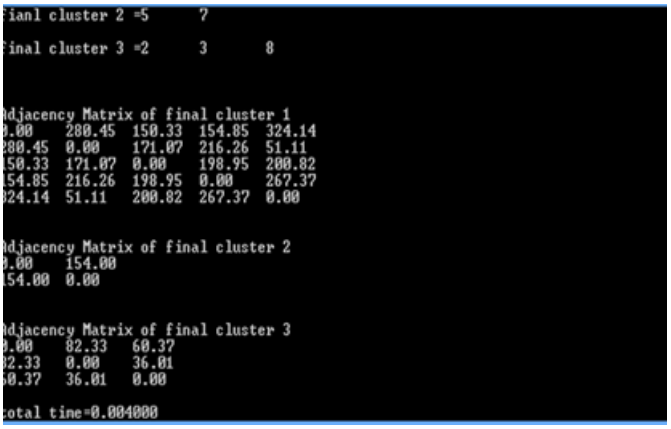

Figure 9: An estimated time for number of vehicle = 10

2) Number of Vehicles = 20 (See Figure 10).

   If the number of vehicles increased to 10, the total time taken to execute the algorithm will be 0.014000 and thus three different clusters will be formed.

3) Number of Vehicles = 40 (See Figure 11).

   When the number of vehicles is 40, the algorithm takes 0.054000 seconds to execute and three clusters will be created.

4) Number of Vehicles=80 (See Figure 12).

   If the number of the vehicles increased to 80, the time taken by algorithm will be 0.173000.

5) Number of vehicles = 100 (See Figure 13).

   When the number of vehicle becomes 100, the time increases to 0.26000 and vehicles are grouped into three different clusters.

5.2 Vehicle Classification in Clusters

The vehicles are distributed along a specific region and after that they are classified into three different clusters. The graphical view of 100 vehicles along with classification in clusters and vehicle head selection is shown in Figure 14. The three difference vehicle clusters formed as under:

- Cluster 1 (Green Cars);
- Cluster 2 (Blue Cars);
- Cluster 3 (Sky blue Cars).

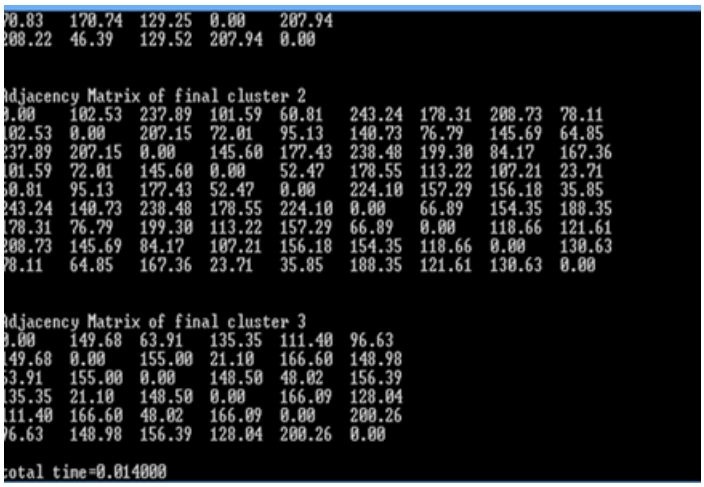

Figure 10: Estimated time for number of vehicle = 20

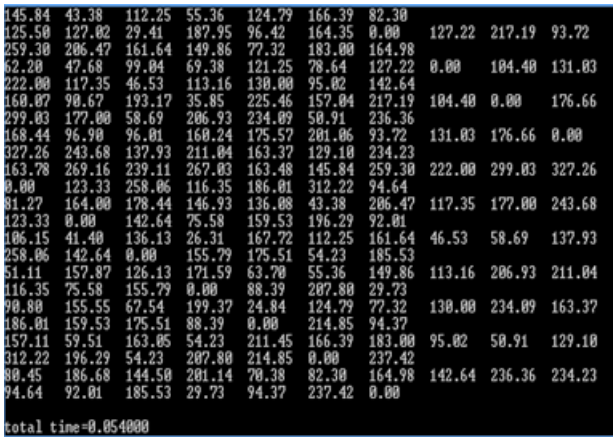

Figure 11: Estimated time for number of vehicles =40

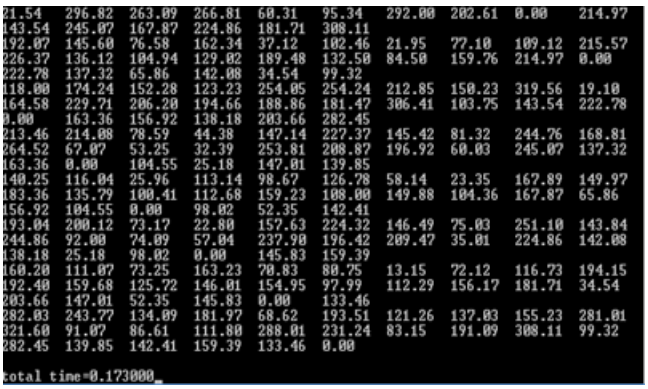

Figure 12: Estimated time for number of vehicle = 80

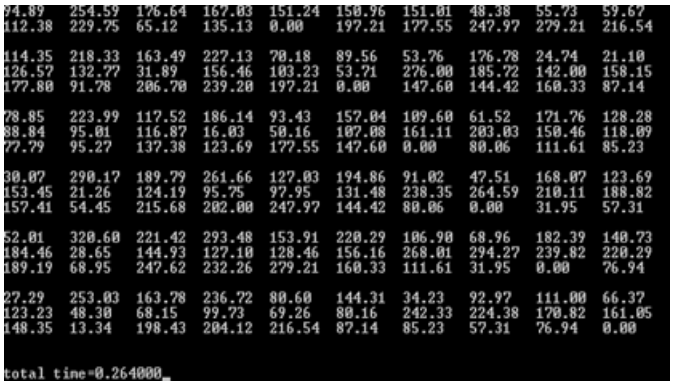

Figure 13: Estimated time for number of vehicle = 100

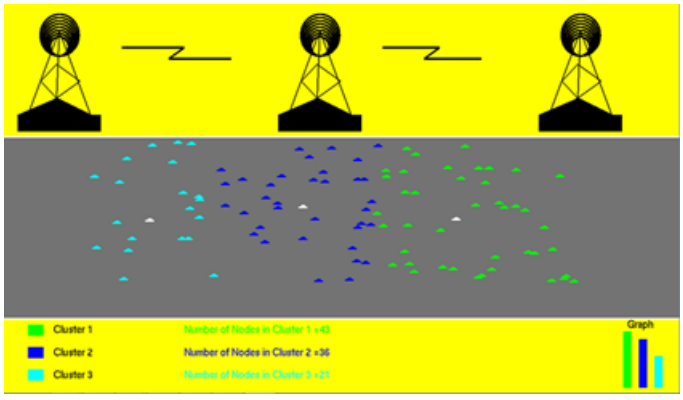

Figure 14: Classification of vehicles and VH selection of 100 vehicles

5.3 Time and Vehicle Density Relationship

As we discussed earlier that the performance of our proposed algorithm is measured in terms of time and stability of the cluster. It means that how much time a given set of nodes will take in the formation of cluster and VH selection. In the following line graph, the relationship between time and vehicle density is shown. The x-axis shows the vehicle density while the y-axis shows the time taken in cluster formation and vehicle head selection (See Figure 15).

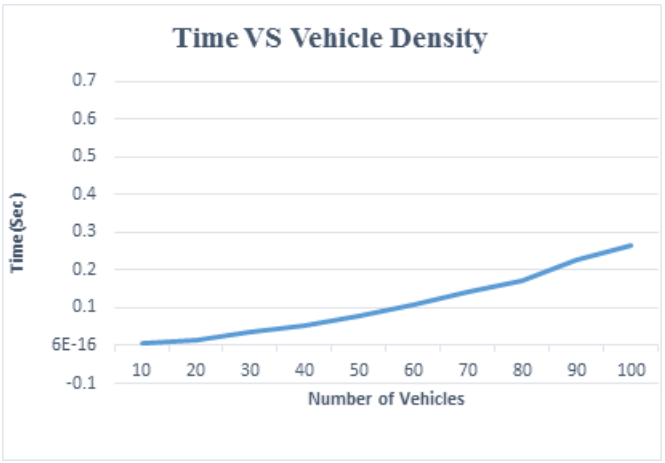

Figure 15: Inter relationship between vehicle density & time

5.4 Cluster Stability Comparison of the Designed Protocol with existing Protocols

The dynamic nature of VANETs is an open challenge for the researchers to design an optimal routing mechanism that could extend communication session among the vehicles. In the proposed solution we have introduced a new vehicle cluster formation & vehicle head selection approach by using modified K-Means & Floyd-Warshall algorithm. In order to measure the performance of our proposed protocol, a simulation was created that shows different vehicles are distributed along a specific path. The vehicles are grouped into three different clusters and after the formation of vehicle clusters the vehicle head selection is performed. The results of our proposed solution are compared against the following protocols:

- Lowest ID Clustering: The vehicle head is that vehicle which has the lowest ID and the algorithm is rerun with every change in network topology.
- CGSRP Clustering: Lowest ID Clustering is being used in this protocol: however, vehicle head election is preserved unless two vehicle heads come into contact with one another or a node no longer is in radio contact with any vehicle head.
- COIN Protocol: The COIN protocol considers relative mobility clustering and vehicle head election is based on vehicular dynamics and driver intentions. The COIN produced good results from Lowest ID clustering and total number of cluster elections become significantly lower [5].

The measurements are performed on a variety of network topologies with variations in network dynamics in order to capture the capabilities of our proposed protocol. It is observed that our proposed protocol "The novel protocol for vehicle cluster formation and vehicle head selection" forms a stable cluster by the selection of an optimal and centralize vehicle head with in each cluster. The performance results we got from the simulation are compared with the existing vehicle ad-hoc network cluster based routing protocols in different time spans. We noticed that our designed protocol improves significantly the lifetime of the vehicle cluster and network topology. In this section the results are shown in the form of graphs.

5.4.1 Cluster Stability Comparison with Existing Protocols in VANET for Timespan 10 Minutes

The lifetime of the vehicle head is the most direct gauge of the stability of vehicle head selection. As we can see that our designed protocol is 672 times better than Lowest ID, 15 times better than CGSRP and almost doubled in the improvement against famous COIN Protocol. This measurement was done for time span of 10 minutes. The graph indicates that our designed protocol creates more stable cluster comparative to the present protocols discussed above. The stability of vehicle cluster gives us stable network topology for vehicular ad-hoc network. That's means more the stable is the vehicle cluster more stable will be the network topology. Actually the main purpose of the designed protocol is to form stable vehicle cluster so that stable network topology can be achieved and network performance can be improved. The stability of the network topology can be observed in the following graph in Figure 16.

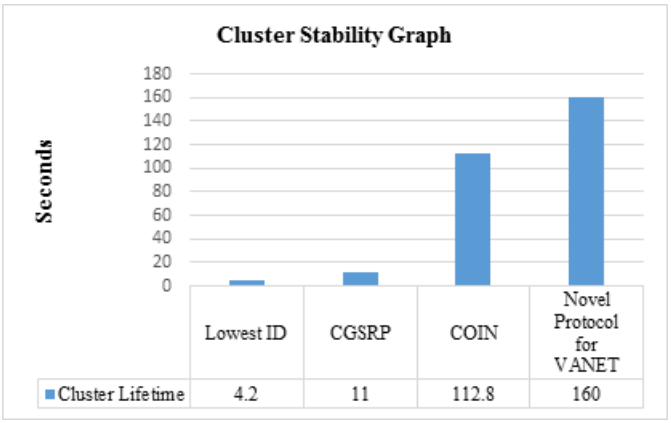

Figure 16: Cluster Stability Comparison results with existing protocols for time span 10 minutes

5.4.2 Cluster Stability Comparison with Existing Protocols in VANET for Timespan 20 Minutes

Here we have measured the designed clustering protocol performance for a 20-minute timespan on the highway scenario as described (See Figure 17).

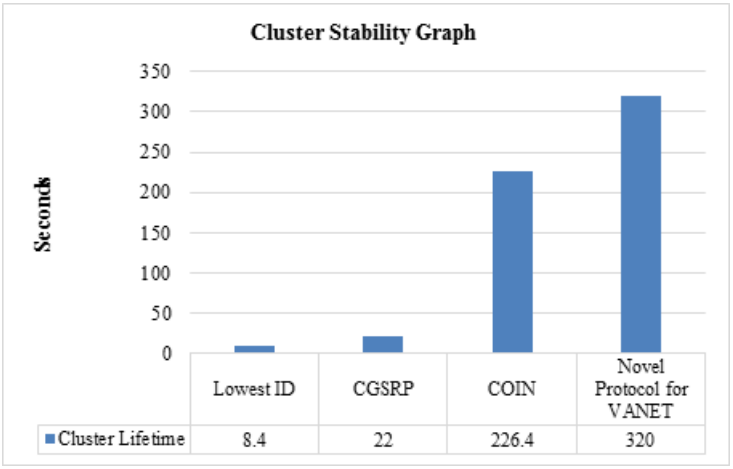

Figure 17: Cluster Stability Comparison results with existing protocols for time span 20 minutes

5.5 Cluster Stability Comparison with Existing Protocols in VANET for Timespan 30 Minutes

The designed protocol selects an optimal vehicle head that has the centralize position in a cluster which increases the lifetime of the cluster and stability increases significantly as we can see in the graph comparisons. Here time span is taken as 30 minutes (See Figure 18).

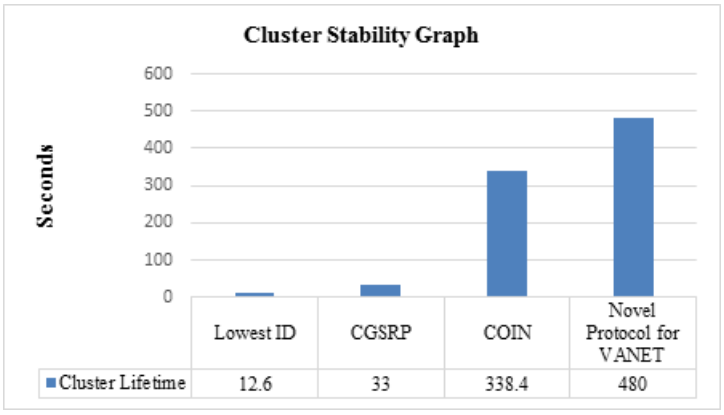

Figure 18: Cluster Stability Comparison results with existing protocols for timespan 30 minutes

The average vehicle head lifetime is the most direct measure of the stability of vehicle head selections. It has been observed from our experiments and simulations that our designed protocol "Novel protocol for Vehicle Cluster Formation and Vehicle Head Selection in VANET" produced significant improvements over other approaches using two different unique properties - the average vehicle head lifetime and the time taken by the number of vehicles in a VANET. The designed protocol selects an optimal vehicle head among all vehicles in the cluster by using Floyd-Warshall algorithm. The stable

vehicle head results in the formation of stable clusters, which further gives us strong network topology and network performance is improved.

6 Conclusion

The highly dynamic nature of vehicles in vehicular ad-hoc networks causes the rapid change in its network topology. However, the clustering algorithm scan be used to stabilize the network topology in vehicular ad-hoc-networks. The clustering technique provides the degree of performance which is necessary to handle the message flooding and hence decrease the protocol overhead happening within the network. The controlling vehicle in a cluster is known as a vehicle head. The optimum vehicle head is that vehicle which occupies a central position nearest to the rest of the vehicles within a cluster. Our protocol design centers on the application of the K-means theorem and Floyd-Warshall algorithm and forms vehicle clusters and then it selects a stable vehicle head, based on the optimum route to the nearest vehicles.

The practical implementation and evaluation of our work shows that our centralized cluster based routing protocol is highly adapted to congested environments and significantly improves the lifetime of a vehicle cluster, by the formation of stable clusters and the selection of an optimal vehicle head. The designed protocol currently considers the uniform speed of the vehicles in all known clusters. In future refinements of the protocol, the criteria can consider random variations in the vehicle speed and directions. Furthermore, weights can be assigned to those vehicles which have the lowest variation in speed and direction in the vehicular ad-hoc networks. In similar way this work can also be further extended to utilize the big data transmission.

References

[1] R. Anitha and P. Kamalakkannan, "Enhanced cluster based routing protocol for mobile nodes in wireless sensor network," in *Pattern Recognition, Informatics and Mobile Engineering (PRIME'13)*, Salem, 2013.

[2] J. Breu, A. Brakemeier and M. Menth, "A quantitative study of Cooperative Awareness Messages in production VANETs," *EURASIP Journal on Wireless Communications and Networking*, vol. 1, no. 98, June 2014.

[3] S. Dhankhar and S. Agrawal, "VANETs: A Survey on Routing Protocols and Issues," *International Journal of Innovative Research in Science, Engineering and Technology*, vol. 3, no. 6, pp. 2319-8753, June 2014.

[4] N. Ghanishtha and J. Yogesh , "Review on classification of different VANET Protocols based on routing information," *International Journal of Advanced Research in Computer and Communication Engineering*, vol. 4, no. 5, pp. 175-180, 2015.

[5] M. Inam, A. Ul A. Ikram, M. Ahmad, "Hierarchal Energy Efficient Routing Protocol in Wireless Sensor Networks (HEERP)," *International Journal of Computer Science and Telecommunications*, vol. 4, no. 10, Oct. 2013.

[6] V. A. Indra and R. Murali, "Routing Protocols for Vehicular Adhoc Networks (VANETs): A Review," *Journal of Emerging Trends in Computing and Information Sciences*, vol. 5, no. 1, 2014.

[7] V. Naumov and T. Gross R, "Connectivity-Aware Routing (CAR) in Vehicular AdHoc Networks," in *26th IEEE International Conference on Computer Communications (INFOCOM'07)*, Anchorage, AK, 2007.

[8] Z. Rawashdeh and S. M. Mahmud, "A novel algorithm to form stable clusters in vehicular ad hoc networks on highways," *EURASIP Journal on Wireless Communications and Networking*, vol. 1, 2012.

[9] V. Sheoran and D. J. Khurana, "An Efficient Cluster Based Routing With Adaptive Transmission Power in VANET," *International Journal of Advanced Research in Computer Science and Software Engineering*, vol. 5, no. 5, pp. 630–635, May 2015.
[10] G. Swathi and D. Ruby, "Enhancement of Quality of Service in VANET'S By Using Reliable Routing Scheme," *International Journal of Recent Development in Engineering and Technology*, vol. 2, no. 3, Feb. 2014.
[11] L. Zhang and H. El-Sayed, "A Novel Cluster-Based Protocol for Topology Discovery in Vehicular Ad Hoc Network," *Procedia Computer Science*, vol. 10, no. 10, pp. 525–534, 2012.

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