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Secured Data Communication for Lung Cancer Detection and Multi Level Classification

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ABSTRACT: Multimedia plays a very important role in today's data communication over the Internet. Multimedia is one of the recent interests of researchers, developers and users for secured medical data transmission to obtain efficient opinion results. Malignant Tumour is one of the deadliest form of cancers. People confirmed with the lung cancer said to have lived for an average of 5 years. With the proper diagnosis and treatments at the earlier stage, the survival rate can be increased.. Due to reduced human interaction in the recent times, secured data transfer of detected results to the consultants and researchers is of utmost importance.

Discrete Wavelet Transform (DWT) algorithm provide best efficiency feature extraction used as the input data securely transmitted over Internet in the video format.

Network Simulator (Version 2) provides simulation platform to perform wired and wireless protocols simulation. EvalVid framework provides video transmission. NS2 and EvalVid framework are integrated to transfer video over the wireless cellular network with DSR Protocol.

Multimedia transmitted data are shared across mobile communication networks in the form of mp4 data and the results are encouraging.

KEYWORDS: ANN, DWT, GLCM, KNN, ROI, NS2, EvalVid, DSR, Wireless Transmission

I.INTRODUCTION

Interesting work of Veeraprathap V et al, in "Lung Cancer Detection and Multi Level Classification Using Discrete Wavelet Transform Approach", [1] is extended for efficient Secured Data Communication with Dynamic Routing Protocol and Network simulator. Network Simulator Version 2 (NS) is open-source simulation software that has the ability to simulate and verify functioning of various protocols for wired and wireless networks. [2]

EvalVid is a tool designed to transmit video data over communication networks. It is integrated with NS-2 to assess various qualities of received data such as PSNR, overall loss to determine the success rate of video transmission. EvalVid supports data transmission over real as well as simulation networks. [3]

Dynamic Source Routing protocol (DSR) is a simple and efficient reactive routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes based on two main mechanisms: route discovery and route maintenance designed for a MANET of up to two hundreds nodes with high mobility rates and is loop-free.CT scan detected images through various means are processed and shared with the consultants through mobile network for further opinion. Section II – VI depict the working model of Lung Cancer Detection and Section VII uses the detected images and converts to a MP4 data and transfers it over the wireless network. The paper is organized as follows. Section II presents a brief literature review and their implications with proposed system in Section III while Section IV presents System Implementation including flow chart and block diagram. Section V depicts the advantages of the proposed system. Section VI presents the test results obtained from the simulations performed with

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Section VII showing the video transmission of feature detected lung cancer and concluding summary and future work of the proposed system in Section VIII.

II.LITERATUREREVIEW

C.H.Ke et al, [3] proposed video transmission of various formatted videos and retrieving back the sent images with minimal distortion using NS2 with integration of EvalVid toolset.

Yang Chunran.et al., [4] proposed a fully convolutional network (FCN) based on level set method. FCN used for segmentation, nodules detected inside lung area by threshold method and image processing techniques, while segmentation by threshold method based on the coordinate system transformation.

Ahmed Shaffie. et al., [5] proposed a system fused texture andshapefeaturestogetanaccuratediagnosisfortheextracted lung nodules. 3D Local Binary Pattern (LBP) and higher-order Markov Gibbs random field (MGRF) models were utilized. Modelled features used to differentiate between the malignant and benignnodules.

Chen Zhao. et al., [6] proposed a patch-based 3D U-Net and contextual Convolutional Neural Networks (CNN) to automatically segment and classify lung nodule. 3D U-Net employed for segmentation while Generative Adversarial Network (GAN) used to enhance model performance, online sampling strategy determined malignant nodule.

BariqiAbdillah. et al., [7] proposed a detection method based on image segmentation using marker control watershed and region growing approach. Enhancement using Gabor filter, feature extraction was performed providing good results with high accuracy and robustness.

AchimCristian. et al., [8] proposed a system using transthoracic ultrasonography (TUS) and US-guided biopsy technique.

BohdanChapaliuk. et al., [9] proposed an automated diagnose system using 3D convolution and neural networks and accuracy of the networks was evaluated.

Diptarup Bhattacharya. et al., [10] proposed a MEMS based sensor technique. Based on the volatile organic compound concentration exhaled from breath of a person system identified the cancer patient.

Pooja R. Katre. et al., [11] proposed a system with Median filter for noise removal, High boost operator for enhancement and marker controlled watershed for segmentation. Various classification techniques for detecting lung cancer based on suspicious ROI obtained by feature extraction was discussed.

GawadePrathamesh. et al., [12] proposed a system using median filter, Watershed Segmentation and morphological operations.

De-Ming Wong.et al., [13] proposed a lung cancer identification method by exhaled breath using KNN and SVM classifiers with results at accuracy of 84.4%.

III. DIFFERENT STAGES OF MALIGNANT TUMOUR

Lung cancer staging is an assessment of the degree of spread of the cancer from its original source. There are four main stages which includes sub cases, four main stages are considered tumor size being the major factor to differentiate and detect the stages. Medical consultant based on historical and clinical tests recommends CT scan for a suspected patient. The evaluation of non-small-cell lung carcinoma (NSCLC) staging uses the TNM classification (tumor, node and metastasis). This is based on the size of the primary tumor, lymph node involvement and distant metastasis. The stage of tumor depends on the appearance of tumor microscopically and cell's growth rate.

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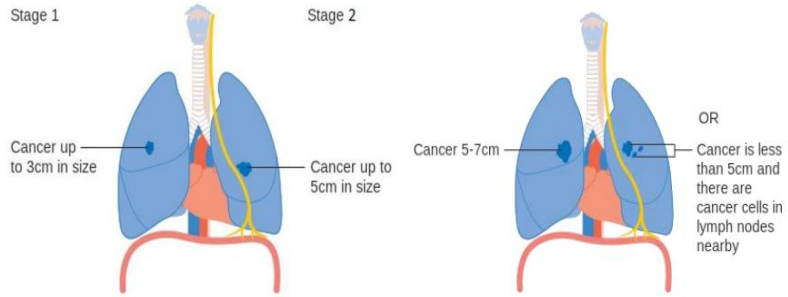

Fig. 1 Stage 1 & 2 of Malignant Tumour

In stage 1, tumor size is lesser than 3cm but the cells look nearly like the normal lung cells, Fig., 1. These cancerous cells are generally slow at spreading and multiplying whereas in stage 2, the size of tumor is greater than 3 cm but less than 5 cm, the cancerous cells become relatively more abnormal and differentiable as compared to stage 1, and might spread faster as well, Fig 2. More advanced stages include stages 3, tumor size being in the range of 5-7 cm not detected in its early stages would lead to death, Fig 2, which tend to present themselves as extremely abnormal and fast spreading cancerous cells. Tackling this dangerous disease has always been a tedious procedure but with new technological advancements an improvement in the qualities of remission and detection has been accomplished, but it's still a long and expensive procedure nonetheless, stage 4 cancer is the final stage with tumor greater than 7 cm illustrated in human body which spreads to other parts of human body, Fig 3.

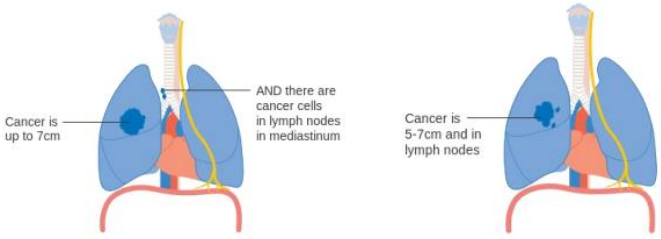

Fig. 2 Stage 3 & sub stages of Stage 3 Malignant Tumour

The CT images assists in detecting the severity of the lung diseases since the visibility of soft tissue is better. Lung disease affects breathing, common forms are acute bronchitis, asthma, Chronic Obstructive Pulmonary Disease (COPD), Acute Respiratory Distress Syndrome (ARDS) and LC.

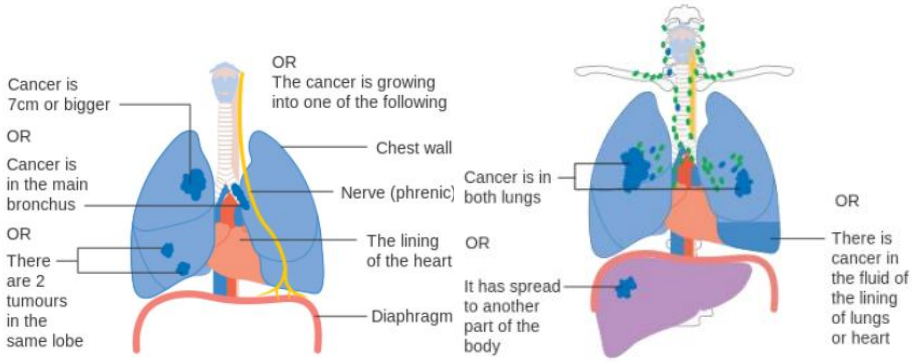

Fig. 3 Stage 4 & sub stages of Stage 4 Malignant Tumour

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IV.LUNG CANCER DETECTION SYSTEM

Lung Cancer Detection System (LCDS) examines CT scan images and identifies tumour affected lungs further subdividing into stages, Fig 4.

1. Image pre-processing
2. Image segmentation
3. Feature extraction

The three phases of image processing listed employed with best techniques along with feed forward neural networks and K-Nearest Neighbour (KNN) algorithm creating an efficient and accurate system than existing methods. Significance given to extraction of tumour region properties given input to classifiers. During diagnosis suspected patient's CT image given as input to system checks the patient condition using trained classifiers. Patient lungs found abnormal further examined to identify the cancer stage and appropriate treatment recommended. Tumour classification performed as per criteria's listed in 8th edition of TumourNodeMetastasis(TNM) staging of lung cancer.360CT scan images of Abnormal and normal lungs are collected from ELCAP image database.

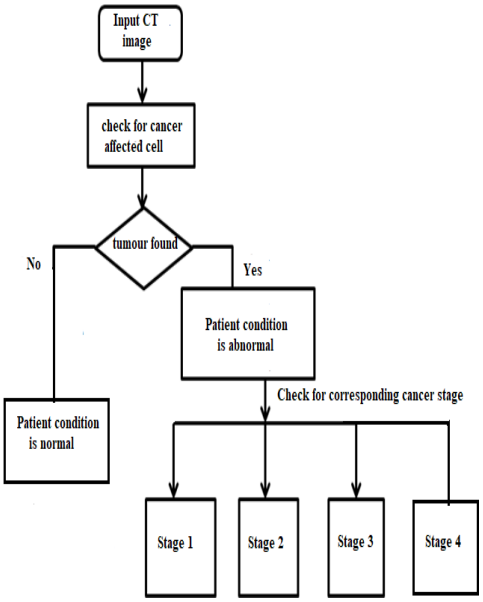

Fig. 4 Flowchart of the Lung Cancer Detection System

V. LUNG CANCER SYSTEM IMPLEMENTATION

Medical images have uncertain tumor boundaries and dissimilarity in tumor appearance makes it difficult to find exact malignancy because of factors such as noise [4]-[7]. To overcome problems method helpful for radiologists in accurately locating tumor is essential [5]-[13]. The doctor suggests CT scan based on the positive results obtained in pre-operative evolution, prostate malignancy and other clinical tests performed in laboratory, Fig 5.

An image read initially by system refers to image acquisition. During the image acquisition, it is very important to eliminate noise content and improve image quality before an examination. Noise removal and contrast enhancement are primary steps of significance.

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Pre-processing performed in stages as follows:

Image resizing

Image conversion to gray scale image

Gaussian filter applied

1. Histogram equalization
2. Media filter applied

Image pre-processing is improvement of the image data suppressing unwanted distortions. Image scaling, color space transformation and contrast enhancement is employed in image enhancement. Masking approach used to identify brighter pixels and darker pixels to separate them, value greater than threshold value implies '1' otherwise '0' [6]. Basic morphological operations dilation erosion, closing and bwareaopen employed [7]. Dilation adds pixels to the boundaries of objects in an image whereas erosion removes pixels on object boundaries.

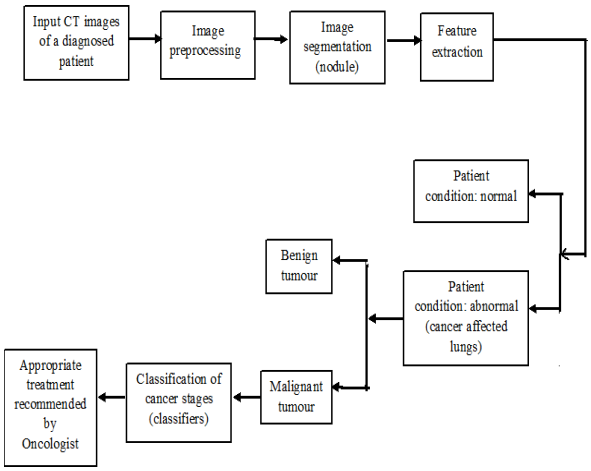

Fig.5 Lung Cancer System Block Diagram

A. LCDS includes the following stages:

1. Acquire CT scan image of suspected person.
2. Pre-processing of image.
3. Segmentation using ROI and Otsu's thresholding approach.
4. Feature extraction using DWT algorithm.
5. KNN and Neural network classification.
6. Diagnosed result.
7. Treatment method.

B. Techniques Used

1. Histogram Equalization(HE)
2. ROI extraction

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3. Morphological Operations
4. Region properties measurement
5. GLCM
6. Artificial Neural Networks (ANN)
7. KNN

Based on size and shape of structuring element involved numbers of pixels are manipulated from the objects. In medical image segmentation accuracy is utmost important, considering impact on human lives. Region growing method and Otsu's thresholding approach used for segmentation.

The former technique performs pixel-based image segmentation involves the selection of initial seed points by examining neighboring pixels of initial seed points and determines to add pixel neighbors to the region [7]. The process is repeatedly performed. Fig., 5.

Feature extraction performed on data set of normal, tumor affected lung CT images. Region properties Area, perimeter, centroid, diameter and eccentricity of Region of Interest (ROI) are included in feature extraction all being scalar quality. The extracted features shape and size given as input to neural networks. Gray-Level Co-occurrence Matrix (GLCM) is texture analysis technique in medical imaging categorizes different combinations of pixel intensity value occurred in an image [4]. Homogeneity, contrast, correlation, energy, entropy features extracted stored in matrix used in training of Artificial Neural Networks(ANN). Discrete Wavelet Transform (DWT) algorithm applied on image, single level wavelet decomposition is computed. Advantage in training the large data as size of features extracted and stored in the form of 2-D matrix is reduced. Eccentricity value indicates deviation of tumor from being circular in shape, differentiates benign and malignant tumor [8]. Centroid gives the exact location of tumor in the form of x and y co-ordinates while diameter helps in analysis of rough size of tumor. Perimeter indicates the number of pixels exist on ROI boundary and area tabulates overall number of pixel elements obtained using extracted ROI. The conversion relation 37.79 pixels equivalent to one cm being used, after normalizing area value pixels are estimated, size of a tumor assessed accordingly. Fig 6.

KNN used to get level data, classifies images based on the similarity with the stored data, ANN trained by different samples produces better accuracy results even for non-trained images compared to other classifiers [9]-[13]. K= 1, 2 and 3 is used to vote for a class of testing data. At the first level of classification KNN checks for normal lungs, abnormal lungs and tumors very large in which cannot be segmented properly and tumors very large in size which cannot be segmented properly.

Fig. 6 Classification as per TNM staging

Stages of Lung Cancer	Tumor area assessed in pixels
Stage 1	0-114
Stage 2	115-190
Stage 3	191-266
Stage 4	>267

Second level of classification involves feed forward neural network type of ANN identifying tumor detected as Malignant or Benign, further evaluating the stages based on features extracted i.e., tumor size (area) and node location (centroid).

VI. MPEG VIDEO TRANSMISSION USING DSR PROTOCOL

NS2 in integration with EvalVid framework is able to send video file over the wireless network using DSR Protocol. Two UDP agents namely myUDP for the source node and myEvalvid_Sink for the destination node are created.

Video transmission over wired network and wireless networks are scripted in TCL language and simulated using Network Simulator (Version 2). Source is attached to myUDP agent to transfer MPEG video from source to destination attached with

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myEvalvid_Sink. Trace file is generated using mp4 trace tool. MyEvalvid application used along with the 2 UDP agents. Using myUDP agent, trace file from the sender side records time in seconds of every transmitted packet and video frame packets are fragmented from the sending source trace file (myUDP) and myEvalvid_Sink, the receiving agent records time in seconds of every received packets.

In wired scenario, 4 nodes are considered which are connected via duplex link. NAM file is generated and is opened at the end of the simulation which shows the frame movements from source node to destination node

.

In wireless scenario, 4 wireless nodes are created. MANET protocol- DSR is used for video transmission. DSR uses the principle of source routing. User specifies the route a packet should take over the network. Once after simulation, trace file and NAM file are generated.

Initially, YUV video sequence is considered where all frames are divided into YUV color components. Entire raw yuv file is encoded into M4V format using EvalVid binary tool. M4V file is converted into MP4 using MP4Box tool. Sender trace file is generated to transmit video using mp4trace binary tool. Once the trace file is generated, NS2 tcl script for video transmission is run. Receiver trace file is created. Using the trace files generated, binary tool etmp4 generates the received video file.

Received video file is then converted into raw yuv file using ffmpeg tool. Transmitted and received mp4 video files are compared to determine the success of transmission.

Tumor detected image at stage 1 of malignant tumour is sent in the form of video with transmitted and received video of same quality. Fig 7 & 8.

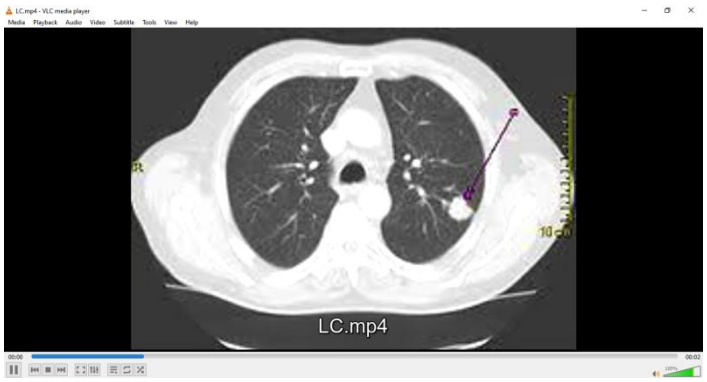

Fig. 7 Transmitted Video at t=1 second

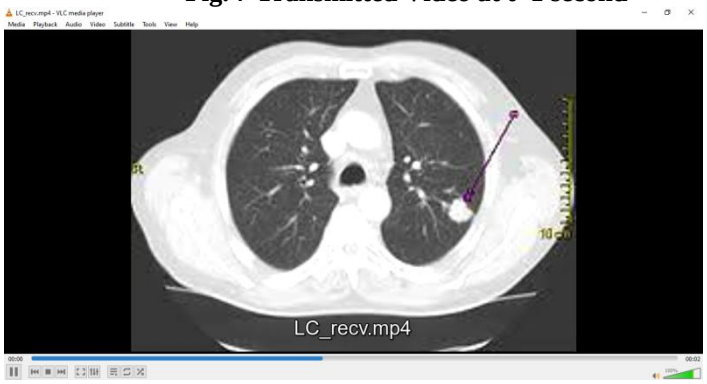

Fig. 8 Received Video at t=1 second

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VII. SIMULATION AND RESULTS

Transmitted video is received with zero loss in case of wired network and 5.88% overall loss in case of wireless network. Wired transmission has a received rate 27.07% less than transmitted rate and wireless transmission has 78% received rate lesser than transmitted rate.

PSNR for wired and wireless network transmission is plotted and observed that wired has an average of 25.03 for 17 frames and wireless has 10.18 for 12 frames. Fig 9 & 10.

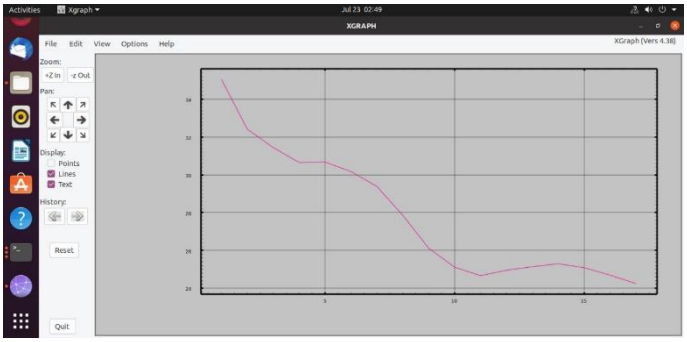

Fig. 9 PSNR of Wired Network plotted against Frame ID vs PSNR in db

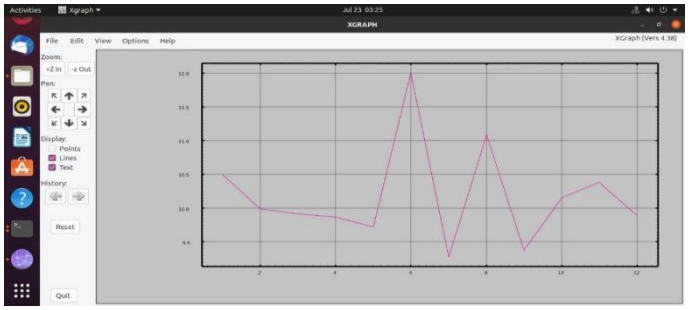

Fig. 10 PSNR of Wireless Network plotted against Frame ID vs PSNR in db

Cumulative rate of transmitted video for wired and wireless networks are 4,43,903 bytes/sec and 23,20,584 bytes/sec respectively. Fig 11 & 12.

Fig. 11 Transmitted Rate of Wired Network with Time in seconds vs Cumulative Value

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Fig. 12 Transmitted Rate of Wireless Network in seconds with Time vs Cumulative Value

Cumulative rate of received video for wired and wireless networks are 3,23,728 bytes/sec and 5,07,965 bytes/sec respectively. Fig 13 & 14.

Fig. 13 Received Rate of Wired Network with Time in seconds vs Cumulative Value

Fig. 14 Received Rate of Wireless Network with Time in seconds vs Cumulative Value

At 5th frame | packet ID, wired transmission provides end-to-end delay of 0.034000 seconds and wireless transmission provides end-to-end delay of 0.0000000. Overall end-to-end delay of wireless transmission is lesser compared to wired transmission. Fig 15 & 16.

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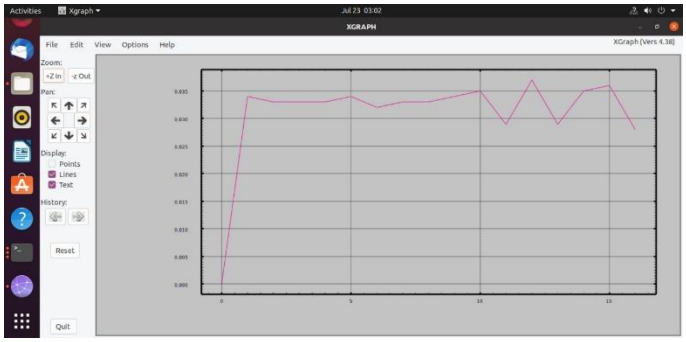

Fig. 15 Frame ID vs Time in seconds plot of End-to-end Delay in Wired Network

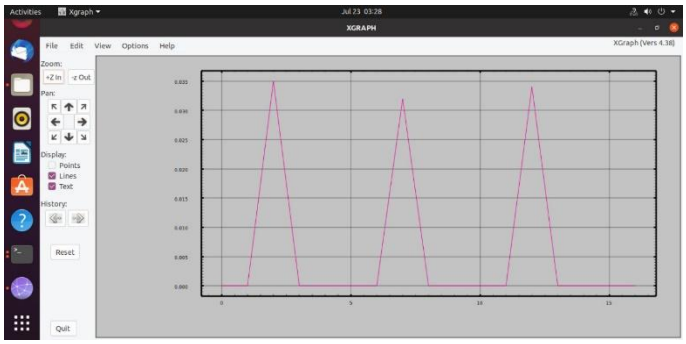

Fig. 16 Frame ID vs Time in seconds plot of End-to-end Delay in Wireless Network

VIII. CONCLUSION

Systematic execution of video transfer from source to destination is carried out for both wired and wireless network. Peak Signal to Noise Ratio for various frames are calculated and compared.

NS2 with the integration of EvalVid framework provides video transmission and quality evaluation of wired and wireless networks using metrics such as overall loss, PSNR, end-to-end delay, sent and received rates.
During pandemic situation like these, human interaction is less. Using the above method, remote transmission and reception can be done which can be used in various situations like consulting consultants online, asking expert reviews, etc.

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