Efficient Methodology for Video Transmission over ZigBee

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***Abstract*- ZigBee is open global wireless protocol based on IEEE 802.15.4 standard. ZigBee operates in the 2.4 GHz frequency band similar to WiFi and Bluetooth, but it operates at much lower data rate of 250 kb/s. It may interfere with other devices which work in same frequency band. This paper introduces Neuro-Fuzzy approach for transmission of Moving Picture Expert Group (MPEG-4) video over ZigBee Wireless. Limited data rate channel in ZigBee may cause data loss and time delay due to high variation in bit rate of MPEG-4 Variable Bit Rate (VBR) which insisting high bandwidth. It leads ZigBee channel to be impracticable for transmission of MPEG-4 VBR video. This new Neuro-Fuzzy application enables ZigBee channel to be able to transmit MPEG-4 video. In this paper, two Neuro-Fuzzy schemes used to supervise input and output from data storage called traffic-governed buffer. The first Neuro-Fuzzy scheme take care that buffer neither oversupplied nor starved with video data. The second Neuro-Fuzzy scheme ensures the departure rate meets the traffic condition of ZigBee. The proposed schemes enable to transmit video over ZigBee with minimum data loss and excellent picture quality.**

Keywords– Two Neuro-Fuzzy scheme, ZigBee, MPEG-4 video, Traffic governing buffer Introduction.

I. INTRODUCTION

MPEG-4 VBR requires a significant data and a large band-width for video transmission. VBR refers to Variation in Bit-Rate that allows the video to use small data in which video have large number of key frames and to use large data in which video have more number of different frames to provide constant video quality. MPEG-4 VBR gives uncertainty, large amount of delay, and more data loss because of variations in bitrate. Some wireless devices like ZigBee is the only standards that uses the radio frequency in order to address the unique need of low cost and low power mesh networks, which can be used in many applications like personal and home control, remote monitoring, smart energy, building automation network applications and telecommunications, But the bandwidth of ZigBee device is limited, variable and uncertain because of large interferences in radio-frequency which present in surrounding environment and portability of ZigBee device. This research uses ZigBee of 2.4 GHz frequency band and limited data rate of 250 kb/s. The frequency band of ZigBee device might be affected due to the interferences of other wireless devices like Wi Fi and Bluetooth which operates in the same frequency range. Therefore it is almost impossible to transmit the MPEG-4 VBR video over the ZigBee channel.

This research uses soft computing techniques to transmit the MPEG-4 video from ZigBee channel. Fuzzy Logic, Neural Networks and Neuro Fuzzy techniques are used to handle the uncertain, unpredictable and ill-defined systems and are applied to many wireless communication schemes out of which some techniques are briefly described below [1].

In 2002, Mohamed Rubino proposed random neural networks to maintain the quality and the transmission rate of video at the receiving end automatically, to provide better performance. The real-time applications which uses this technique to transmit the video over IP networks that produces comparatively good result than the standard approach of transmission [2].

In 2010, Chen et al. had invented new approach for an image restoration method which is based on Hopfield neural network. This approach is used to reconstruct the video quality for a given time interval to image formation and transmission process over GPRS communication system. When the result is drawn out by simulated process this method can restore the video frames effectively which are not clearly defined [3].

Abdennour presented a short-term predictor based on Neuro-Fuzzy technique for MPEG-4 video. This approach is based on Adaptive Network Fuzzy Inference System (ANFIS). Finally he concluded that this proposed system is able to predict accurately for broadcasting video sequences than the

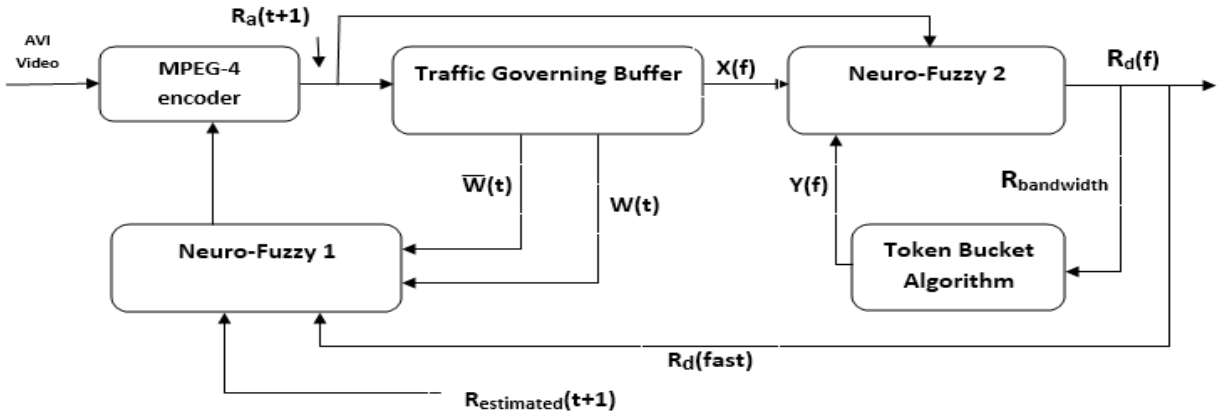

Fig. Two Neuro-Fuzzy scheme for video transmission over Zigbee

linear prediction [4]. Zainaldin et al. proposed a system based low bit-rate adaptive rate control to transmit the video over the ZigBee network. Transform-expand-sample method was employed to design the low rate MPEG-4 video. The network simulator-2 was used to check the transmission of MPEG-4 video over ad-hoc network of ZigBee. He Said that this technique is used to enable the large number of applications for continuous monitoring purposes [5].

II. MPEG-4 ENCODR

Using video compression we can transmit or manipulate video data very easy and fast. Video compression maximizes reconstruction quality and minimizes video file size. Video compression reduces size of file means avoid redundant data. MPEG-4 encoder consists of three modules Temporal model, Spatial model, Entropy model. In Temporal model we encode the first frame as a key frame and encode next frame such that only difference between key frame and that frame is encoded. In Spatial model we uses Discrete Cosine Transform (DCT). In DCT video signal is compressed in such a way that the higher frequencies of cosine waveform are removed. Entropy model uses Huffman coding algorithm [6].

III. NEURO FUZZY SCHEME -1

The Rule Based Fuzzy controller (RBF1) generates input or arrival rate for Neuro Fuzzy Scheme 1.The Neuro Fuzzy Scheme 1 has two inputs first one is mean value of data rate w(t) having four linguistic codes Small, Intermediate, Large and Very large second one is standard deviation w(t) having three linguistic codes Small, Intermediate and Large. It produces constant arrival data rate Ra(t+2) which having seven linguistic codes Very Small, Intermediate Small, Small, Intermediate, Large, Intermediate Large and Very Large. To avoid time delay between the consequent video frames it designed with as minimum as possible to execution faster. RBF1 controller uses twelve rules to provide seven possible output values.

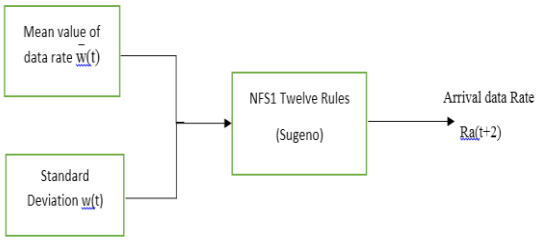

Fig 2. Arrival rate of Neuro-Fuzzy Scheme 1

A Group Of Picture (GOP) contains 12 video frames. The desired arrival rate Ra(t+2) is calculated using the equation

Ra(t+2) = ra(t+2) * (Ra_max - Ra_min) + Ra_min

Where, (t+2) is a GOP encoded by MPEG encoder, ra(t+2) is the fuzzified of Ra(t+2) , Ra_min (min departure rate)=min Restimated(t+1), Rd(Flast).

The fuzzy output of MPEG-4 video is arrival-rate Ra(t+1). The arrival-rate Ra(t+1) of the traffic-governor is controlled on a GOP by GOP basis using the Neuro-Fuzzy scheme-1 [1].

IV.NEURO FUZZY SCHEME -2

This Component controls the data rate from traffic governing buffer and it should associated with the data rate of ZigBee. It has two fuzzified inputs first one is fuzzified data rate from traffic governing buffer x(f), having four linguistic codes and are Empty, Average, Full and Saturated. Second one is fuzzified tokens from token bucket having three linguistic codes and are Empty, Average and Full.

The specified output of this component fuzzy output Rd (f) which is constant data rate from the traffic governing buffer. This data rate is controlled frame by frame by this component. It is having seven linguistic codes Very Small, Small, Medium, Big and Very Big. This component applies 12 Sugeno rules.

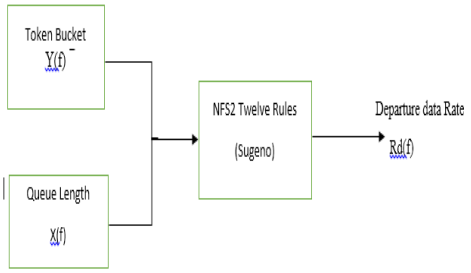

Fig 3. Arrival rate of Neuro-Fuzzy Scheme 2

The desired arrival rate Rd(f) is calculated using the equation Rd(f) = rd(f) * (Rd_max - Rd_min) + Rd_min

Where, f is a frame, rd(f) is the fuzzified of Rd(f), Rd_min (min departure rate)=min Ra(t+1), Rd_max (max departure rate)=max Ra(t+1) [1].

V. TOKEN BUCKET ALGORITHM

ZigBee device consist Token bucket algorithm implicitly. The token bucket is used to prevent the overflow of data into the network. If video data floods the network, the electronic tokens will be taken and the surplus of video data will be kept in the bucket and flushed after some period of time. Because of its ability to flush excessive data, the token bucket is utilized for real time video transmission, which requires video data to be transmitted in sequence. However, token bucket does not accommodate for data loss and video quality. The token-bucket date rate policing therefore is typically less to control the transmission of MPEG-4 video over 2.4 GHz ZigBee wireless [1].

VI. ZIGBEE PROTOCL LAYER

ZigBee is a cheap, less power consumption, and can handle large number of devices and has main applications into automation industry.

The 802.15.4 offers 27 channel spread across 868 MHz, 902 MHZ, and 2.4 MHz license-exempt spectrum. 802.15.4 Radios are required to transmit at 1mW. Depending on the power output, 802.15.4 offers a range of approximately 1 m to 100m. ZigBee devices require less power and they are cheaper than other 2.4GHz frequency band and its simplicity make ZigBee an ideal wireless technology.

The 802.15.4 standard only defines the PHY and MAC layers. ZigBee devices perform 3 roles as coordinators, routers, and end devices. The coordinator acts as coordination node and maintain ZigBee-Specification information about the Personal Area Network (PAN). Routers perform participation in ZigBee's routing protocols. End devices are analogous to 80.15.4's RFDs: they should communicate with each other.

The ZigBee application layer consists of application objects, application support, and device object. The application support connects two end devices together based on services and requirements they provide. The device object connects, respond to binding request, ensure a secure communication, search devices and determine the application services they provide.

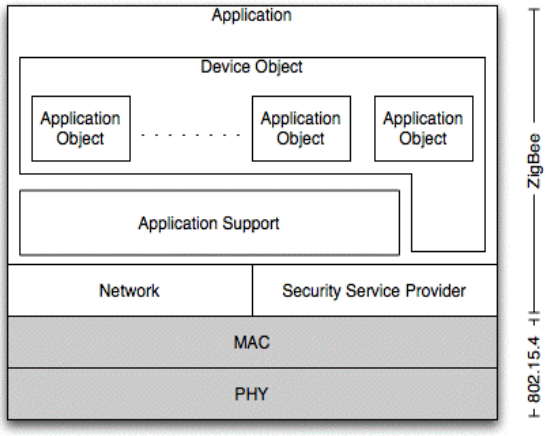

Fig.4 zigbee protocol layers

VII.CONCLUSION

In this paper we presents two Neuro-Fuzzy Schemes governing the input and output of traffic governing buffer, which used to decrease excessive output data rate from traffic regulator to ensure that MPEG-4 VBR video data knows traffic condition before entering into the ZigBee network. These two Neuro-Fuzzy Scheme are modelled to control the traffic condition and to decrease the standard deviation at a different levels of noise, Noise from surrounding devices working at 2.4 GHz frequency band.

These two Neuro-Fuzzy Schemes technology is appropriate for real time application as results generated as per traffic condition during transmission. These schemes used to degrade in flooding and data loss of MPEG-4 VBR video which shows maximum data transmission and simultaneously better and consistent image quality.

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