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Development of Flood Monitoring System for Transferring High Resolution Multimedia Frames

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Abstract— Recent increase of Urbanization encroachment and filling up of natural drainage channels and water bodies lead to urban flooding during heavy rainfall. Among various disasters, flooding is unique as it has a very high degree of predictability. The flood will result in loss of life , damage to buildings and other structures. During heavy rainfall the mobile networks lose their connectivity due to signal loss, delay, fading etc., so the monitoring and transfer of flood related information will become a challenging factor. This raises a demand for an effective and efficient flood monitoring system to transfer flood related information to the control room. In this paper, we have developed an Flood Monitoring system for transferring High resolution Video frames which uses concurrent multipath scheme in stream control transmission protocol, even in the worst network condition without any loss.

Keywords— SCTP, multi-homed network, High resolution video, H.264, Concurrent Multipath Transfer

I. INTRODUCTION

A flood is an excess of water or mud on dry land. The urban flooding is caused by the overflow of water in an water course such as river, pond or drainage ditch. Some of the reasons for urban flooding are heavy rainfall, deforestation, urbanization, poor water and sewerage management, lack of attention to the nature of hydrological system and lack of flood control measures due to the delay in receiving flood information from the flood area to the control room.

In order to minimize the flooding effects, there should be an immediate transfer of video information from the flooded area to the flood surveillance room without delay in a fully fledged way in the mobile environment .Since, the mobile nodes are movable within its terrain area that results in instability and uncertainty of data sharing. Hence, there is a need of transferring flood expected area information that can be affected between the source node and the surveillance room.

Previously, there have been many approaches introduced and implemented for monitoring the flooding areas. Out of them, there have been common drawbacks identified in terms of exchanging information between source and surveillance centre without compromising data loss and delay. In addition to that, the quality of the video must also be taken into account while receiving, since the flooding cannot be predetermined and pre planned fully amidst natural calamities which create technical difficulties over the data reception under mobile adhoc environment.

II. OBJECTIVES

From the real time needs and drawbacks of the existing flood management surveillance system, the following objectives are set to achieve designing and developing an Urban flood monitoring high definition video surveillance system as follows:

- To improve the transmission efficiency of scalable videos of the flooding areas.
- To eliminate the path switching overhead in multipath mobile environment during flood.
- To overcome out of sequence packet delivery to the client due to packet loss and to reduce receiver buffer block
- To successfully transmit the high definition video concurrently in multi-homed network.

III. RELATED WORKS

Currently most of the countries doing research in disaster management. According to the inference from the research article in the journal “Golden Research Thoughts” on ‘flood control policies in India’ 2012 ,the Central Water Commission manages a major network of such flood forecasting stations on inter-state rivers in 18 states in India. The techniques of observation of hydrological and hydro-meteorological data and their transmission to the forecasting station have been constantly under review and updating. Flood management does not aim at total elimination or control of floods or providing total immunity from the effects of all magnitudes of floods, which is neither practicable from economic considerations nor even necessary, keeping in view other realities that are faced in the Indian context.

Feng Xu and Wentao Wang (2010) developed a solution based on digital signal processing methods to solve problems such as big errors of data in the form of video transmission between flood suspected area and the control room by means of embedded design approach and real-time monitoring.

Lai C.L et al (2007) proposed a simple and effective method for automatic disaster detection in the early stage by real time video analysis. A fully automatic process is developed to substantially improve the performance, especially in early detection thus to reduce the loss caused by natural disaster, of the existing security surveillance systems.

Jiyan Wu, et al (2015) formulated a 'Concurrent Multipath Transfer - Content Aware' (CMT-CA) solution featured by scheduling based on the estimated video parameters.

Chau Yuen et al (2015) presented a mathematical formulation for multipath load distribution and derived the solution based on utility theory.

Wei song and Weihua Zhuang (2012) proposed an analytical approach to focus on video streaming traffic and to evaluate the packet level for improving performance of a multipath transmission scheme, which sends video traffic bursts over multiple available channels in a probabilistic manner.

S. Prabhavat et al,(2012) have discussed traffic splitting and path selection for load balancing and to maintain packet ordering.

Vicky Sharma, Koushik Kar (2012) developed a Multi-Path LOss-Tolerant (MPLOT) transport protocol for an effective utilization of the available bandwidth and diversity provided by heterogeneous, lossy wireless paths.

S. Han et al, (2011) developed a packetization-aware fountain code for high quality video streaming.

From the literature survey, the following are the limitations in existing flood monitoring system:

- Most of the video surveillance for flood control system concentrates on data acquisition rather than data transmission and its quality.
- The system performance with high energy efficiency schemes lacks to provide high quality real-time video streaming.
- Quality of Experience (QoE) metrics from the past history of flooding has not been defined well.
- Algorithms used to deliver multiple video streams are not considering the time- varying channel status.
- No solution is given for mobile video delivery in wireless networks to reduce the packet delay and consumption of bandwidth.

IV. STREAM CONTROL TRANSMISSION PROTOCOL (SCTP)

Stream control transmission protocol (SCTP) is the IETF standardized transport layer protocol, which can be used in the place of both transmission control protocol (TCP) and User datagram Protocol (UDP).SCTP is a connection oriented protocol to provide a reliable data transfer operating on the top of a connectionless packet network like IP. It provides i)error free data transfer ii) data fragmentation based on the path's MTU size iii) network-level fault tolerance with multi-homing feature. It exploits the inbuilt multi-homing and multi streaming features for transferring data across multiple independent end to end paths.

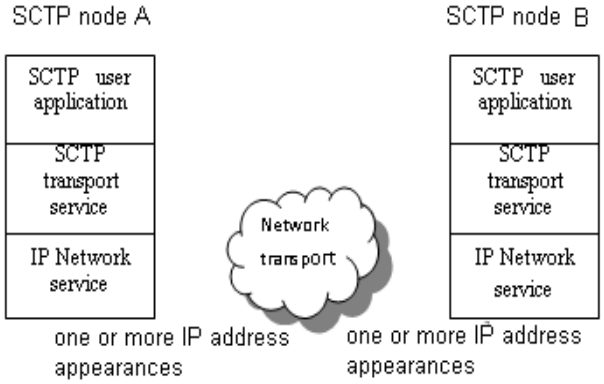


Fig.1 An SCTP Association

Fig.1 shows the SCTP Association. In each endpoint chooses a single peer IP address as the primary address through which new data is transmitted during normal transmission. If the primary destination becomes unreachable, the SCTP sender switches to an alternate destination address to complete the data transfer.The ability of SCTP to support network connections in a single end to end association enables it to provide uninterrupted continuous communication sessions in any mobile environment.SCTP has been recognized as an efficient transport layer protocol to meet the gap between stringent Quality of service (QoS) requirements for video transmission and efficient utilization of the available resources.

V. FUNCTIONAL DESCRIPTION OF SYSTEM MODEL

In order to monitor and evaluate the flood suspected area through high definition videos in mobile adhoc environment, an effective flood video surveillance system is proposed, by using CMT scheme on the realistic hardware based multi homed mobile network for providing high quality video transmission with minimum delay.The fig.1 shows the overall functional diagram of the proposed surveillance system for Urban flood monitoring.

The system has three major parts, namely transmission section, multi-homed mobile network and receiver section. The surveillance camera located at the flood prone area gives the input video signal to the monitoring system. The transmitter section comprises of a multi stream encoder and a traffic allocator. The uncompressed analog video signal from the camera is digitized and fed to the multi-stream encoder. The encoder compresses the received signal into N multiple streams of H.264. This standard provides a high resolution video stream (of 1080p).Then the traffic allocator assigns the streams to multiple end to end paths. These paths are maintained by multipath routing protocol at both transmitter and receiver. This protocol finds the multiple routes between source-destination pair, based on fault tolerance, path diversity and load balancing. The transmitter section forwards video streams to the receiver via multi-homed mobile network.

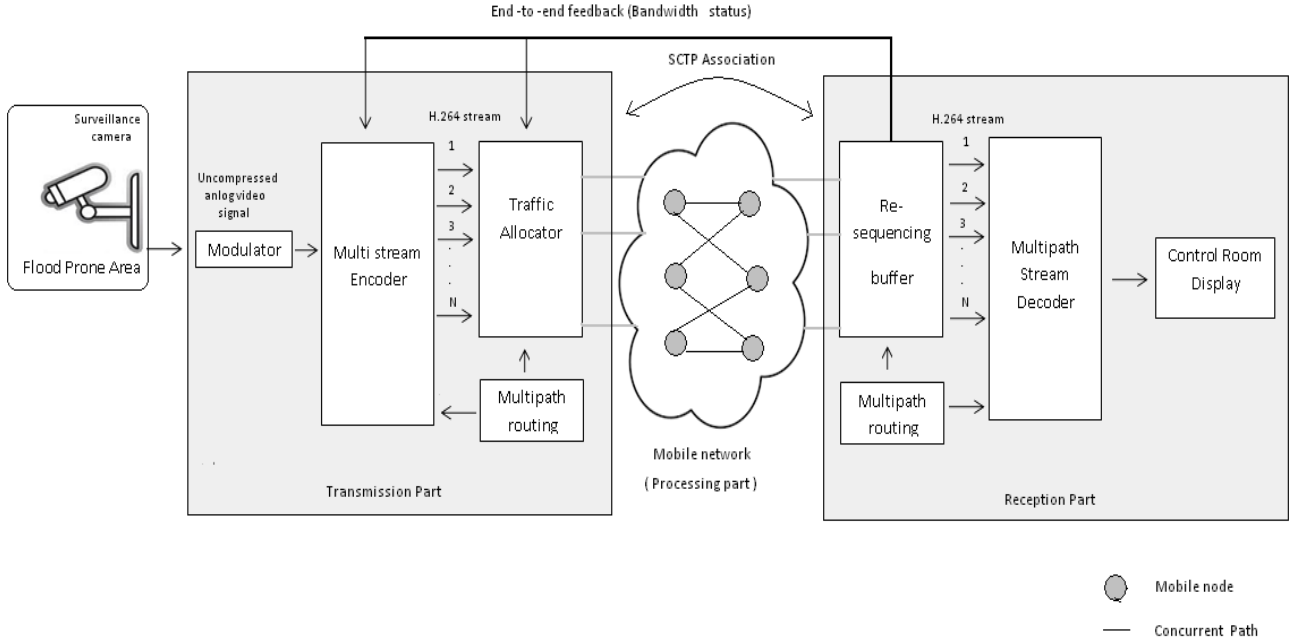


Fig 2.Overview of the proposed flood monitoring system

At the receiver side, the arrived streams are rearranged in the re-sequencing buffer. The video signal is extracted from the buffer, decoded and then displayed at the control room.

The difficult task is to identify the shortest path in the movable environment concurrently under three cases as follows. Case i) The primary path as the ideal path

Case ii) Non-availability of Primary path leads to choose the alternate path

Case iii) If the secondary path fails

The processed video information is to be sent through multi-homed mobile network by adapting one of the above mentioned cases. The ultimate aim of designing multi-homed concurrent scheme is to ensure that the data should not be lost at any cost, since the information about the flooding area must be reached over the control room successfully and successively. The video streaming experiments can be performed with the bandwidth up to 3.2 Mbps.

A. System Configuration

The experiment consists of 2 host nodes namely sender S and receiver R

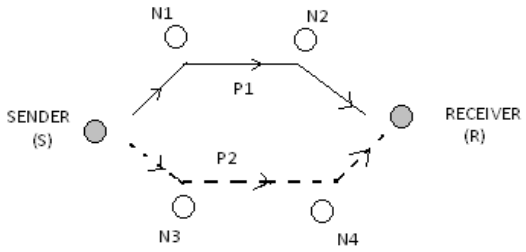


Fig.3 multi-homed mobile network scenario

Sender → Node that receives video from surveillance camera.
Receiver → Control room
Primary Path (P1) S→N1→N2→R
Secondary Path (P2) S→N3→N4→R

B. Flow Chart

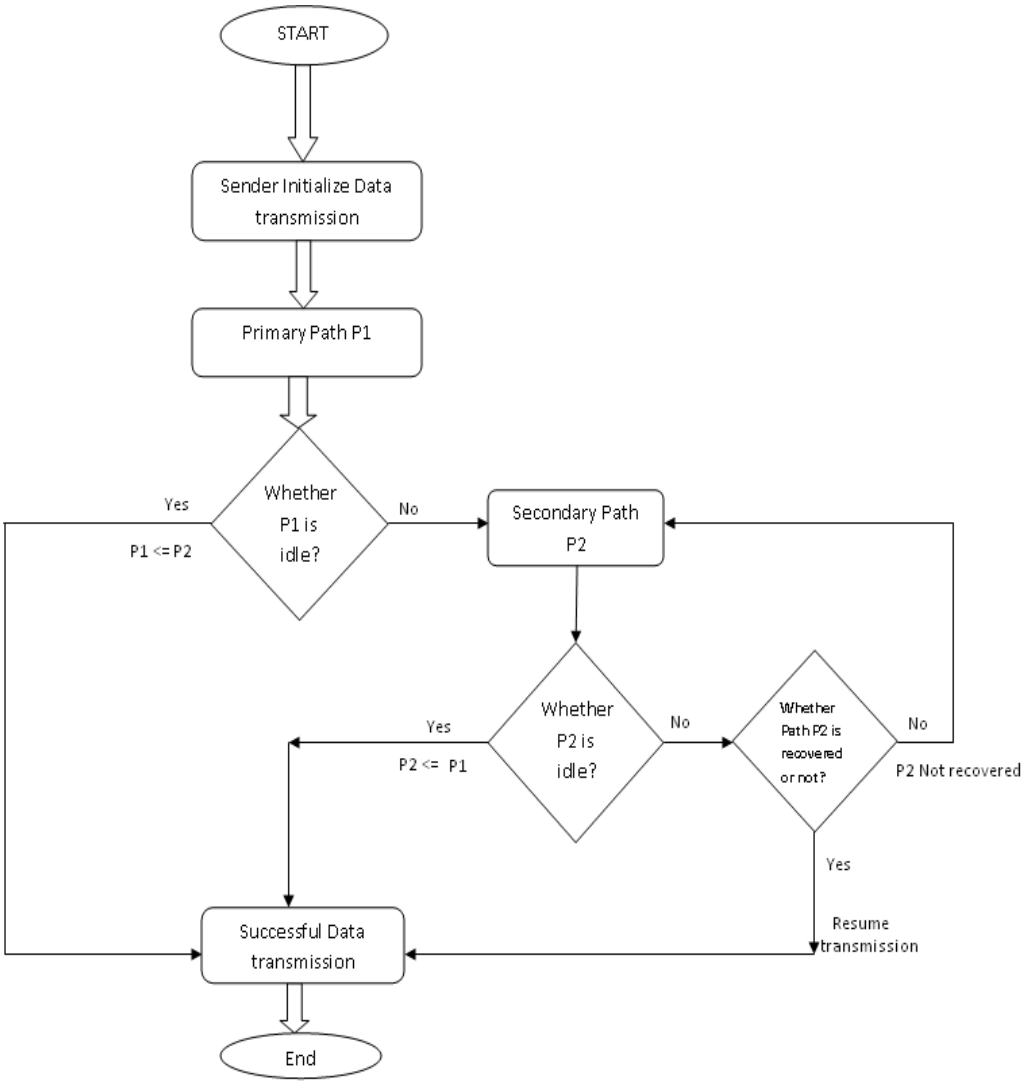


Fig.4 Flow chart for path selection

B. Algorithm

Step: 1 Sender (S) initializes the video transmission

Step:2 S chooses the idle path for Transmission

S→P1 (since P1 <= P2); S→N1→N2→R

Step: 3 If S receives the ACK from the receiver (R) accomplish the video transmission through P1.

Else Check whether P2 is idle

Step :4 If P2 is Idle (P2<= P1).

S→ P2;

S→N3→N4→R

Else wait until RTT elapse (t= 3ms)

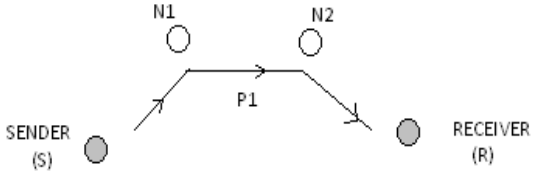
Step:5 If RTT Elapsed go to step2

Else transmission resumed

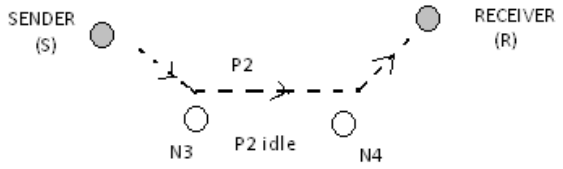
VI. EXPERIMENTAL SETUP AND OUTPUT

The simulation environment for the proposed flood monitoring system is created with two multi-homed hosts with idle primary path and secondary path. The simulation will be carried out using NS-2 for the below mentioned four cases.

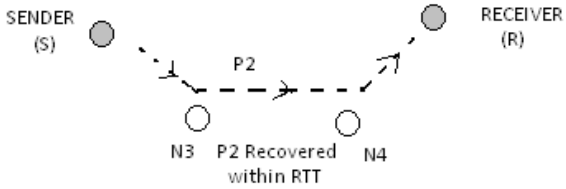
Case i) Sender (S) initiates the data transfer through idle primary path P1.



Case ii) S chooses idle secondary path P2, when P1 is not idle.



Case iii) If P2 is not idle and P2 is recovered within RTT ,S transmits the frames through P2.



Case iv) If P2 is not idle and P2 is not recovered within RTT ,S transmits the frames through P1.

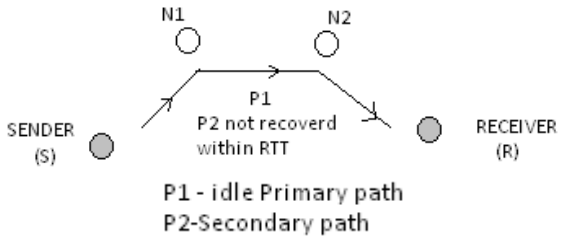


Fig.5 Simulation environment for various scenario

C. Novelty Of The Proposed Work

The novelty of this work comprises the development of the mobile adhoc environment ,for the flood level scenario and the concurrent multipath transfer for transferring high quality video images.

VII. CONCLUSIONS

Flood monitoring system for transferring high resolution multimedia frames has been developed. The proposed system is designed for monitoring the flood levels and those places will be shot concurrently in order to send the same to the control room. In turn ,the control room forwards the frames that have been sent by the proposed device to the central surveillance facility room for taking further actions in terms of precautionary measurements to either save the people of that flood effected area or to safeguard and prevent the unexpected massive outcomes by the flooding. Since the proposed system has used SCTP,the reliability is ensured along with the maintenance of the quality of video frames. It is also ensured that the proposed monitoring system is well ahead of the existing system by means of negligible data loss in the form of packets and reduced delay in transferring the moving images. The proposed surveillance system needs to be undergone with various case studies of flood levels and locations.

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