Event Based Surveillance using WiMAX

Suherman\textsuperscript{1}, Marwan Al-Akaidi\textsuperscript{2}, Al-Khowarizmi\textsuperscript{3}, Yulianta Siregar\textsuperscript{1}

\textsuperscript{1}Electrical Engineering Department, Universitas Sumatera Utara, Medan-Indonesia
\textsuperscript{2}American University in the Emirates, Dubai, UAE
\textsuperscript{3}Universitas Muhammadiyah Sumatera Utara, Indonesia

*suherman@usu.ac.id

Abstract. WiMAX provides high bitrates wireless connectivity. This high bit rate wireless connection is potential to be used as the wireless camera surveillance infrastructure. However, real cases show that existing camera resolution does not help much when investigations go in detail. The captured images are often blurry when identifying someone ID. Therefore, more camera resolution is needed. However, problem emerged as higher camera resolution means higher bandwidth requirement. This paper proposed an event based video transmission to tackle bandwidth shortage. Video is sent only when special event occurred, such as fast movement or object detection. Otherwise, video is just recorded locally. The NS-2 simulator was employed to examine the idea. Low bit rate video was initially employed and sent together from surveillance cameras to server. The quality of video is then measured. The camera codec was then replaced by using higher coding rate video. As result, bandwidth drain occurred that produced high packet losses and poor video quality. The event based surveillance was the applied that enable at most 25% possibility that a video sent to server. As results, system is able to maintain high quality video received by the server.

1. Introduction

Video surveillance cameras have been widely installed to help monitoring places or objects. Infrastructures have been built by using cable, optics and radio. Video resolutions are also improved to enhance image quality. For the latest item, higher bandwidth infrastructure such as optical network and high speed microwave link such as WiMAX are needed. However, when events occurred demanding details on surveillance images, quality is an issue. High resolution camera that is able to identify persons or object in details is demanded.

Meanwhile, video processing technologies are in progress, including motion detections, searching, tracking and behavior analysis [1]. Those processing techniques are able to identify either video needs special attentions or not. Or at least, time stamps can be added to mark video part that can be visited when an event occurred or details are requested. Video processing technologies can be used to support efficient surveillance systems [2].

Efficient surveillance system can be approached by various techniques. Radio standard of WiMAX provides architecture and QoS leveling to enable application variations [3]. However, there are more enhancements provided by researcher such as enhanced bandwidth request mechanisms [4, 5], transmission scheduling [6, 7] or cross-layer schemas [8-10].

This paper proposes surveillance enhancement by employing the high resolution cameras that are able to provide sufficient information when details on images are demanded. In order to overcome bandwidth degradation, video processing techniques are applied to decide either an important event occurred or not. Video is sent to server only when important event occurred. Otherwise, video is just recorded at surveillance node as memory spaces are not expensive. In order to examine the proposed method, WiMAX simulations were employed with video quality measurements were performed based on packet losses and peak signal to noise ratio (PSNR).
2. Methodologies

In order to observe the proposed method, NS-2 simulator was set up with WiMAX NIST module that covers 1000 m serving four subscriber stations in various locations as depicted in Figure 1. The radio system uses 64 QAM modulations with a two-ray ground propagation model and download ratio 30% so that most bandwidth is for uplink traffics.

Sequences of images coded by using MPEG4 with rates of 500 kbps is simulated for low resolution camera and MPEG4 with bit rate of 700 kbps represent the high resolution video. These videos were generated from the akiyo_cif.yuv video trace. The video is chopped into some packets with size of 1024 byte sent through the WiMAX link using user datagram protocol (UDP) [11].

The received packets within the server are then reconstructed into video traces. And by using the evalvid framework, traces were reconstructed to the received video file. Losses when reconstructed this video file is noted and the quality was compared to the original transmitted video file. PSNR values are then obtained. Packet delay and PSNR are the main measured parameters.

![Figure 1. Simulation configuration](image_url)

The WiMAX architecture is set to be flat all traffic is set to have best effort (BE) services. Figure 2a shows the original architecture and Figure 2b is the flat architecture. BE is a simple QoS which does not involve negotiation and parameter enforcement. Original architecture provides UGS, crtPS, nrtPS and BE [3]. It also does not perform polling.

![Figure 2a. Original architecture](image_url)
The evaluated system uses the packet-aware bandwidth request mechanism [13] that manages request using reduced contention window of truncated binary exponential backoff (TBEB) technique and piggyback the next P frame transmission request. The sorting scheduler uses packet aware scheduler that prioritizes important frames [13].

3 Evaluation results

Figure 3 shows delay comparisons between conventional surveillance with low camera resolution and high resolution. The high camera resolution experiences 107.88% higher average delay than the low resolution. Delay achieved 59.9 ms per packet. Although it seems acceptable, one frame may be sent in more than four packets, that makes delay four times higher and become unacceptable for real-time application. Meanwhile, by implementing the proposed method for high resolution video, delay decreases about 31.25% with average delay 41.1 ms, which is much lower than the conventional method (Figure 4).

![Figure 2. WiMAX architectures][1]

![Figure 3. Delay comparison between low and high resolution in conventional surveillance][2]
High resolution surveillance: conventional versus event based

Figure 4. High resolution surveillance: conventional versus event based

High resolution video causes PSNR drops from 35.96 dB to 32.6 dB in conventional surveillance. However, by applying the event based transmission, PSNR increases as video is sent only when an event detected. Simulating the event results 75% traffic decrement then enables video transmission to have sufficient bandwidth. Figure 5 shows the comparisons high bit rate video sent by conventional method and the proposed method. Overall, the video performance (PSNR) increases significantly compared to the conventional method by 19.6% in average. The transmitted video by using based event transmission has even better quality than low resolution video, in average 38.99 dB and 35.96 dB respectively.

Figure 5. PSNR comparisons

4. Conclusions
This paper has proposed event based surveillance using WiMAX, where high resolution video is used to maximize the monitoring purpose. Instead of sending video continuously to server, video will be sent if a predetermined important event is detected. Otherwise, video will be saved locally. So that the overall bandwidth requirement decreases and the performance of the transmitted video is better. Simulation using NS-2 shows that the high resolution surveillance application with the proposed method performed better the conventional method. Video quality/PSNR increases about 19.6% with lower transmission delay. Future work may deal with techniques as the trigger event in the proposed method and solutions to minimize the drawbacks.
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