Jurnal
Teknologi

Full Paper

THE STUDY OF VEGETATION EFFECT ON WIRELESS STREAMING VIDEO FOR AGRICULTURAL MONITORING

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Article history
Received
1 June 2015
Received in revised form
13 July 2015
Accepted
20 August 2015

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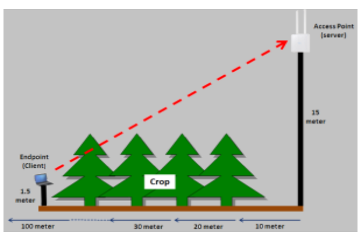
Graphical abstract



Abstract

This paper presents the study of video streaming over wireless channel based on experimental measurements in the presence of fading caused by the physical environmental. The emulation of video streaming file through wireless channel is measured using IxChariot software from Ixia. The obtained emulation of signal quality from the video streaming file was measured in terms of network throughput, RSSI and packet loss. The results show the credibility of wireless network for streaming video file in agricultural area. The statistical results show that there is significant negative effect of physical environmental condition on wireless video streaming and received video quality.

Keywords: IxChariot, RSSI, throughput, byte loss, jitter, wireless network, wireless video streaming

Abstrak

Kertas kerja in membentangkan kajian 'Streaming video' pada saluran tanpa wayar dinilai melalui pengukuran uji kaji dengan kehadiran susutan pada sistem rangkain disebabkan oleh keadaan fizikal sekitar di sekeliling. Satu ukuran emulasi fail video streaming dihantar melalui saluran tanpa wayar diukur menggunakan perisian IxChariot. Kualiti isyarat emulasi diperolehi dari fail video streaming diukur dari segi pemprosesan 'throughput', 'RSSI' dan 'Packet loss'. Keputusan menunjukkan kredibiliti rangkaian tanpa wayar untuk 'streaming' fail video di kawasan pertanian. Keputusan statistik menunjukkan kesan negatif yang ketara disebabkan keadaan fizikal sekitar keatas 'streaming video' tanpa wayar dan kualiti video yang diterima.

Kata kunci: IxChariot, RSSI, pemprosesan, kehilangan paket, ketar, rangkaian tanpa wayar, 'streaming video' tanpa wayar

1.0 INTRODUCTION

The proliferation of internet usage had given a great impact on many aspects especially connectivity between disparate systems. Improvement in has wireless communication has led to the development of wireless networks that have become the most crucial facility in most industries [1]. In precision agriculture for example, wireless technology has become an efficient systems for monitoring crop growing conditions, farm equipment and, in some cases controlling devices. Unpredictable weather condition can have a significant on yield in agricultural industry. In some agricultural and conservation sectors, monitoring is implemented for security to detect such as wild animals, poachers, etc. that will can contribute to losses. The deployments of monitoring devices such as surveillance camera and sensors can assist farmers to ensure that crops are not damaged, maintain good growing conditions and improve yields. Video surveillance is a modern system for monitoring agricultural areas which is already widely used by many farmers. The video system is frequently incorporated into an overall systems designed for monitoring herds. When using video technology to monitor large machinery, the focus is less on theft but more on their operations or theft of spare parts, fuel and tools. In terms of safety and accident prevention, video surveillance can be used to monitor and prevent unauthorized access to machinery. The risk of injury is often very high when some machines are used. In some instances, video monitoring may be employed to ensure that the machines are operated properly as a means to reduce breakdown and costly repairs.in some most instances, video cameras can be directly installed on large agricultural machinery to monitor processes. Video data help farmers optimize multi-stage work processes, reduce maintenance time, and possibly cut down the staffing requirements. However, there are several issues that need to be considered before the deployment of wireless device in agricultural environment. Where the wireless devices are remotely deployed, the signal may need to propagate through vegetation of varying type and density. These have different effects on wireless signal strength and dispersion which affect the data packet transmission rate. Moreover, the effect of weather conditions such as windy and rainy conditions on wireless network data throughput especially during streaming of video file need to be investigated before deploying surveillance cameras.

Video streaming may refers to real-time transmission of video which means that the video and audio signal must be sent or received continuously. Streaming live video over wireless channel may suffer significant degradation in the video quality due to the fluctuations of wireless channel conditions. It is more challenging to obtain consistently good quality real-time video over a wireless network compared to a wired network. The basic problems in wireless video streaming in agriculture are attenuation, scattering, diffraction and absorption of the signal by leaves, twigs, branches and tree trunks. Furthermore, movement of the vegetation due to wind and attenuation due to rain can affect the signal quality especially for video streaming. A sunny day may improve the visualization of camera however as the heat increases the quality may vary and the throughput of wireless network will be affected. For the benefits of agricultural monitoring, it is crucial to investigate the effects and variations caused by environmental conditions to wireless. This paper investigates the effect of vegetation on wireless streaming video foe smart agriculture monitoring at 2.4 GHz band.

2.0 RELATED WORK

Agriculture has always played an important role in the economic cycles [2]. Improvement in agricultural practices and the employment of technologies have resulted in a significant contribution the farming to the economy of many countries. Improvement in agricultural is not only in the amount of production but also in the quality of the produce. Reliance on fewer large scale production means the supply is susceptible to adverse weather which may be localized. Environmental factors such as climate change, weather condition and intruders (theft and vandalism) are a concern to farmers.

The deployment and performance of wireless systems are affected by irregular terrain, foliage, types of crops, the density of crops and weather conditions. Wireless sensor are widely used in precision agriculture for monitoring crop growing conditions which include factors such as temperature, humidity, wind, air and soil moisture. Although most of the wireless sensor nodes only transmit parameter values which are often widely used for managing water resources [3], visual monitoring is often required especially for high valued crops or those that are easily susceptible to adverse condition. The installations of cameras and other monitoring devices using wireless technology are common to assist farmers.

However, the challenge in using wireless technology in agricultural monitoring is that the size of video files is large compared to other sensors. The transmission of large video files affects the bandwidth that is available over the wireless link for other services. In addition, attenuation of the signal strength due to vegetation and time variability of the channel due to weather conditions affect the video quality in terms of data throughput, jitter, packet loss, receive signal strength indicator (RSSI), etc. S. D. S. Torshizi *et al*. [4] claimed that the impact of vegetation on wireless network throughput is a major concern in tropical countries like Malaysia. The authors also studied the performance metrics and found that packet loss increases when there is no multipath component from the vegetation. Many studies have been done on the quality of wireless network [5], link reliability [6], etc. rather than the video streaming for agricultural monitoring purposes which will be highlighted in this paper. Therefore, this paper studies the fluctuation effect caused by changes in the environment in agricultural areas using an emulated video files.

3.0 METHOD

3.1 Tools

The experiment such as shown in Figure 1 was conducted in indoor environment to investigate the difference between wired and wireless streaming to establish a reference before conducting the experiment in the real agricultural test-bed. The comparison of wired and wireless streaming is shown in Figure 2. The 1.5 Mbps live video streaming format was emulated and injected into network using IxChariot Software.

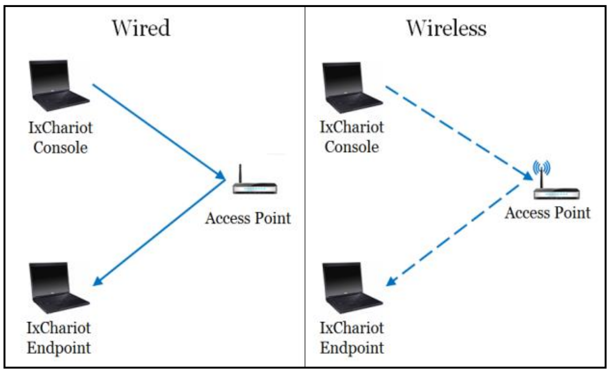


Figure 1 Experimental setup for wired and wireless streaming

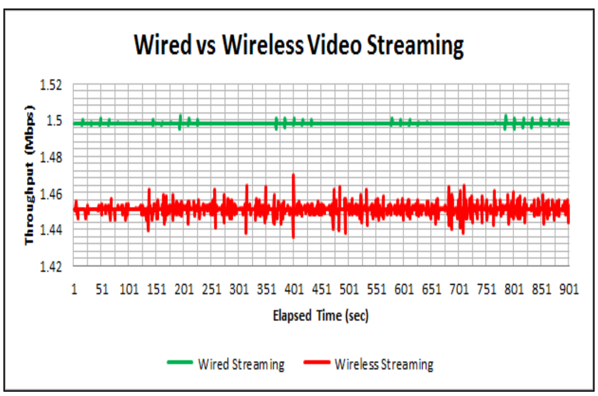


Figure 2 Comparison of streaming video on wired and wireless transmission

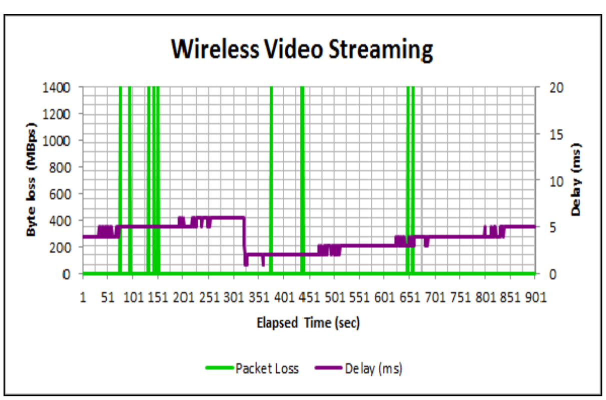


Figure 3 Byte loss and delay within wireless streaming

IxChariot is a software based network assessment tool used for measuring network performance metrics such as throughput, RSSI, Packet Loss and Jitter for video under real world condition. The measurement was made by sending a data from one endpoint to the other endpoint or a pair of network computer. IxChariot emulates distributed applications, captures and analyzes the resulting data. In this experiment, IxChariot was used to emulate the video streams through the use of scripts within the streaming script file directory. These streams will simulate the behavior of traffic through the network.

Based on Figure 2, the throughput for wireless streaming was unstable. The throughput suffers a drop from 1.5 Mbps to average of 1.45 Mbps. Based on Figure 3 the result shows 5ms delay and 1% of packet loss within wireless streaming.

3.2 Testbed

University Malaysia Perlis Agriculture Research area, as shown in Figure 4, practices mix-crop farming. The farm was divided into several plots and the description is shown in Figure 5.

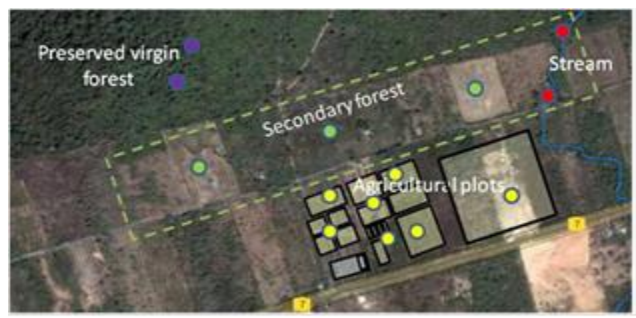


Figure 4 The whole area of UniMAP Agriculture and Biodiversity research area

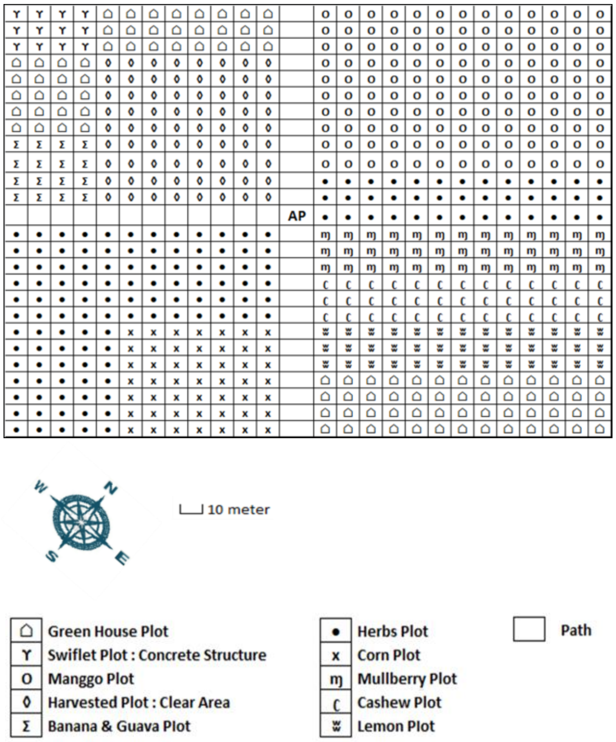


Figure 5 Plots in agriculture research area

1) Green House plot: Several greenhouses ofdifferentsizes occupy this area with average height of 3 m. Tomato, rock melon and grapes were planted in these green houses. The height of crops is 2 m and trunk size is 0.5-1 cm.

2) Swiftlet Plot: Occupied building of 7 m height for production of swiftlet nest. The experiment is not conducted inside the building rather data is collected around the structure.

3) Harvested Plot: Clear land area with no crops after harvest season.

4) Mango Plot: 12,500 m^2 plot planted with mango tree. The distance between the mango trees is 3.5 meters. The average height is 3-4 m with average trunk 5-10 cm diameter.

5) Banana & Guava Plot: Small area was alternatively planted with banana and guava with average height of 2- 3 meters.

7) Corn plot: Corn area planted with average of 2 meters height.

8) Mulberry Plot: Area planted with young mulberry tree with average height of 2 meters with small branches.

9) Cashew Plot: Area planted with cashew with crowded branches tree with average height of 2 meters.

10) Lemon Plot: Area planted with lemon tree with crowded branches with average height of 2 meters.

11) Path: Route for vehicles.

3.3 Testbed

The experiment was conducted on a real field made of 12 acre. A 15 m height pole was installed in the center of the farm area and a high power outdoor Access Point (Altai A2) is installed at the tip of the pole. IxChariot was used to inject the video file into the network and to measure the network statistics such as throughput, loss packet and jitter, etc. Figure 6 depicts the setup a laptop is being used as a client. Based on Figure 7, data was collected at every 10m distance up to 100 m continuously from the pole in 8 different directions; North, North-West, West, South-West, South, South-East, East and North-East. The laptop which acted as a client was mounted at 1.5 m above the ground while the data was collected every 1 second for 10 minutes at every position

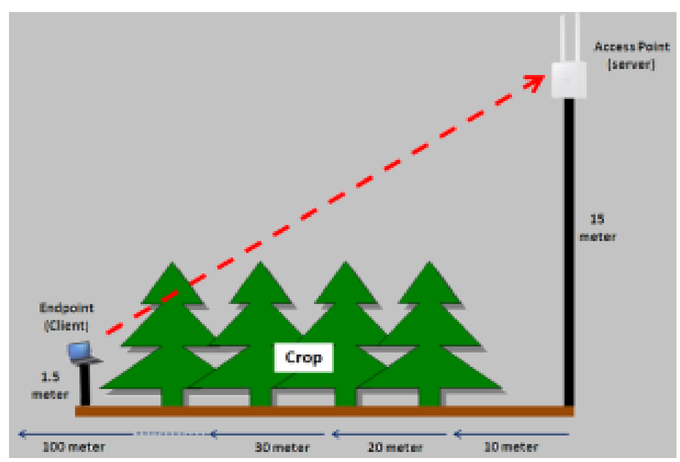


Figure 6 Experimental setup on agriculture test-bed

4.0 RESULT AND DISCUSSION

This section describes results of vegetation effect on the signal strength and quality of the deployed wireless network for video streaming transmission based on experimental observations. During the experiment, RSSI, throughput, byte loss and jitter of the signal are collected.

Figure 7 shows a comparison between the RSSI with distance for all eight directions. Based on the result, it shows an unstable reading on the North, North-East and East when compared to other directions. A greater path loss is seen at 30m distance of North and 20 m in the East direction with values of -90 dBm and -88 dBm respectively. The reason is due to scattering effect caused by high density of vegetation where mango, mulberry, cashew and lemon trees are planted. The height of these trees also obstructed the transmitter to receiver path. Results in [7], [8] shows that vegetation attenuation can significantly increase path loss.

Figure 8 compares the network throughput in each direction at every 10 m distance. Using the same setup such as shown Figure 5, 1.5 Mbps live video streaming was injected into the network using IxChariot. The throughput shows the data rate that the deployed network can support. Based on Figure 8 the throughput value decreases at 30m along the North path the RSSI results. From these results there is strong correlation between RSSI and throughput.

Figure 9 and 10 show the percentage of byte loss and delay jitter respectively. The result of the losses and jitter are very important they determine the quality of a live video through the network. The signal propagation is free space, the path loss (L) can be predicted using free space loss (FSL) as in (1),

$$L_{FSL}(dB) = -27.56 + 20\log_{10}(f) + 20\log_{10}(d) \quad (1)$$

where f is the frequency in MHz, d is distance between the isotropic transmitting and receiving antenna in meters.

Byte loss and jitter are inversely proportional to the throughput. From the result, byte loss and jitter increase in the network while the throughput decreases. The decrease in the network throughput is the result of drop of signal strength. From the analysis, we can see that the density of trees influence signal attenuation and hence wireless network performance and quality.

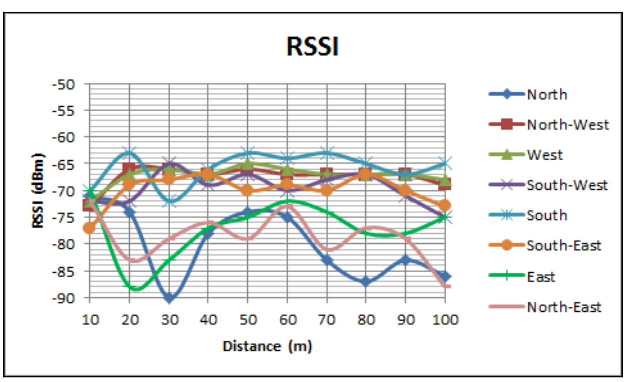


Figure 7 RSSI result for every direction and position

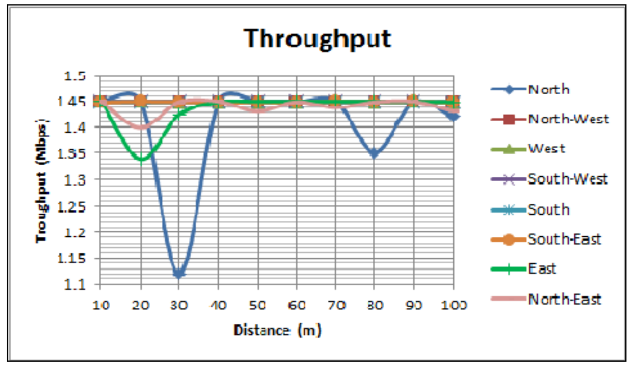


Figure 8 Throughput result for very direction and position

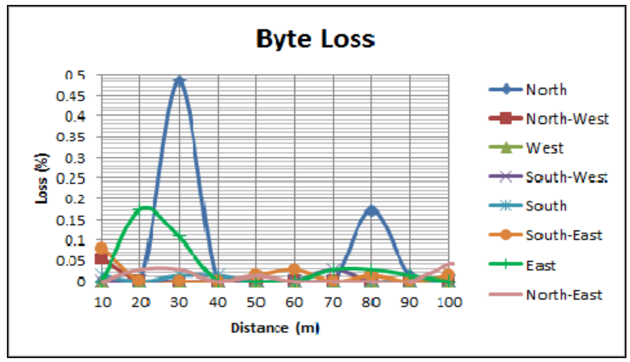


Figure 9 Byte losses result for every direction and position

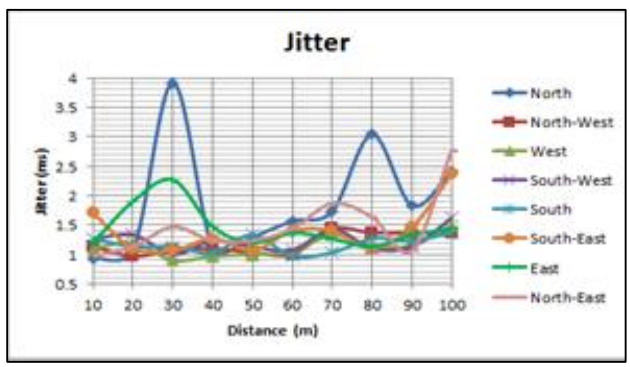


Figure 10 Jitter result for every direction and position

5.0 CONCLUSION

This study uses video streaming over wireless channel which to evaluate network performance through in the presence of fading caused by vegetation. IxChariot software is as important tool used in this experiment to assess the feasibility of using streaming video file over wireless channels in agricultural area. Result show that vegetation attenuation significantly affect data throughput. From these result, it can be concluded that for effective transmission of data over wireless link in agricultural environment, all system should be install at heights that above surrounding vegetation.

Acknowledgement

The author would like to thank Institute of Sustainable Agrotechnology of Universiti Malaysia Perlis (UniMAP) for accommodation and facilities to run our experiment.

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