The 433 Mhz Radio Assessment for Periodic Monitoring Image Delivery

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ABSTRAK

Radio 433 MHz bekerja pada frekuensi Industri, Sains dan Medis (ISM) dan populer untuk banyak aplikasi karena memiliki karakteristik pelemahan sinyal yang rendah dan tidak sensitif terhadap interferensi. Tulisan ini menguji penggunaan radio tersebut untuk aplikasi monitoring dengan pengambilan gambar periodik. Hasil pengujian menunjukkan bahwa radio dapat mengirimkan gambar dengan kehilangan paket lebih rendah dari 6% dan menghasilkan periode pengambilan gambar 40 s untuk bit rate 100 kbps.

***Kata kunci**: 433 MHz radio, aplikasi monitoring dengan gambar periodik, raspberry pi.*

ABSTRACT

The 433 MHz radio works in the Industrial, scientific and medical (ISM) frequency and gains popularity for various applications as it has low signal attenuation and insensitive transmission characteristics. This paper examines the radio for periodic monitoring image application. The assessment results shows that the radio link is able to deliver image with losses lower than 6% and period of image 40 s for 100 kbps bit rate.

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***Keywords**: 433 MHz radio, periodic image monitoring application, raspberry pi.*

INTRODUCTION

The 433 MHz frequency channel is part of the Industrial, scientific and medical (ISM) channel allocation which is license free (Hill R., 2014). The ISM 433 MHz signal propagation is low signal attenuation and not sensitive to metal and water reflection, which is suitable for low power transmission for few kilometers distant. Beside its low power consumption, the 433 MHz radio construction is relatively simple with small antenna requirement (Tuset-Peiró et al, 2013). The system has been used in many countries including Europe, America, China, and Japan which results high availability (Lin Z. et al, 2014).

There has been intensive works done by researchers in employing 433 MHz radio system. Li et al (2013) experimented 433 MHz radio propagation characteristics on greenhouse. The regression analysis results demonstrated the regression parameters and the transmitting power were quadratic relationship. It also show that there is quadratic regression equation between the environmental factor n and transmitting power. The 433 MHz radio have also been used for biomedical applications (Kim S., 2013). The results shows that the 433 MHz body sensor network (BSN) is comparable to IEEE 802.15.4 BSNs in the proximity of Bluetooth or WiFi networks. The radio frequency identification (RFID) can also take advantage of 433 MHz based wireless sensor communication (Weyn M., 2013). Considering the wide usages of 433 MHz radio, and due to the nature of insensitive signal reflection to metal and non-metal materials, this paper examines the 433 MHz radio system to be used for a radio link providing periodic image transmission for eruption image monitoring system. This paper focuses on 433 MHz channel capability assessment in delivering image packets.

2. RESEARCH METHOD

2.1 Hardware and software design

Figure 1 shows the radio design for periodic monitoring image delivery that consists of remote unit and the image receiver. Remote unit is built by using Raspberry Pi as the controller, 3DR 433 MHz transmitter as the radio link, power bank 3000 mAH for the power source and a camera for capturing image periodically. The receiver contains a 3DR 433 MHz radio receiver connected to a laptop.

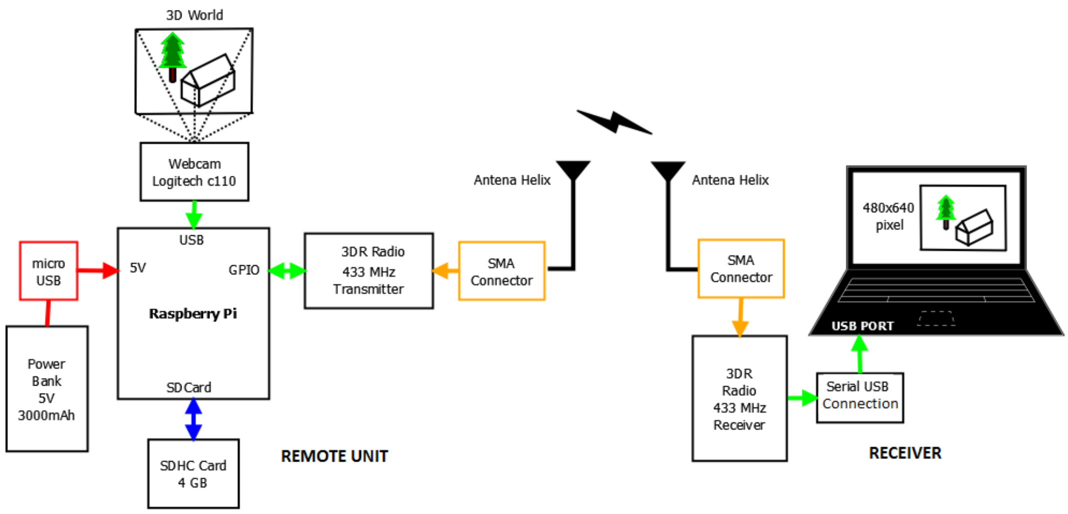
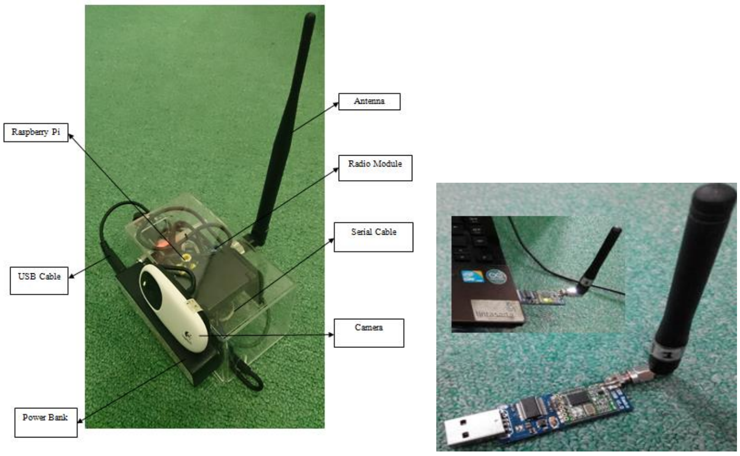


Figure 1. Radio design for image monitoring

Figure 2 shows the constructed radio system. Software included in image transfer is based on those of installed in devices. The image data is captured by using Real Term, a serial capture software. Image is encoded to RGB format by using Matlab code.



(a) Remote unit   (b) Receiver unit

Figure 2. The evaluated 433 MHz radio system

2.2 Evaluation design

The 433 MHz radio evaluation for periodic image transmission involves device tests and image streaming tests. Device tests include remote unit battery test, camera test, connection test, data capture test, communication range test. The streaming tests measure loss and delay parameters.

Device tests are started from the hardware connections, Raspberry Pi operating system installation, radio configuration and connection establishment. Device tests quantification is represented by the remote powering measurement. Streaming tests include direct connection through the Ethernet, wireless connection through the 433 MHz radio, image capturing and image transmissions.

3. EVALUATION RESULTS

3.1 Remote Powering Measurement

There are three conditions measured in the experiments; standby, data transmission, and image transmission.

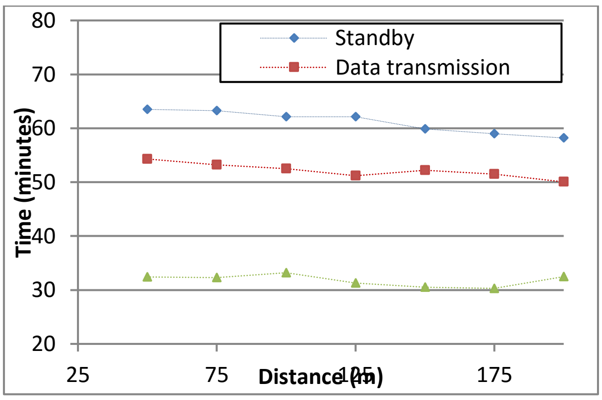


Figure 3. Battery lifetime

The battery lifetime decreases when the distance between receiver and remote is further (Figure 3). Three conditions show the same reduction pattern. However, image transmission consumes energy the most, while the standby power absorbs the least. Image transmission uses in average 48% higher than standby power and 37% more than data transmission. This data brings the fact that the remote monitoring unit should the worst condition (image transmission) and the distance when planning the power reliability for remote monitoring unit.

3.2 Direct Connection Test

Direct connection test is performed to find out the potential factors affecting the monitoring image transmission besides channel interferences. Therefore, direct connection is made by using the Ethernet cable from remote unit (Raspberry Pi port) to computer Ethernet port. The statistic results are plotted in Figure 4, which shows that most connections are successful, the main disturbance is the cable connection between modules (9.23%), and the unknown problem achieves 4.62%. The unknown problem may be caused by the problem within the receiver software.

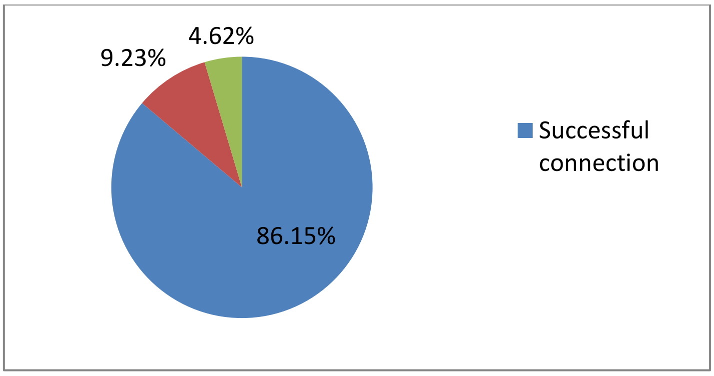


Figure 4. Direct connection test

3.3 Wireless Connection Test

Wireless connection uses the Universal Asynchronous Receiver Transmitter (UART) protocol through 3DR 433 MHz radio module. The experiment shows that the radio connection is sensitive to signal reception that results 30% connection failure (Figure 5). Therefore, sufficient signal reception should be ensured before the radio link is used.

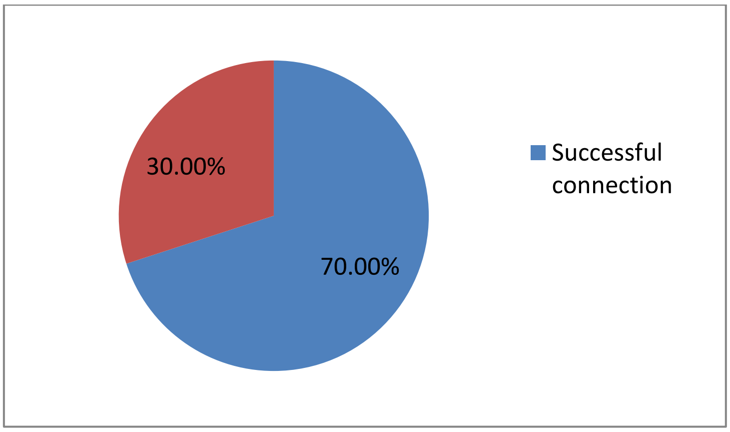


Figure 5. Wireless connection test

3.4 Image Transmission Test

During image capturing and transmission using JPEG format of 480x480 image resolution, it is obtained that packet loss increases to radio link distance (Figure 6). The packet loss increases in the second order of polynomial with R-square 0.549. The loss occurs from 2.3% to 5.2%.

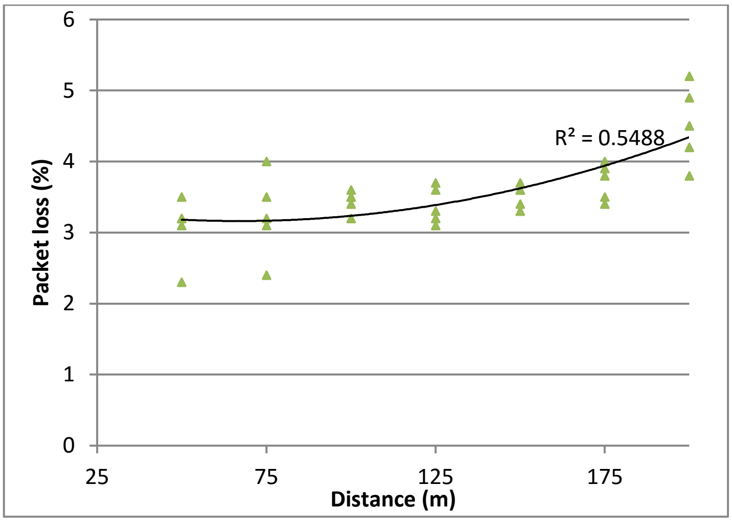


Figure 6. Image transmission test

By adjusting bit rate of 433 MHz radio to certain values, the required time for sending one image for 50 m distance is plotted in Figure 7.

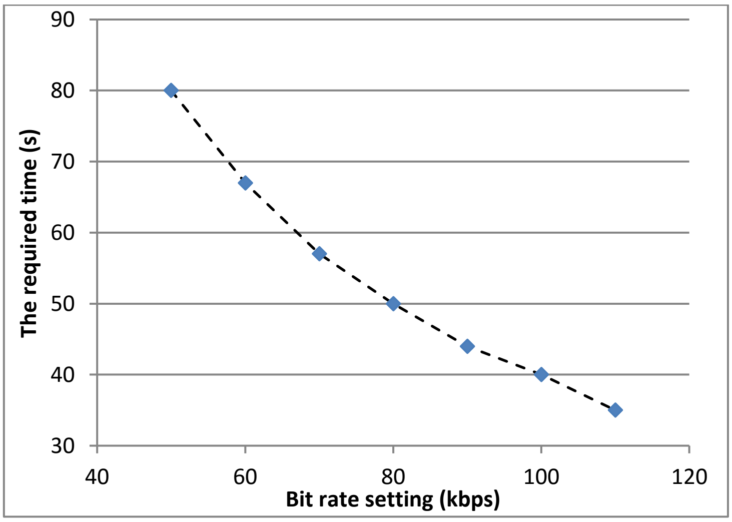


Figure 7. The time for sending a single image

Figure 7 shows for the given bit rate, the period of image capturing should be less than certain value. For instance, by using bit rate 100 kbps, a single 480x480 JPEG image requires 40 s to be sent completely. This means that for periodic monitoring application, the period of image capturing should not exceed 40 s. The higher the bit rate setting, the smaller the image capturing period. The bit rate setting is depending upon the 433 MHz radio type.

4. CONCLUSION

This paper examines the use of 433 MHz radio for periodic image monitoring which covers device and connection tests. It is revealed that the link distance influence the amount of energy taken from battery, and image transmission energy consumption is 48% higher than standby power consumption. Further, for sufficient bandwidth and distance, the packet loss of image transmission is between 2.3% and 5.2%. The image-capturing period depends on radio bit rate, for 100 kbps bit rate, image capturing period should not less than 40 s.

Future works may deal with efforts for increasing the channel capacity as well as the frequency of image capturing.

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