Development of an Electronic Wireless Monitoring Mailbox using RF Module

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Abstract- Mailbox is an important gadget that receives letter or mail but unfortunately its existence is barely noticeable. Users normally do not notice of a received mail especially when they are not at home or for the flat or condominium dwellers, their mailbox are located away from their apartment. In an attempt to solve the above problem, a concept of mailbox notification system and mail minder that uses is introduced. This paper presents the development of an Electronic Wireless Mailbox using radio frequency (RF) Module that allows on received mail. This system introduces a new way to transfer input data on the mailbox using wireless RF module. The RF transmitter will transmit the incoming data received from the mailbox to the receiver. This system showed that mailbox users are able to remotely check the status of their mailboxes via an LCD display located at their vicinity. It is also hoped that the developed system could assist the disabled and the old folk.

Keywords: mailbox, wireless, RF module,remotely

I. INTRODUCTION

Mailbox is a private box into which mail is delivered. It is also known as letterbox or postbox. There is also electronic mail that has its own system which is also called mailbox, but this electronic mail could not receive real postage like envelopes and packaging. Although the electronic mail was introduced in the late 90's which is fast and cheap to send information and communicate worldwide but the postal system using mailbox is still required. Most of the important and official documents are sent by the conventional way. This electronic wireless mailbox system using wireless RF module is designed to give a better service for busy user, the disabled and the old folks. RF module is a low cost alternative in wireless communication. It is a radio-frequency with rates of oscillation in the ranges of 3 kHz to 300 GHz which respond to the frequency of radio waves. RF is usually refers to the electrical rather than mechanical. This project presents a new and low cost electronics mailbox that uses the latest technology which will alert users when a mail is received the user is notified via LCD.

The sketch of electronic wireless mailbox is as shown in figure 1.

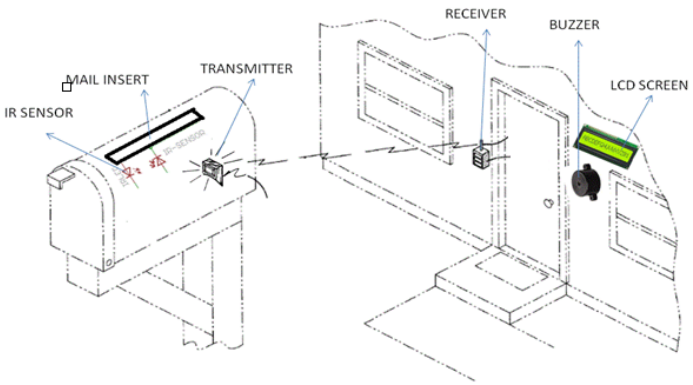

Figure 1. Sketch of the electronic wireless mailbox.

From the previous research on real time mailbox alert system via short message service (SMS) or email [1], this system aids the users by sending real time notification on mail delivery which overwrites the conventional way of checking mails. This system is quite complex and users need to check on their mail to get to know their mail notification SMS on the other hand is rather inconvenient to the old folks as some of them are IT savvy. Another project for wireless mailbox that available in the market is using wireless zigbee module. This module has the same function with the RF module to transmit and receive the signal. User can choose to use zigbee module or RF module although both are having same function but their difference is on power consumption because the zigbee module are available with operating frequency of 2.4GHz to maintain the communication while the RF module frequency just only 433MHz. So it shows that the power consumption of RF module much lower than zigbee module. The price also much lower compared to zigbee module.

Thus, this project uses RF module that will give another alternative in technology that is simple and low maintenance cost. Users just have to monitor their LCD that will show the number of current mail. A buzzer will be activated to alert the user of the current incoming mail.

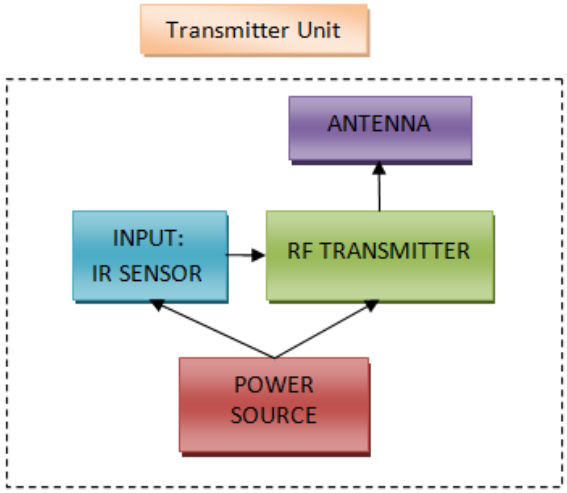

Figure 2. Block diagram for the transmitter.

A general RF communication block diagram of the transmitter unit is shown in Figure 2. For this project, IR sensor is used as the input to detect incoming mail. When an input is detected, the RF transmitter uses the radio frequency to send signal to the receiver. The frequency of operation for both transmitter and receiver is 433MHz.These signals transmit through RF to the receiver. A transmitter antenna electrically connected to send signal to the receiver when an RF transmitter accepts serial data.

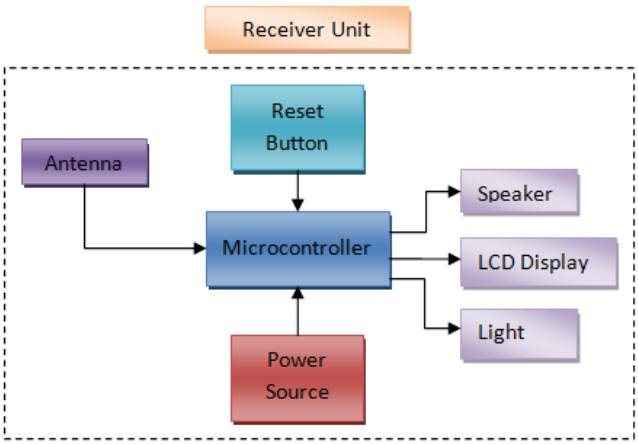

Figure 3. Block diagram for the receiver.

The receiver set also has the antenna to receive the signal from transmitter. Signal of frequency 434MHz will only be received by the receiver. The received signal will be decoded and the output sends to the microcontroller. The microcontroller will select the appropriate program that will output to the speaker, LCD and LED when a mail is received. The LCD display the number of mail, the LED shows a mail has arrived and the speaker will alert the user. The system also has a reset button to reset the system.

II. METHODOLOGY

A. Flow Chart

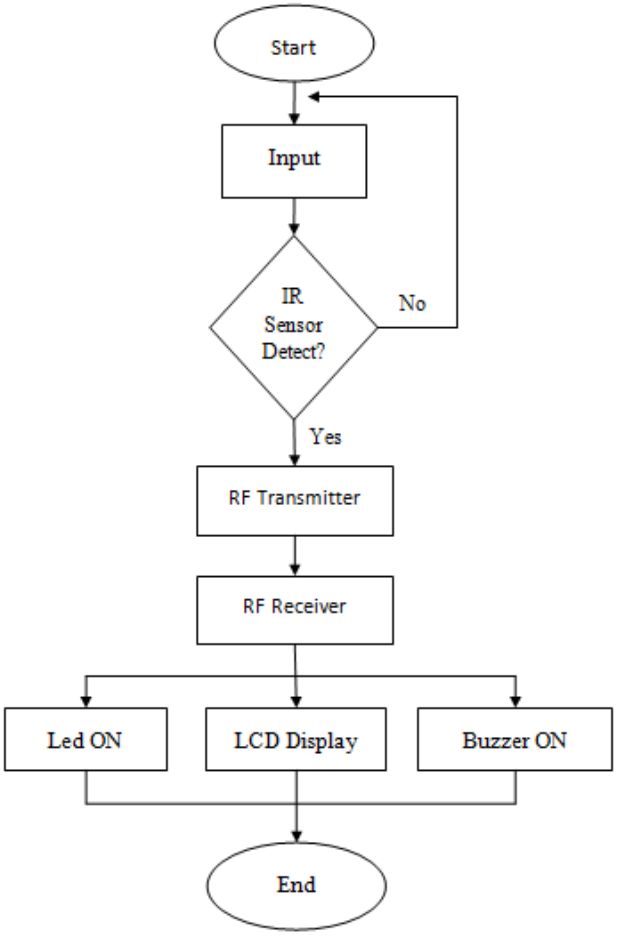

Figure 4. Operation of the Electronics Wireless Mailbox.

Figure 4 shows the flow chart of the Electronic Wireless Mailbox (EWM). When the sensor detects the incoming mail, RF transmitter sends input data to the receiver. The microcontroller, Arduino Uno as the USB interface is used that will read the received input data from the receiver. If the sensor does not detect any input mail, the operation will loop again until the next input is received. Therefore, when the RF sensor detects an input then only the data is successfully received by receiver. Hence, the output of the receiver will be send to the microcontroller. The microcontroller will function as a controlling input to display the output. If a successful mail is received, a green LED will be lit followed by an alert sound from the speaker while the LCD will display the current number of mail received.

B. *Circuit Design*

Figure 5 shows a schematic diagram of a transmitting unit. The RF transmitter and receiver circuits used in this project acts as a mean of communication. Another set of transmitter and receiver also available at IR sensor that is attached together with the RF transmitter. The microcontroller used is Arduino Uno that functions as a controller unit for the whole system.

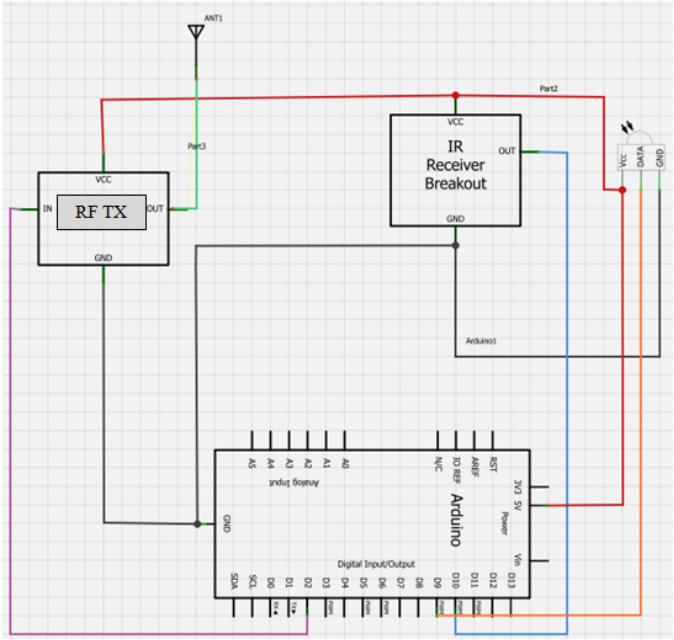

Figure 5. Schematic diagram of a Transmitting Unit.

For the transmitting unit, three main components are involved namely, RF transmitter, microcontroller and IR sensor. This unit will only be operated when a mail is being placed by the postman at the mailbox; which will be detected by the IR sensor. An antenna is required by the wireless RF module to send signal to the receiver.

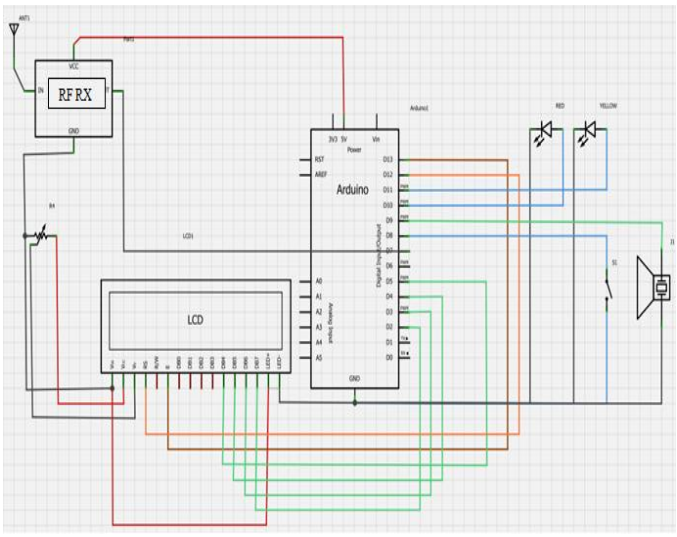

Figure 6. Schematic of Receiver Unit.

At the receiving unit, its function is very similar to the transmitting side except it only receives what has been transmitted from the transmitting side. The receiver decodes the signal and sends to the microcontroller for further action. Outputs of the microcontroller are connected to the LCD which displays the current mail status, a buzzer and an LED to indicate that a mail has been successfully detected.

C. *Design Specification*

TABLE 1. RF Transmitter Module Specification

No	Specifications	RF TRANSMITTER MODULE
1	Operating Voltage	3V to 12 V
2	Operating Current	Max ≤ 40mA (12V), Min 9mA (3V)
3	Oscillator	(Surface Acoustic Wave) oscillator
4	Frequency	433.92MHz
5	Frequency error	±150kHz(max)
6	Modulation	ASK/OOK
7	Transfer Rate	≤10Kbps
8	Transmitting power	25mW (315MHz@12V)
9	Antenna Length	18cm (433.92MHz)

The RF module operates and sends signal using radio frequency that range between 30 KHz and 300GHz. Digital data of this RF module is represented in the amplitude of carrier wave. The RF transmitter and receiver used in this project operate at the frequency 433MHz. This low cost transmitter can transmit signal up to a maximum of 100 meters distance depending on the environment. Antenna design and supply voltage will affect the distance of the signal strength.

TABLE 2. RF RECEIVER MODULE SPECIFICATION

No	Specifications	RF RECEIVER MODULE
1	Operating Voltage	5.0V + 0.5V
2	Operating Current	≤5.5mA @5.0V
3	Operating Principle	Monolithic super heterodyne receiving
4	Frequency	433.92MHz
5	Bandwidth	2MHz
6	Modulation	ASK/OOK
7	Transfer Rate	≤9.6Kbps
8	Data Output	TTL
9	Sensitivity	-100dBm
10	Antenna Length	18cm (433.92MHz)

RF receiver module use equivalent product specification as the RF transmitter. This RF receiver must use a match frequency of 433MHz similar to RF transmitter in order to receive RF signal from the transmitter.

TABLE 3. DIGITAL IR MODULE

No	**Specifications**	**DIGITAL IR RECEIVER AND TRANSMITTER MODULE**	
1	Power Supply	5V	
2	INTERFACE	DIGITAL	
3	Modulate Frequency	38Khz	

III. RESULT AND DISCUSSION

Throughout the wireless communication evolution, there have always been concept and model that combining the advantages of the usage of wireless communication with other device. The design of the wireless electronic monitoring mailbox gives great flexibility to the user, allowing the user to monitor the mailbox at a great distance. Without having a trip to monitor mailbox, it provide different benefits, such as low power consumption, low cost wireless communication device, less maintenance and easy to maintain. The operation of the project from figure 7 shows that LCD and LED are one of the outputs in the project.

Figure 7. No mail receive condition.

Figure 7 shows the prototype for the mailbox from the receiver part. It shows that no signal has been received yet. Thus, the LCD is displaying “NO MAIL RECEIVE” to the user. Figure 7 also shows an LED attached on the left side of the device emitting to indicate no mail has been received. Apart from the LED or LCD that functions as a displaying unit to the user, there is also a buzzer that will beep each time an incoming mail is inserted. Since, no mail is detected, thus a beeping sound will not be produced. Although this project has low power consumption but it still need sufficient power to power up the circuit so it will transmit data smoothly. The power supply must be supplied to the both transmitter and receiver circuits. When the receiver receives signal from the transmitter, the counter will start to increment by one for each mail inserted into the mailbox. This is shown in figure 7 on how it displays at the LCD display.

Figure 8. The prototype shows the mail detected.

The current amount of mail will appear at the LCD once mail is inserted. The first LED will turn off to indicate there is insertion mail in the mailbox and the middle LED is emitting together with the buzzer sound. User just needs to monitor their mailbox from their LCD display placed at home.

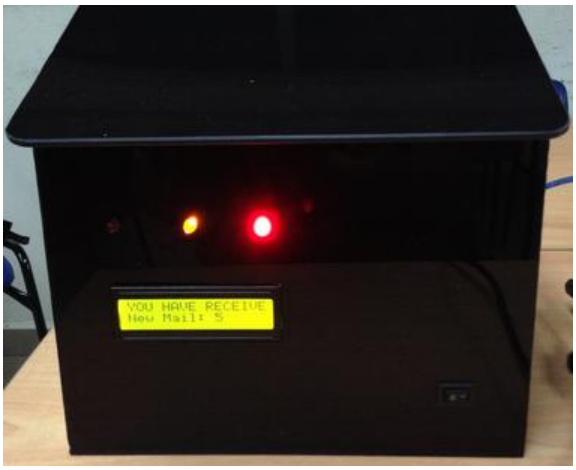

Figure 9. Maximum number of mail set.

From the program coding, it have been set that maximum number of mail is five. The right LED will turn on together with the LED attached in middle. Buzzer will beep twice to inform the user that their mailbox has reached its maximum number of mail. The maximum number of mail notifies to the user that they need to go and check their mailbox. In this project, the amount of incoming mail can be set by the user, such that it is easier for them to monitor their mailbox. It also depends on the average of how many letter or advertisement they receive per day or per week. For this project it is tested that the maximum number of mail inserted is five.

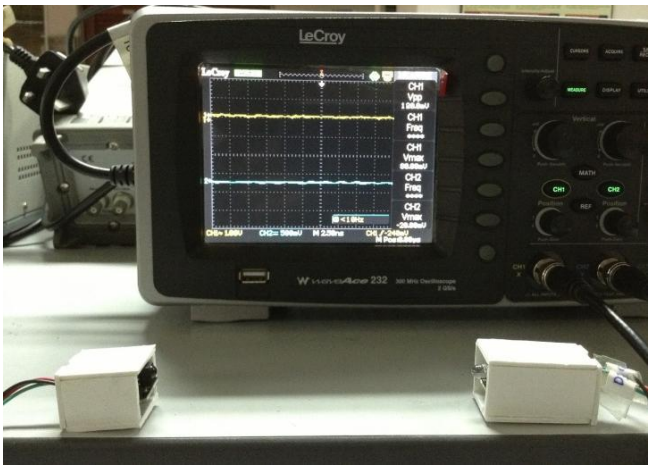

Figure 10. Output Signal when no mail received.

Figure 10 shows the output waveform of the RF module operation by using oscilloscope. From this result, the frequency waveform is tested to observe whether it will operate with the matching frequency waveform. The digital data in the RF system is represented as amplitude of carrier wave. Meanwhile, RF transmission system used transmitter and receiver to pair the operation of radio frequency at 434 MHz by modulating signal known as Amplitude Shift Keying (ASK). Figure 10 show that the output waveform before detecting any mail in the mailbox while the linear waveform indicates that there is no signal from transmitter and receiver unit.

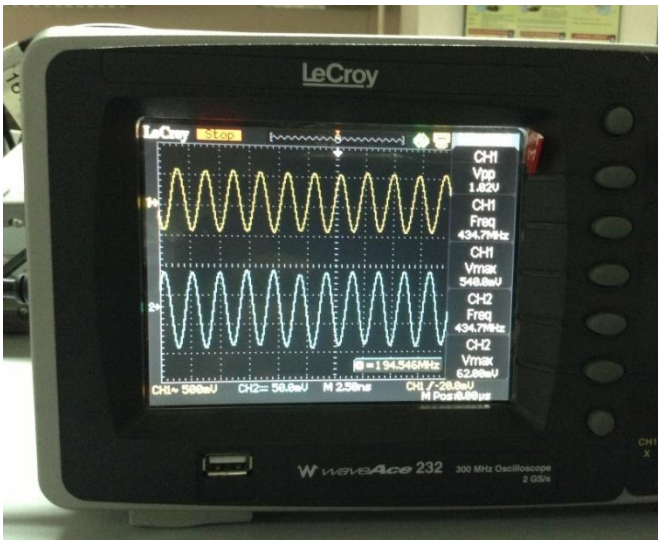

Figure 11. Oscillating signal when mail detected.

When the signal is transmitted from the transmitter to the receiver, the output from the linear waveform is transformed as shown in figure 11. The yellow signal is from the transmission data line (TX) while the blue signal is taken from the receiver data line (RX). From the oscilloscope, channel 1 is measured for RF transmitter while channel 2 is set as RF receiver. When the RF transmitter sends the serial data to the receiver, the linear carrier waveform from the transmitter unit, in the form of sine wave, evidently shows that there is a signal sent from the transmitter. Therefore, from the analysis made using the oscilloscope on these two channels, it has been concluded that both channel 1 and channel 2 are getting the frequency of 434MHz. Thus, this has proven that the module has met the design specification for frequency. From the both channels, it can prove that the RF signal can operate due to the matching frequency of 434MHz with the pairing operation.

IV. CONCLUSION

This project has proved its application in detecting mail inserted in the mailbox and transmit signal to the receiver. The usage of low cost RF wireless module replacing other wireless module also has proved that it could function well like the other module. RF wireless module also depends on the condition of the environment. It can support up to 150m distance for the receiver to detect the transmitter signal at the open space condition. For the usage of this mailbox at the condominium or apartment, RF module can send signal from the ground floor to the sixth floor. Thus, this project has surely gives an impact to the user in term of its usage, low cost and low maintenance. This system can be used by different level of people due to its simplicity in design and easily used. It will surely give benefits especially to the disable people and the old folks.

V. RECOMMENDATION

For the future development, as an improvement for the product to be marketable, more features need to be added and improved since the project prototype has some limitations; for example in sending notification alert directly to the user. Hence, for the improvement of the project this system can add up a new function in notifying user through the social media like twitter by using the Ethernet Shield. Instead of using Ethernet Shield, this system also can upgrade the notification of receiving mail using other method like Global System for Mobile Communication (GSM) that able to notify the user automatically when a new mail received by sending notification using short message service (SMS).

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