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Ethernet Based Intelligent Security System

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Abstract: This paper is design and implemented for capturing the images by triggering the sensors at home for providing security .system consists of multiple PIR sensors, temperature sensor, LDR sensor and ultrasonic sensor as a sensor group, MVM. Ultrasonic receivers and transmitters are located at opposite ends to reduce the interference from other frequencies in ultrasonic signals here as per the detection of a human, we are turning on the camera nearby surroundings so security will results in good factor. Person identification is also indicated by slot indicators.

Keywords: PIR sensor, Ultrasonic Sensor, MVM.

I. INTRODUCTION

Recently surveillance systems have become more important for everyone's security. The embedded surveillance system, frequently used in a home, an office or a factory, uses a sensor triggered to turn on a camera. Some designs use different types of sensors to achieve reliability by means of the different features of each sensor. In this paper we extend our previous design not only by using both multiple PIR sensors and ultrasonic sensors as a sensor group, but also by using the MVM. To enhance the reliability of the ultrasonic sensors group, we propose adding to the number of bits with coding to reduce the probability of code breaking.

II. SYSTEM ARCHITECTURE

Fig.1 shows the home embedded surveillance system which has two groups of sensors, indoor and outdoor. The outdoor sensor group contains a number of PIR and pressure sensors located next to windows and doors of a home. The software module of the power embedded board turns on the Web camera to confine images and user can outlook the images captured by the home surveillance system.

A. PIR Sensor

PIR is mostly made of Pyroelectric sensors to increase an electric signal in reply to alter in the incident thermal radiation. Every breathing body emits some low level radiations and the hotter the body, the more is emitted radiation. Commercial PIR sensors typically include two IR-sensitive elements with opposite polarization housed in a hermetically sealed metal with a window made of IR-transmissive material (typically coated silicon to shield the sensing element). When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. This chip takes the output of the sensor and does some minor processing on it to emit a digital output pulse from the analog sensor. Schematic of PIR sensor output waveform is shown in Fig. 2.

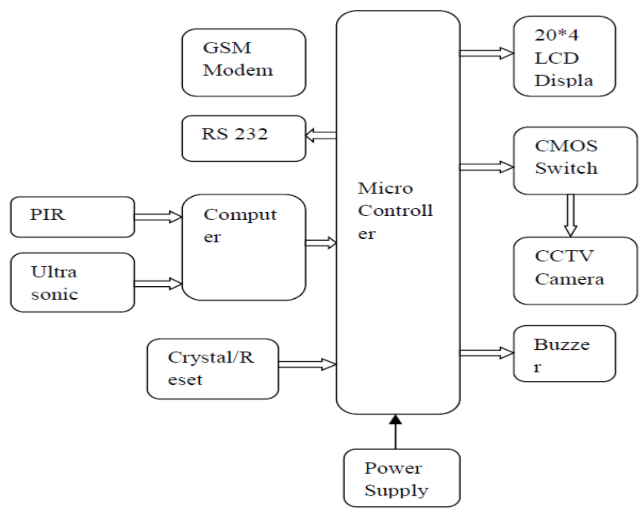

Fig.1.The home embedded surveillance system with ultra-low alert & GSM model.

B. Ultrasonic Sensor

Ultrasonic sensor is non-contact distance measurement module, which is also compatible with electronic brick. It's designed for easy modular project usage with industrial performance. A short ultrasonic pulse is transmitted at the time 0, reflected by an object. The senor receives this signal and converts it to an electric signal. The next pulse can be transmitted when the echo is faded away. This time period is called cycle period. The recommend cycle period should be no less than 50ms. If a 10µs width trigger pulse is sent to the signal pin, the Ultrasonic module will output eight 40 kHz ultrasonic signal and detect the echo back. The measured distance is proportional to the echo pulse width and can be calculated by the formula above. If no obstacle is detected, the output pin will give a 38ms high level signal.

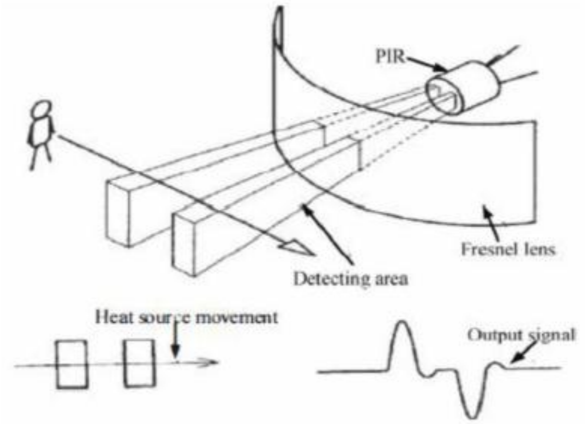

Fig.2.PIR sensor output waveform.

C. Software

The whole system is built around a MCU. MCU requires to be burned with software written for specific applications. The code is written using ASSEMBLY language and compiled using MPLAB. MPLAB generated a hex file which is burned using a burner into the IC. This section demonstrates the flowchart of the software which helps to visualize the coding steps as shown in fig.3.

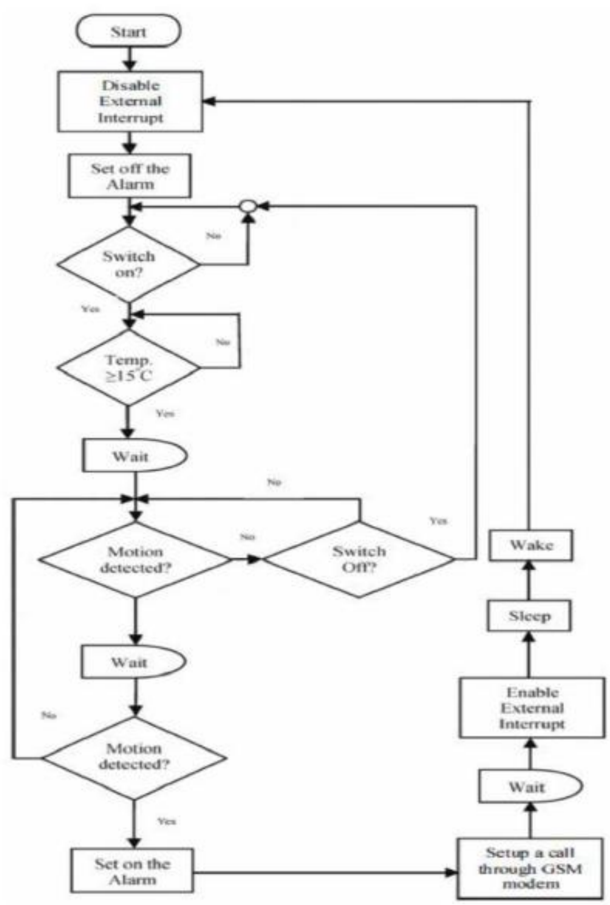

Fig.3.Software flowchart.

D. Wireless Camera

Wireless technology is being applied to just about everything these days, and video surveillance takes good advantage of it. A wireless camera is one with a built-in transmitter to send video over the air to a receiver instead of through a wire as shown in below fig.4. The thing that many people aren't aware of is that there are multiple types of wireless technology in use, each with unique advantages and disadvantages. Most wireless cameras are technically cordless devices, meaning that though they transmit a radio signal, they still need to be plugged in to a power source. Wireless is the commonly used industry term, though. Some do have batteries, making them truly wireless, but these tend to only last for a few hours at a time between charges. These devices work on a simple principle. The camera contains a wireless radio (RF) transmitter. This transmitter broadcasts the camera's video, which can be picked up by a receiver, which will be connected to a monitor or recording device. Some receivers have built-in storage, while others must be connected to a DVR.

Fig.4.Wireless camera.

1. Analog vs. Digital

There are 2 basic types of RF transmissions, analog and digital. Analog devices send out a constant string of data when they transmit. These can be picked up by any receiver that picks up signal in its frequency range. This means that anyone with a properly tuned receiver can pick up a transmitter. It also makes interference more likely. If there are multiple transmitters in the same area, the most powerful signal will knock out any others in range. They are easier to set up, though, since no pairing between camera and receiver is necessary. Digital wireless cameras work a little bit differently. They modulate their signal slightly, constantly cycling through frequencies in a order to avoid interference. This also makes transmissions more secure. In order to pick up this video feed, a receiver needs to be paired with the camera. This means they are being programmed to cycle through frequencies at the same rate. Whether analog or digital, most commercially available electronic devices that broadcast do so in either the 2.4 GHz or 5.8 GHz ranges.

2. Types of Wireless

Whether analog or digital, most commercially available electronic devices that broadcast do so in either the 2.4 GHz or 5.8 GHz ranges. 900 MHz and 1.2 GHz were common at one time, but have both been nearly completely phased out of use. 2.4 GHz and 5.8 GHz cameras are similar in function. Both contain a transmitter that sends a signal to a receiver, which can be connected to a monitor to view or a DVR to record.

2.4 GHz:

- Available in digital and analog.
- Has a maximum practical range of about 700 feet.
- A single receiver can carry a maximum of 4 transmissions.
- The frequency most cordless/wireless devices transmit on, so analog devices are very prone to interference.

5.8 GHz:

- Available in digital and analog
- Maximum range of about 2000 feet
- A single receiver can carry a maximum of 8 transmissions
- Used by fewer household devices, less prone to interference
- Analog signals can still be picked up by outside receivers

Wi-Fi: Wi-Fi cameras are wireless IP cameras. They allow multiple devices to be networked together and access a local area network through a wireless router. Each device talks to the router, which can send information back and forth to other networked devices as well as to and from the internet. A typical Wi-Fi router has a range of about 150-300 feet and can (for practical purposes) connect as many devices as they have bandwidth to support. Typically, routers are not included with these cameras and must be purchased separately. What makes Wi-Fi cameras so popular is that they allow remote access to a video feed from outside the network. Set up can be more complicated than traditional wireless cameras and usually requires the user to have a PC available to set up the camera.

Cellular: Cellular cameras, sometimes also called 3G cameras contain a cellular transmitter and connect to a cellular network to send video. In function, they can be very similar to Wi-Fi cameras. This is the newest of the wireless technologies, and reliability can vary widely, largely based on network conditions.

These also tend to be very costly. Not only is equipment expensive, but it also requires a cellular data plan in order to transmit video. These costs can vary by cellular carrier, and a lack of cellular coverage can render the devices inoperable. As costs drop, expect to see this type of camera become more and more popular.

3. Manual of RC100 a wireless Supervision Receiver

The RC100 is wireless supervision receiver. This product is suitable for the supervision of the places such as supermarkets, department stores, homes, workshops, hospitals and so on.

Basic specification parameters:

i. Receiving Frequency: 950 MHZ~1200MHZ
ii. Video output: 75Ω/1vp-p
iii. Audio output: 10kΩ/200mvp-p
iv. Power consumption :< 2w
v. Work Temperature: 0~40^{0}C
vi. Size: 115mm × 60mm × 20mm

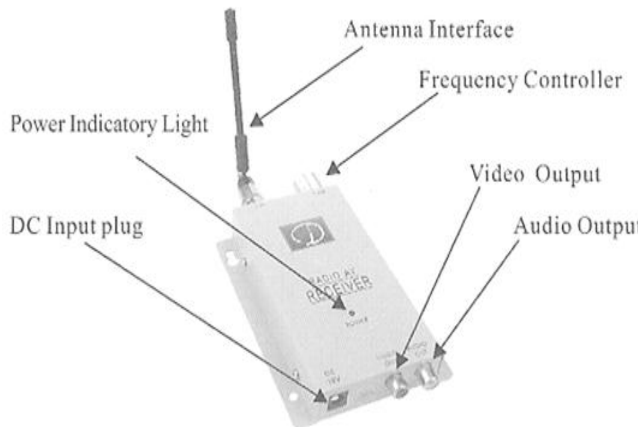

Fig.5. Diagram of the whole products.

4. Operating Instruction

Camera Temperature:

- Install the camera transmitter on the place you need to monitor.
- Insert the DC +8v/200mA power adaptor into the interflow power plug, and insert its DC output plug into the DC input plug of the camera transmitter to put through the circuit as shown in Fig.5.

Receiver:

- Insert the antenna into the interface of the receiver and fasten it.
- Use AV line to connect audio and video output of the receiver with the interface of the TV set or monitor.
- Insert the DC+12v/500mA power adaptor into the interflow power plug of the receiver, and insert its DC output plug into the DC input plug of the receiver to put through the circuit, and at the moment the power indicatory light shines.
- Adjust the frequency controller of the receiver to the sending frequency of the corresponding camera transmitter with hands, and you can get the picture and sound by the TV set. Adjust the supervision position of the camera transmitter to the supervision object, and you can make effective supervision.

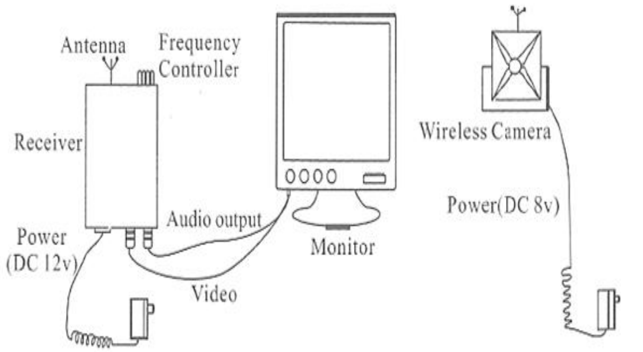

Fig.6.

E. Microcontroller Unit

The LPC21418 microcontroller is based on a 16/32 bit ARM7 TDMI-S CPU with real-time embedded trace support and emulation that combines the microcontroller with high speed embedded flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and its architecture enable 32-bit code execution at the maximum clock rate. For typical codes, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty. A serial communications interfaces ranging from a USB 2.0 Full Speed device, SPI, multiple UARTS, SSP to I2Cs and on-chip SRAM of 8 kB up to 40 kB, make these devices suitable for communication gateways and protocol converters , voice recognition and low end imaging ,soft modems, providing both high processing power and large buffer size. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins and PWM channels make these microcontrollers particularly suitable for industrial control and medical systems.

Fig.7. GSM modem.

F. GSM Modem

Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication. GSM is the name of a standardization group mobile cellular radio system operating at 900 MHz. A GSM modem as shown in below Fig is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem while a wireless modem sends and receives data through radio waves. The working of GSM modem is based on commands, the commands always start with AT (which means Attentions) and finish with a <CR> character. For example, the dialing command is ATD<number>; ATD3314629080; here the dialing command ends with semicolon as shown in Fig.7. The AT commands are given to the GSM modem with the help of PC or controller. The GSM modem is serially interfaced with the controller with the help of UART.

III. IMPLEMENTATION AND EXPERIMENT RESULTS

In the experiment results we found that an ultrasonic signal would be affected by environment sounds and the amplitude of the reference voltage. Those factors affect the transmission distance and the error rate of detecting. We therefore put the transmitter and the receiver on both ends of the sensing area and make sure the intruder passes through if the outside group has detected an individual. Fig.8 shows an ultrasonic signal being interfered with by another ultrasonic frequency. As ultrasonic signal interference causes difficulties in setting up the amplitude of the reference voltage of the circuit, therefore we use the coding signal to reduce ultrasonic signal interference based on the characteristics of the ultrasonic signal as shown in Fig.9.

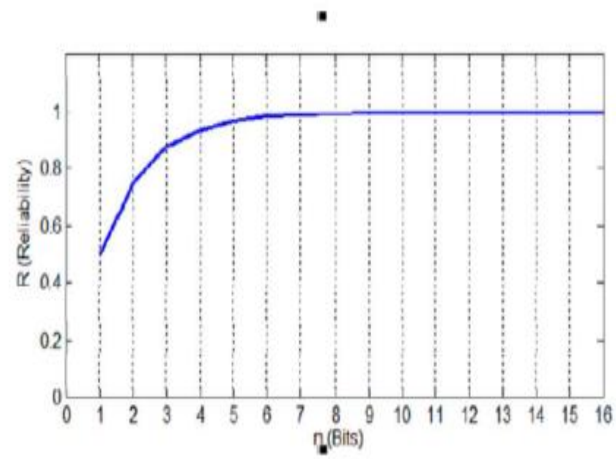

Fig.8. Relationship between reliability and number of bits of the ultrasonic signal code.

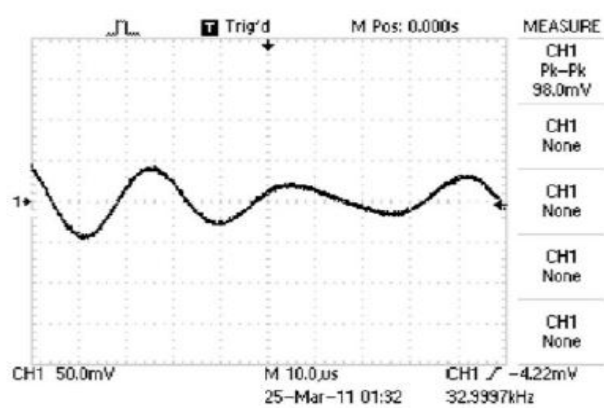

Fig.9. Ultrasonic signal interfered by another frequency.

In Fig.10 we see that the signal has been coded by our system. The coded signal is not affected by another frequency because our design receives a signal through the code instead of through its signal's frequency.

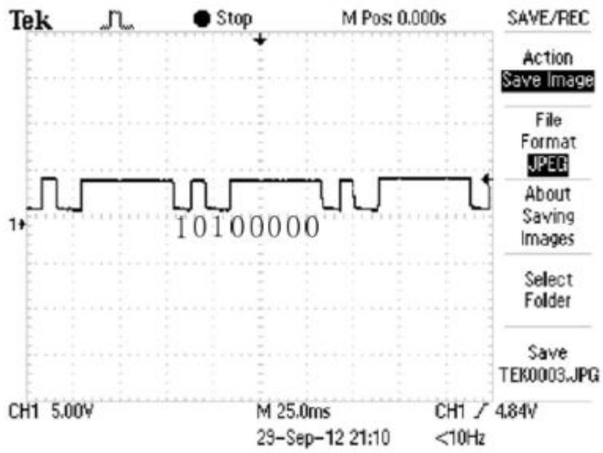

Fig.10. Our ultrasonic coding signal in the scope.

Fig.11 shows the signal judgment of our experiment. When judging a coding signal, one method of our design counts the rising edge number. If the rising edge number is equal to two, it means the signal is correct. Lines A and B of Fig.11 show a coding interval.

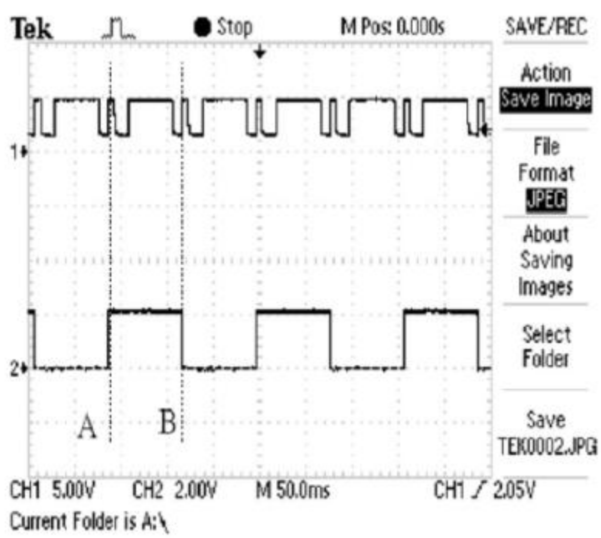

Fig.11. Judgment from received ultrasonic coding signal.

Fig.12 shows our design that consists of the internal software flowchart of an embedded surveillance. If the indoor sensors detect an intruder, the MCU turns on the Web camera to capture images. After the intruder has been detected outdoors, the MCU software sub module of the ultrasonic coding signal is executed as shown in Fig.13. Our design transmits the ultrasonic coding signal, and the receiver checks whether the coding signal is correct or not. If the coding signal is correct, the ultrasonic sensor group continues for some seconds to make sure that there is no intruder. If the coding signal is not correct, our design also starts the majority voting mechanism (MVM) to make sure whether there is any detection.

Fig.12. Software flowchart of embedded surveillance system.

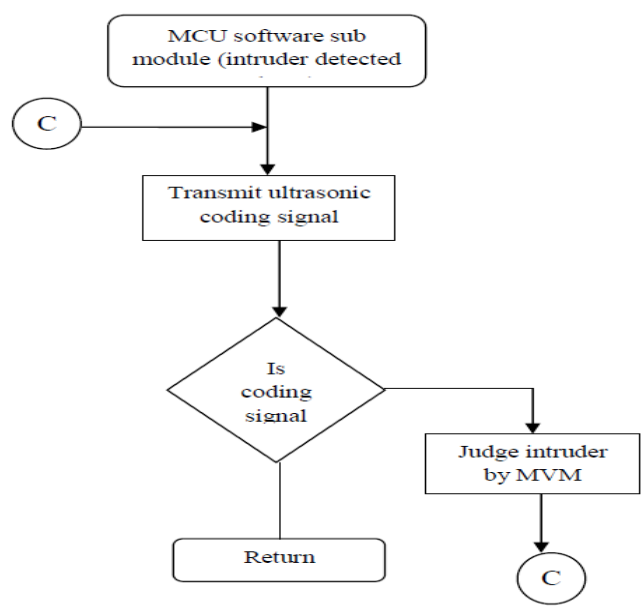

Fig.13. Flowchart of detection by ultrasonic coding Signal.

Fig.14 shows the distribution of scattering after adding a PET bottle focus.

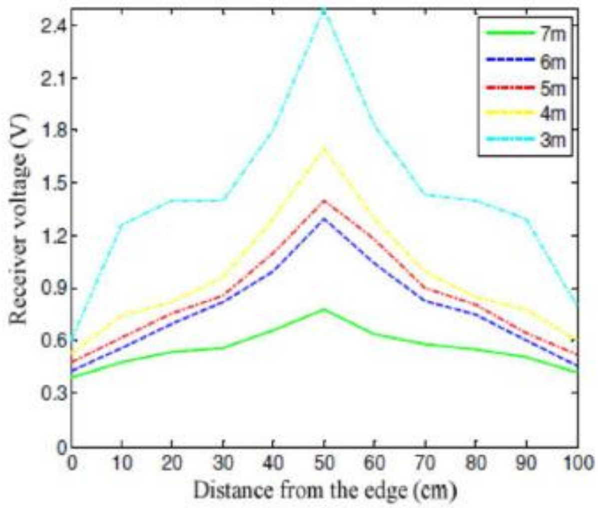

Fig.14. Curves showing distribution of scattering after adding PET bottle focus.

Fig.15 shows the arrangement of our experimental environment that detect intruders in a suitable place. Transmitter and receiver of the ultrasonic sensor module are placed in a line direction. When an intruder enters the detection area, the ultrasonic coding signal will be blocked and the PIR sensors will detect temperature changes.

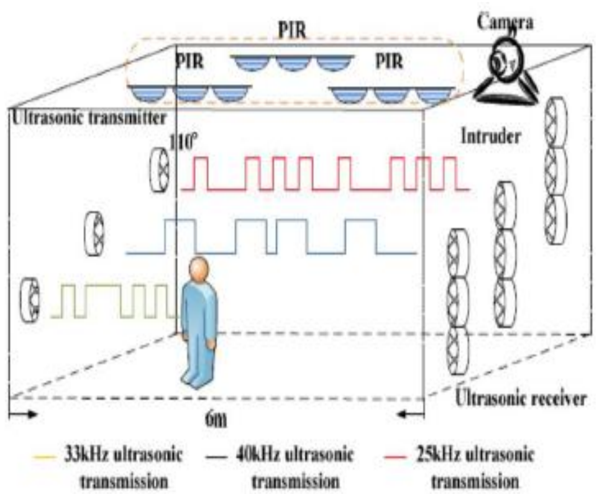

Fig.15. Arrangement of our experimental environment.

Table I compares our coding signal and non-coding signal. The coding signal is not interfered with by other frequencies unless their patterns are similar. It is easier to break anon-coding signal than a coding signal. When we add to the bits of the ultrasonic coding signal, the message type rise with2N A non-coding signal transmits just two types of messages, 0 and 1. N means number of bits. With more message types, more codes can be used in the same design to decrease the probability of breaking a signal. In our design, when N is equal to 8, the message combination of the ultrasonic coding signal is 128 times better than that of non-coding signal, and the reliability is enhanced from 0.5 to 0.996.

TABLE I: Comparison of Our Coding Signal and Noncoding Signal

Ultrasonic signal patterns	Interference by Other Ultrasonic Signal	Probability of Breaking signal	Message Combination	Reliability
Coding	Low	Low	2^N	High
Non coding	High	High	2	Low

IV. CONCLUSION

Our experiment shows two different types of sensors which are enhancing the overall sensing probability by using the MVM to reduce the shortcomings of both the ultrasonic sensors and the PIR sensors. By adding an ultrasonic coding signal our design reduces the miss rate of the receiver with ultrasonic sensors by different patterns, improving the reliability of the overall system.

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