

The motion detector sensor engineering essay



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Home automation is a system that uses to help the resident to do the household activity or housework. These housework or household activity can be from pet feeding, plant watering, home entertainment system and so on. It can be operate either automatically or sometime control remotely which all depend to the home resident [2]. The entire system can be controlled by using from remove control, computer, internet until telephone. The home automation covered very wide of hoe system and it is also including home security system. The home security system basically can be separate to five categories [3], there are:

Detection of intrusion

Simulation of presence

Detection of fire, gas and water

Medical alert and precise

Safe closing of blind

For this project, only 2 categories have been discussed. There are detection of intrusion and detection of fire. And there are 4 types of intrusion which are [3]:

- i) Detection of movement
- ii) Magnetic contact of door or window
- iii) Glass breaking and pressure change
- iv) Pressure change

2. 1 Part research and analysis

2. 1. 1 Motion detector sensor

Only detection of movement has been discussed for this project. In here, the detection of movement means the movement that cause by human being and a motion detector sensor being use to detect the motion. A motion detector sensor can separate to active and passive and it can detect motion by using optics or acoustics. An active motion detector sensor is dispersing a constant field to detect motion. The field will remains static until something is enters it then disturbs the reflected pattern. Meanwhile, a passive motion sensor is waiting in standby mode in order to trigger a threshold setting when motion is detected. However, active and passive technique both have similar disadvantage. They only can sense very limited range that may weaken with distance. As the result, combination of both techniques has been used to gain greater effectiveness to detect the motion [4]. There are several types of motion detector sensor being use in the market [5] for example:

i) Infrared motion detector sensor

Infrared motion sensor is the most reliable and cheapest among the entire motion sensors available in the market. The concept of infrared motion sensor is using the infrared light spectrum to measure the heat of objects that pass in front of it. Then it will compare the heating level to heating level that cause by objects that behind it. The wavelength infrared wave is between 0. 7 and 300 micrometers but shorter than the wavelength of visible light but longer than microwaves that cannot be

detected by human senses but can be felt as the heat. This infrared motion detector sensor can be fitted with different lenses to get greater distances.

Basically the infrared motion detector sensor separate to 2 types only, there are passive and active infrared motion sensor [6]. The passive infrared sensors will detect electromagnetic radiated energy that generate by external sources like thermal energy emitted by people in the infrared range as figure.

The thermal energy will reaches to the sensor that comprise more than one individual sensor which made from pyroelectric materials. This sensor will generate an electrical voltage according it is heated or cooled [7].

Figure 1: The operation of passive motion infrared sensor [8]

Meanwhile, the active infrared sensors will generate a multiple beam pattern of modulated infrared energy and react if it has change in the modulation of the frequency or an interruption in the received energy. The active infrared motion basically consist emitter and receiver pairs to generate IR detection zone. However, this emitter and receiver pairs need to adjust probably to achieve the best balancing between reflected IR energy and transmitted IR energy. This balance is called as the threshold level of reflected IR. If the reflected IR energy significantly above the threshold level, IR motion detector sensor will trigger on as figure:

Figure 2: The operation of active motion infrared sensor [9]

ii) Microwave motion detector sensor

Figure 3: The operation of microwave motion sensor [10]

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The microwave motion detector sensor is type of active sensor that using radar call Doppler radar to send out microwaves in order to detect and measure the movement of an object. Then it will receive the returning waves that cause by moving object to determine the distance, direction even the speed of the object. Basically the microwave motion detector has 2 types, they called bistatic and monostatic [11].

The bistatic type contains emitter and receiver which operate separately to configure the beam to fit particular situation. It has a larger detection range which up to 1500 linear feet but it cannot define the area of detection and easy to cause the error [12]. Meanwhile, the monostatic type can define detection area based on microwave beam that it emits. The detection range is smaller than bistatic which only 400 linear feet but it more efficient [12].

Although the microwave motion detector sensor cover a larger area than infrared sensor and more reliable over longer distances, but it is least popular because of their vulnerability to electrical interference and expensive cost [11].

iii) Ultrasonic motion detector sensor

Figure 4: The operation of ultrasonic motion sensor [13]

An ultrasonic motion detector sensor will detect the movement by generating the sound wave in the ultrasonic frequency range around 30 kHz to 50 kHz within the limited area [14]. It will generate a cone-shaped sound wave and listen to the echoes. . The sound wave generally inaudible to humans and most animals but it does not pass through most objects. So, if no object is moving within the zone of detection, the pattern of sound wave

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in its environment and the time that reflected back will remain the same. However, if something moves, the microwave detector will detect and analysis the level or phase of returning sound waves then will trigger on the sensor [14]. Basically this ultrasonic motion detector sensor separated to 2 types, there are active and passive. [15]

The active ultrasound motion detector sensors emit sound waves from quartz-crystal transducers then the sound wave will cover within the field of detection. The sound wave will not disrupt if there is no any movement detected. However, the sound wave will disrupt when movement detected and reflected back to receiver. The receiver will sent the signal to control unit and trigger on the sensor by analysis its sensitivity and calibration. Although the microwave motion detector sensor very efficiency in performance, but it is weak in very short of the field of detection that only detectable up to forty feet [15].

Meanwhile the passive motion detector sensors operate on the principle of sounds for example breaking glass to trigger on the sensor. These sounds produce sound waves that detected by the sensors which same concept like the active sensors. The signal will sent to control units to determine if the sound wave pattern falls within established normal parameters [15].

Table below is the summary of technologies to detect the motion:

Technique

Description

Advantages

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Disadvantages

1) Infrared

[6]

Active: Generate multiple beam of modulated infrared energy and receive any interrupt or change of received energy

Passive: detect electromagnetic radiated energy that generate by external sources like thermal energy

i) Low cost

ii) Easy to maintain

i) Cover very small area

2) Microwave

[12]

Cover area with electronic field and receive any disturb or movement of electronic field

i) Cover large area

ii) Quick response

i) High cost

ii) Too sensitive

3) Ultrasonic

[15]

Generate sound wave and reflect the sound wave if any disturb or movement

i) Cover large area

ii) Quick response

iii) Long lifetime

i) Easy affect by environment vibration

ii) High cost

Table 1: Summary and comparison of 3 technologies to detect the motion

2. 1. 2 Heat detector sensor

For another category which is detection of fire, there also have several techniques to detect it. These techniques are sensing in temperature, humidity and smoke [3] and sensing in temperature will be discussed in this project. There are few technologies in this market to sense the temperature [16] like table:

Technologies

Description

Advantages

Disadvantages

1) Thermocouple

[17]

Consist junction of 2 types of metal that joined together will produce voltage which varies with temperature change

i) can used in wide temperature

ii) Fast response

i) Low accuracy

ii) short life time

2) Resistance thermometer (RTD) [18]

Electrical resistance of pure metal will increase with rise of temperature

i) High accuracy

ii) Good stability

i) Slow response

ii) High cost

3) Thermistor

[19]

Type of ceramic resistor that resistance will change with temperature changing

i) Accuracy in small scale of temperature range

ii) Good vibration

i) Limit in small temperature range

Table 2: Summary and comparison 3 of technologies to sense the temperature in the market

2. 1. 3 Wireless system application

Short range radio application

The table below show that the summary of some short range radio application and characteristics that use in the market.

Application

Frequency

Characteristics

Security system

300MHz -500MHz, 800MHz, 900MHZ

Simplicity, easy installation

Emergency medical alarms

300MHz-500MHz, 800MHz

Convenient carrying, long battery life, reliable

Computer accessories

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UHF(Ultra High frequency)

High data rates, vary short range, low cost

RFID (Radio Frequency Identification)

100kHz to 2. 4GHz

Vary short range, active or passive transponder

Wireless microphone and headphone

VHF(Very High Frequency), UHF(Ultra High frequency)

Analog high fidelity voice modulation, moderate price

Keyless entry(gate opener)

UHF(Ultra High Frequency)

Miniature transmitter, special coding to prevent duplication

Wireless bar code readers

900MHz, 2. 4GHz

Industrial use, spread spectrum

Table 3: Short range radio application [20]

Figure 5: Radio communication link diagram [21]

Figure above is the radio communication link diagram. In transmitter, the source data will send to encoder to create a group of bits then sent the

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signal to receiver to make sure that no any false occurrences happen. Then the receiver will check and only accept the signals that the same address bits same with it. The signal that sent which also call message frame has 4 fields [21] like figure:

Figure 6: Message frame [21]

The first field is called preamble that as start bits to tell the receiver the message begins. Next field is called address, it will identify address and notifies the receiver come from which units that message is coming which sent by transmitter. Then the data field will follow on which it may indicate what type of event is being signaled in some protocols. Finally last field is parity which allows the receiver to determine whether the message was received correctly or not [21].

When several transmitters are used with the same receiver, all transmitters need to have the same identification address which set by receiver where receiver need to be set to recognize the identification address of all the transmitters that used in the system. Table below is the summary of advantage and disadvantages of two addressing system [21]:

Advantages

Disadvantages

Unlimited number of transmitter can be used with a receiver

Limited number of bits increase false number and interference from adjacent system

Can be used with commercially available data encoder and decoders

Device must be opened for coding during installation

Transmitter and receiver can be easily replaced without recoding the opposite terminal

Must be used with a dedicated microcontroller and cannot be used with standard encoders and decoders

Each transmitter is individually recognized by receiver

Limited number of transmitters can be used with each receiver

Large number of code bits reduces possibility of false number

Longer code reduces probability of detection

Table 4: Advantages and disadvantages of two addressing system [21]

2. 2 Review of similar product

No

Product

Specification

Cost

Reference

1

Motion detector alarm set

- Detect motion and activates alarm
- Build in high output 105dB alarm
- Keypad to arm or disarm and security code
- 120VAC adapter operate

US

\$24. 99

[22]

2

Wireless motion system CWA2000

- Transmitter can transmit signal to receiver until half mile away
- Activates LED and buzzer on base station when detect motion
- Expendable up to 8 motion sensor
- Can adjust sensitivity of detection
- Receiver required AC power and 4 AA batteries for backup mode
- Sensor required 4 AA batteries

US

\$99. 00

[23]

3

Skylink SC-10 wireless Home security system

-Consists 2 door or window sensors and 2 keychain transmitter

-Arm or Disarm by using keychain transmitter

-Build in high output 110dB siren

-Expendable up to 15 sensors

- operate by AC power and 4 AA batteries for backup mode

US

\$109. 95

[24]

4

Powermax + wireless intruder alarm

-Support real time viewing from camera

-Consist 3 PIR sensor and 2 magnetic door sensor with wireless

-External high output siren

- Sent message to user by email, SMS or phone when any incident happened
- Support latchkey to inform parent when child arrive to home
- Remote home management which provide control and status update up to electrical devices
- Required AC power to operate

£257. 00

[25]

3. 7 Hardware description

3. 7. 1PIC16F874A microcontroller

Figure 14: Pin description of PIC16F874A microcontroller [26]

The behavior of the Home Security system basically control by three PIC 16F8XX microcontrollers. The PIC16F8XX microcontroller is under Microchip PIC microcontroller device and very commonly being use because of low-cost, low-power consumption but high speed in performance and I/O flexibility if compare to other device and family. The microcontroller emphasizes almost same function as a microprocessor but PIC Microcontroller only operates at very low speed or frequency which only few MHz or even lower if compare to microprocessors that operate with high speed or frequency. Besides, PIC microcontroller consumes very small among of power consumption which only around miliwatts. So, PIC Microcontroller is more suitable for home security system compared to

microprocessor in terms of size, cost, power consumption and the memory to control the input/output devices.

They are three types of microcontroller also take into consideration, which are PIC 16F84A [27], PIC16F874A [26] and Atmel-AT89C2051 [28]. The comparison was made before the final decision make. Below is the table of comparison between 3 microprocessors:

Features

Microchip (PIC16F84A)

Microchip(PIC16F874A)

Atmel(ATmega88V)

Instruction

35 single word

35 single word

131 single word

Operating speed

20MHz

20MHz

20MHz

Flash Program Memory

1024 x 14 words

4k x 14 words

8k x 14words

Data Memory(RAM)

68 x 8 bytes

192 x 8 bytes

1k bytes internal SRAM

EEPROM

64 x 8 bytes

128 x 8 bytes

512 x 8 bytes

I/O Port

13

33

23

Counter/timer

1

3

2

Counter bit

8 bits

16 bits

16 bits

Series Interface (MSSP)

-In-Circuit Serial Programming™ (ICSP™) – via

two pins

– Synchronous Serial Port (SSP) with SPI™

(Master mode)

– I²C™ (Master/Slave)

– Master/Slave SPI Serial Interface

– Byte-oriented 2-wire Serial Interface (Philips I²C compatible)

Operating Voltage

2. 0V-5. 5V

2. 0V – 5. 5V

1. 8V – 5. 5V

Software

– MPLAB® IDE

– MPLAB ICD2

– MPLAB® IDE

- MPLAB ICD2

ATAVRISP