Applications of Smart Home system for disabled people for using wireless network

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Abstract : *In this essay, it will discuss the application of smart home system for using wireless technology to help disabled person to enhance their life style. Smart home system is a kind of automatic system which it can detect the different kind of parameters such as the movement of users, temperature, relative humidity and pressure etc. According to these sensors, the relative data will be transferred to the corresponding devices and the system will decide the action according this information to satisfy the user. This essay will attempt to introduce some application of smart home which is automatic door lock system and gas detection system. Furthermore, a warning for gas leakage system is optimized for disabilities. The objectives of this essay focus on application of wireless sensor network (WSN) in smart home system and the application of the system. The programmed Tmote sky wireless sensor nodes are used to carry out the actuations. Software and hardware requirement are developed and designed. Finally, the system will be tested and real world and the result will be analyzed.*

Keywords - *Smart home system, wireless sensor network, automatic door lock system, gas detection system.*

I.   INTRODUCTION

Smart Home means that using the most updated information and communication technology to connect all the available electrical, digital and mechanical devices. Therefore, it create improvement of the energy efficient in the house and building. The rapid analysis and development in microelectronics, networks / communication and other technologies provided sufficient criteria to develop different kinds of wireless sensors. These sensors are consisted widely distributed services by using various sensors to keep monitoring environmental and physical aspects. For example are temperature, vibration, sound, pressure and motions etc. Micheal Banatre [1] claimed that sensors are capable computation and communication while enable to detect and sense the data with high accuracy and efficiency. Wireless sensor network (WSN) could be regarded as a series of the less energy consumption sensor.

Figure 1.1 WSN Node

Figure 1.1 showed that a sample of WSN node. Typically, sensor nodes has limited for amount of power and processing ability. However, when several sensor nodes connected or communication

through the network, they can share the measurement or information to speed up the process. Therefore, a network which called ad – hoc network is created for combined these nodes in a group.

A sensor network provided a platform for sensors to share information from anytime and anywhere. The wireless sensor network plays as an essential role in smart home environments in order to it can be achieved by processing, spreading data, collecting and analyzing.

WSN also provided the function of revolutionary detection in a wide range for various application of systems. Moreover, there are many advantages when adapting sensor networks. Several advantages are listed as following:

- Reliability
- Flexibility
- Cost of Efficiency
- Accuracy
- Easy installation

Tilak etal. [2] claimed that intelligent sensors could handle prudential supervision and receive information from different kind of issues such as floods, earthquakes, machine crashes and even terrorist attacks. The sensor network should be possible to predict and decide the action when the possible issues are happened. Tilak [2] also thought that sensor network should be contained the functions which listed below:

- Information gathering
- Environment monitoring for a different of fields and various applications.
- Information processing

Information gathering

Information gathering improves the organization and individual to complete complicated tasks otherwise the tasks will be extremely hard to finish. The information gathering helps to collect information systematically so that user can easily find out the useful information to accomplish the tasks.

Environment monitoring for a different of fields and various applications

Sensor networks can be played as a platform to allow sensors collect and share information to other sensors or electrical devices. Keeping in collecting and sharing information continuously could be effectively monitoring any changes of environment in different fields and updates in various applications.

Information processing

It refers to manipulation of widely information by digital electronics equipment such as computer. The information processing system contains in business software, networks, operating systems and computer. It means that the data which need to be operated and transferred.

In this essay, it will mainly discuss the smart home system [3] for disabled people. Automatic door / window lock system and gas detection system are mainly analyzed.

II. METHODOLOGY

2.1 Hardware Design

In this essay, Tmote sky nodes [4] is used as operated system to control and implement the smart home system. According to data catalogue of Tmote sky nodes, it has a radio chip which called Chipcon, available to transfer and receive signal and message by using radio frequency. This chip supports IEEE 802.15.4 ZigBee communication standard which has higher sensitivity comparing with specification of IEEE 802.15.4 and less power consumption. Besides, The CC2420 [5] support reliable wireless communication.

Figure 2.1 Example of layout plan for home and locations of WSN Nodes

2.2 Sink Node

Sink nodes can be defined as the brain of the network. In order to it is connected to the server with USB driver. When it is communicating with the server, at the same time, it is available to communicate with other nodes as well. From this characteristic, it is capable the data transmission between network and computer. The data transferred to computer which can record the data received from sink node and trigger another device in the network.

2.3 Door Control Node

The function of door control node is that control door control system operated automatically. Typically, it is combined with an actuator node and sensors. This node is capable to detect movement and doorbell button and also capable to control locking and opening the door. From the figure 2.2, it demonstrated the hardware model of automatic door control system.

According to the tasks and functionalities, sensor nodes can be classified such as door control node, sink node, human node and gas detector node. Figure 3.1 showed the layout plan of home and the location setting out of WSN nodes.
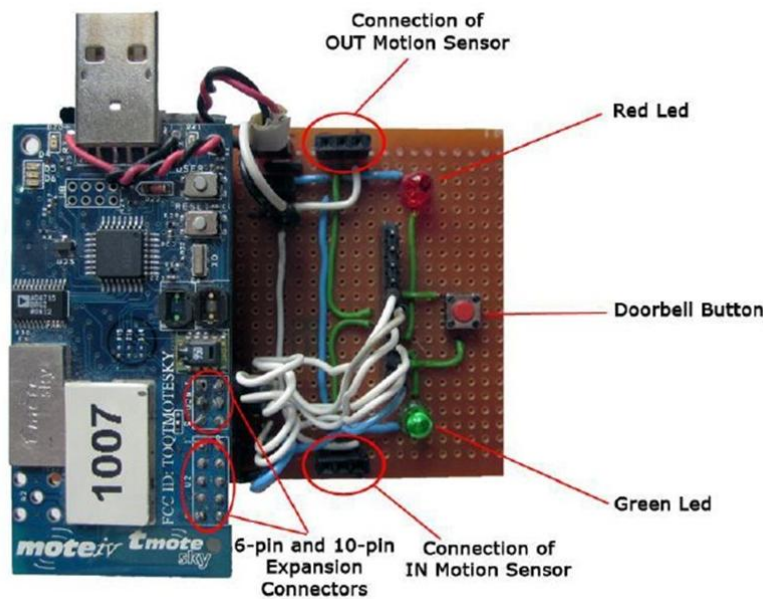

Figure 2.2 Model of Door control node

There are two different expansion for 6 – pins and 10 – pins Tmote Sky connectors [4]. With connecting with these connectors, all additional devices for example analogue sensors, display monitor and other electronic devices can be managed by Tmote Sky module. The expansion slots of Tmote Sky module are connected the output of doorbell as well as motion sensors and it is regarded as input of door control node. Moreover, it is concerned as output side of door control node which connected expansion slot. Figure 3.3 and Figure 3.4 showed the expansion connector of door control node in 6 – pins connector and 10 – pin connector.
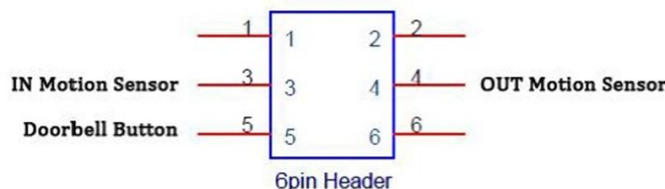

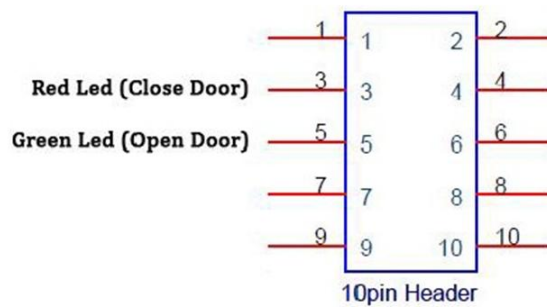Figure 2.3 Expansion connectors for Door control nodes of 6 – pin connector

Figure 2.4 Expansion connectors for Door control nodes of 10 – pin connector

Two types of passive infrared sensors which are called PIR sensors are used for motion detection. Usually, these kinds of PIR sensors are connected with expansion connectors. Typically, these sensors are installed at the door frame while one sensor is responsible for detecting movement for outdoor and another one detect the indoor movements. By detecting the indoor and outdoor motion by these two sensors, the system can be triggered when someone come close to the door whatever in indoor or outdoor area.

From figure 2.2, it is showed a button which connected to door control node. This button simulates the doorbell button. When someone presses the doorbell, the system will be activated. The consequence of pressing doorbell button will be mentioned in later chapter.

From figure 2.2, it also showed red led light and green led light connected in the nodes. When the system opens the door, the red light will be switched on. However, when the system closes the door, the green light will be turned on instead. In the following chapter, an experiment in real world will be conducted for testing the reliability of system.

2.4 Gas Detector Node

Gas detector node is responsible for gas leaking detection. Typically, there are several gas detectors which are installed around the house to detect gas leakage. When in case gas leakage and detected by gas detector, the output of circuit for gas detection will be set to high priority and affect the input of node.

2.5 Human node

Human node is the code which controlled by human directly. It allows communication and connection to other nodes and interaction with user such as identification of human. For human node, id is unique for every human node.

Figure 2.5 show an extra device which has a slightly motor for vibration and connected to human node. This device is managed by expansion connector of the node. It is available to notice user especially deaf people which vibrate them physically when there is some notification message generated. [6].
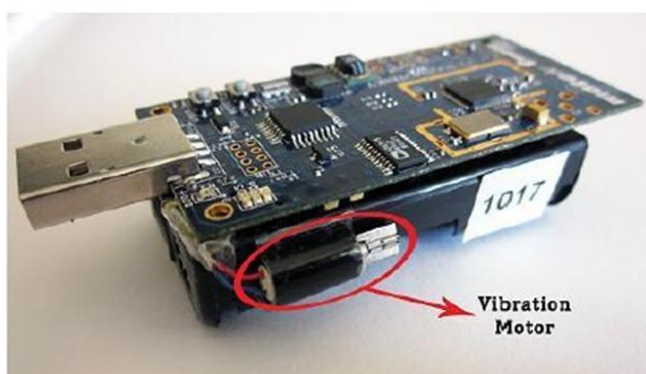

Figure 2.5 Vibration motor connected with Human node

2.6 PIR Sensors

Passive Infrared Sensor (PIR Sensors) [6] is capable to detect motions and sense a human movement in the detect range of sensors. It is an electronic device which detects the change of motion and measuring the different infrared levels for surrounding objects. The advantage of these sensors are low power consumption, easy to handle and inexpensive. Figure 2.6 showed the PIR sensor.

Figure 2.6 PIR sensors

Figure 2.7 showed PIR sensor module. It is one of the prepared circuit which included PIR sensor and it provided simple on / off signal and it generate signal to output pin when it detected movement.

Figure 2.7 Module of PIR sensor

From figure 2.8, it showed the PIR sensor module contains a 3 – pin output at the bottom. The left pin is ground and the next pin is digital output. Finally, the right pin is power input pin which the specification standard is 3.5 V – 12 V DC input.
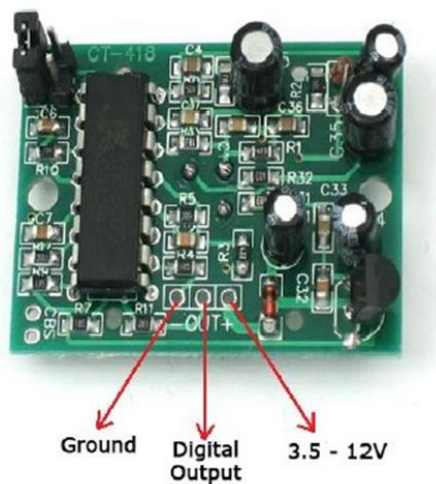

Figure 2.8 Back side of PIR sensor module

2.7   Gas Sensor
Figure 2.9 showed the gas sensor which the model number is MQ-6. It mainly detects the dangerous presence such as gas leakage etc. It has very high sensitivity to LPG, propane and butane. Besides, it can detect most of natural gas. [7]. It is adaptable for various applications and low cost.
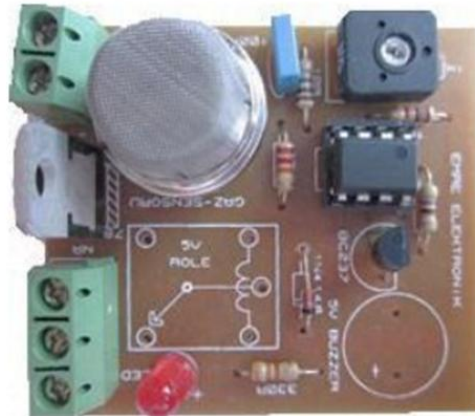
Figure 2.9 gas sensor   Figure 2.10 Circuit of Gas detection

Figure 2.10 showed a circuit of gas detection which connected gas sensor. It provided an on / off signal and it generate signal to output pin when it gas leakage.

III. SOFTWARE DESIGN & LOGIC DIAGRAMS

3.1   Software Design
3.1.1.   Design of Graphical User Interface (GUI)

It is a user interface that enable user to interact with program visually. A GUI gives visual icons and graphical logo to a program. By giving various applications with a set of user interface components, GUI can decrease the spending time to remember the sequence from the user. So that user can spend more time to focus on productive manner by using the program.

3.1.2   Main Menu

Main menu is kind of application of GUI [8]. It usually operated in the computer to control and monitor all smart home system status. User can through this menu to adjust or change the setting of all smart home system in the house. Besides, the main menu connected with database as well as sink node which user can increase or delete the information which stored in database as well. Figure 3.1 showed the screenshot of main menu for easy understand how the main menu interfaces.

Figure 3.1 Main menu of smart home system

From the main menu which figure 3.2 showed, some real time information are provided such as relative humidity, temperature, time and date. In order to WSN nodes installed humidity and temperature sensors, the related information will be generated and measured by those sensor. Through the wireless network, the data will finally transfer to computer and displayed on the main menu.

Besides, the main menu is capable for real time update. The icon or location will be changed if the user moved from the kitchen to the sofa, the location of human node will also be changed and displayed on the main menu.

Figure 3.2 Real time update in main menu displays

3.2 Logic Diagram (Sink Node)

Sink node is communicated all nodes in the networks and computer at the same time. The state schematic is showed below:
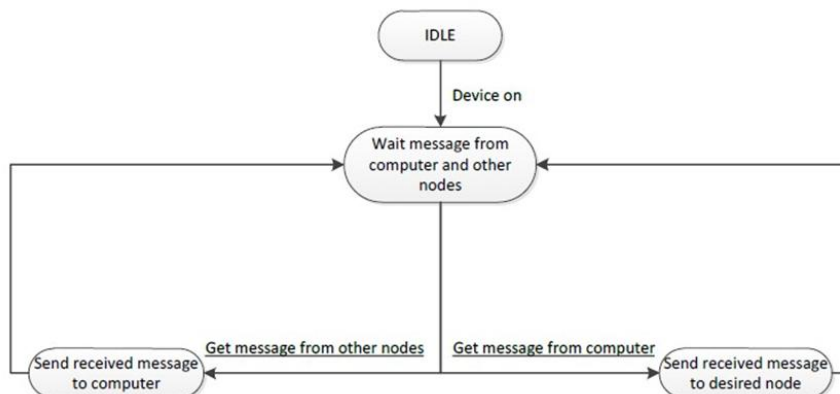

Figure 3.3 Logic Diagram (Sink Node)

3.3 State Schematic for Door Control System

Door control node manages the door control system and the logic schematic is shown in Figure 3.4 as below:
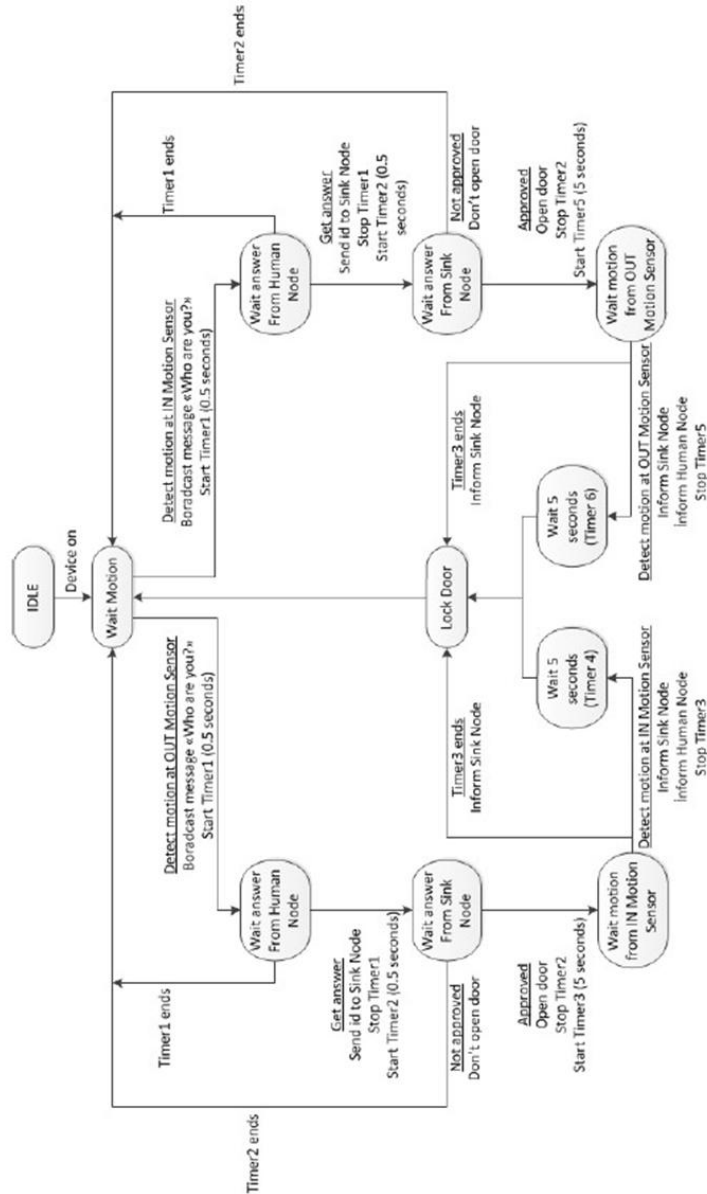
Figure 3.4 Logic diagram (Door control Node)
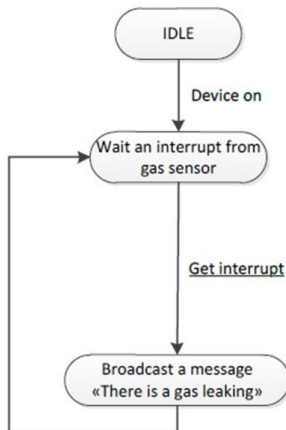
3.4 Logic diagram (Gas detector node)

Figure 3.5 Logic diagram (Gas leakage Node)

3.5 Logic diagram (Human Node)

Human Node is prepared for disabilities for user identification and notification in sometimes. The special thing is that the status of human node will be change through the user is detected within the house or outside of house. For example: If the user is outside of house, the status of human node would be defined as "Out state". If the user is in the house, the status of human node will change to "In state" instead of "Out state". The logic diagram Figure 3.6 will be shown in the following:
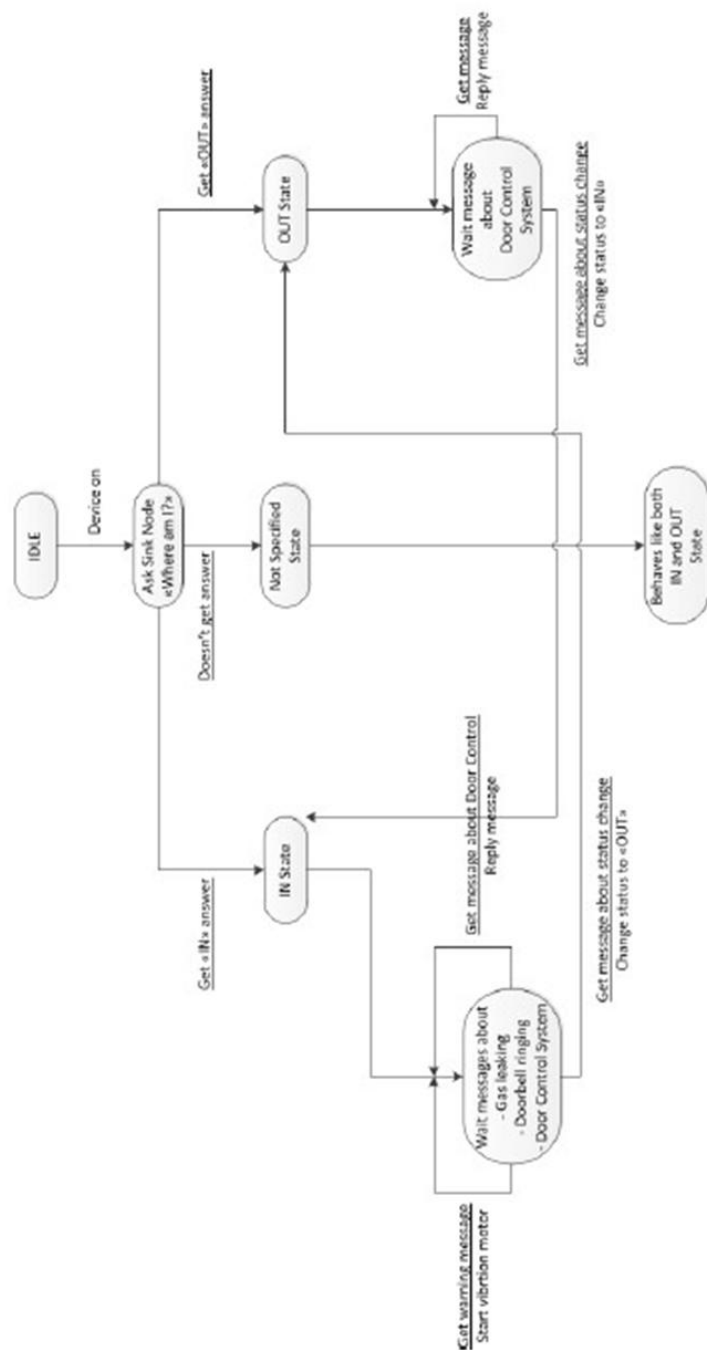
Figure 3.6 Logic Diagram (Human Node)

IIII. CONCLUSION

This essay was inspired from the issues encountered from daily life for disabled people which most of people may not aware of their difficulties. In fact, sometimes disable people may need the help at home but

other people cannot assist them immediately. A proper smart home system can assist them to solve their difficulties which caused from their disabled diseases.

In the world, there are many analysis about smart home system but seems less analysis which mainly focus to help disabled people. Therefore, this essay aims to develop a proper smart home system to help disabled people to enhance their quality of daily life.

In this project, a wireless sensor network was recommended to set up a smart home system. Actually, the advantages of using wireless network build up a mart home network which is easily installation and implementation. Besides, when comparing with traditional connection of smart home system, less conduit and wiring works are required for increase or eliminate smart home device. In order to these advantages, wire sensor network is selected to be operated in this essay.

After adopt wireless sensor network to be used for set up a smart home network, the function of smart home system of this easy should be investigated. Finally, three functions are selected to be further investigated which is door control function, function of gas leakage detection and doorbell notification system. The mentioned systems are mainly designed for disabled people whom lost arms and hands, deaf people and Alzheimer people respectively.

After completed the hardware and software of the system built up, execution and implementation in the real world is necessary to prove that the system is work and operate successfully. The experiment is created to testing three mentioned systems respectively. Each system will be tested 20 times and recorded the result whatever success or failure. It means that 60 times experiment will be tested in total. From the result, it found that there is no system operation failure in the testing for each scenario. It means that there are 100% of successful rate for system operation and the result can be concerned as satisfy.

Actually, in Hong Kong, there are around a half million of people defining as disabilities. They may encounter more problems in daily life due to physical disabled. Therefore, they may need extra cares for them and they should deserve a better life quality just like healthy people. A smart home system can assist them to complete some actions or generate some notification to remind them to compensate their disability. For example: Door control system can open or close the door automatically to assist disabilities whom lost arms or hands. Smart home system not only makes convenience to normal healthy only, more contribution can be made for disable people.

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