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Multifunction Sensor Node For Home Intelligent System And Raspberry Pi As Gateway

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Abstract

Smart home systems call for intelligence, compactness and cost effectiveness and by using a multisensor node all these can be achieved. Multisensor node which consists of different types of sensors integrated on a single development board, helps in monitoring various parameters within the home enviornment and finally making use of the concepts of Internet of Things, notifications are sent to the remote locations as an alert. A brief discussion on the building blocks of multisensor node and communication with the centrallised hub and cloud is presented.

Keywords: Accelerometer, Gateway, Gyroscope, Raspberry Pi, Microcontroller, Multisensor node, Zigbee

Introduction

A smart home is an application of ubiquitous or pervasive computing of enviornment [1]. An early definition of smart homes was provided by Lutolf [2].According to Lutolf, "the smart home concept is the integration of different services within a home by using a common communication system. It assures an economic,secure,and comfortable operation of the home and includes a high degree of intelligent functionality and flexibility". The definition is about home automation and doesnot deal with home intelligence. An elaborated definition of a smart home was published by Intertek in 2003, which was involved with the Department of Trade and Industry Smart home project in the UK [1].According to Intertek, a smart home is a dwelling incorporating a communication network that connects key electrical appliances and services and allows them to be remotely controlled, monitored or accessed. A home needs three things to make it smart,

1. Internal network-wire, cable, wireless;
2. Intelligent control-gateway to manage the featured systems;

3. Home automation-products within the home and links to service and systems outside the home [9]

Jackie Craven's definition goes highly in accordance with proposed system with multisensor node, according to which, "a home which is smart, is the technology used to make all electronic equipment around the home act as "smart" or "intelligent" or automated that is to say smart home has highly advanced automatic system for lighting, temperature control, security and many other functions [7].In the present days, mobile devices like smart phones and iPads are being used to handle daily tasks that traditional desktop and laptop computers once handled. Home automation can be defined as accessing or controlling many of our home appliances, security, climate, and video monitoring from a remote or centralized location. A home automation system allows us to check in on our home from a remote location, giving us true peace of mind. Some systems will let us interact with the home security system, providing the ability to arm and disarm our home remotely. Some complete home automation systems will alert us by phone, text or email if there is any unusual movements within our home. Cheaper rates of cameras and different accessible network technologies have made remote home monitoring more effective enabling us to control everything from our cell phone. In this paper, we present the design and implementation of a home security system to detect an intruder at home when nobody is present [11]. Home automation systems using Bluetooth and Zigbee also come under this category. These have limitation of limited access range. Remotely controlled systems use an Internet connection or integration with an existing home security system to allow the user complete control of their system from their mobile device, personal computer, or via telephone from their home security provider. Associating mobile devices such as PDAs and Smart phones with the automation system gets easier in wireless networks [6]. Smart home networks can be broadly divided into two kinds: wired networks and wireless networks. Most research on smart home system is based on the wired network. In order to access the Internet, all equipment and household electrical appliances must connect through the cable. For the new buildings and the new household electrical appliances, the wired home network can be constructed in the early days; however for the old buildings and old household electrical appliances, wiring is very tough. Therefore, the use of wireless network technology promoted the rapid development of the intelligent home network [8].

Related Work

Smart home network technology can be classified into two main types, which are wiring system and wireless system [5].Whatever be the mode of technology, the major concern is the distributed nature of sensors around the house. This leads to added hardware cost and space. Moreover such systems are built in for one particular enviornment where each device is monitored with a sensor and hence limits the usability of the system [3]. Lack of real time and proactive mechanism, and adaptibility for future expansion are other reasons that calls for a better smart home system with newer technologies. Some people have done similar projects, but they use Pyroelectric Infrared (PIR) module and a Infrared (IR) sensor, built around ARM7 microcontroller and the system sends a message to the user through GSM modem on account of the

presence of any unauthorized person. There have been works highlighting the importance of Zigbee as a low cost, low power, less complex wireless standard and sensors like temperature sensor, LPG sensor, Contact sensor are proposed to be deployed for fire detection, gas leakage detection and determination of whether any door is closed or open, respectively. Finally, a warning message will be generated, and played through a loudspeaker for the user to take notice in case of an elderly assist system and an SMS will be sent to the using GSM modem to take required action.

Embedded Internet System

From past few years, Internet of Things has been a widely disccused topic. Countless number of sensors can be networked together and accessed via the Internet. Here we consider a limited number of sensors and. Later this restricted number can be expanded to create a more generallised system.Cloud Computing refers to the provision of computing as a service rather than a product. It can share resources, software, and information to computers and other devices as a utility (like the electricity grid) over a network (typically the Internet) [7]. Using cloud storage, people can remotely store and access their data and resources without any constraint over storage and maintenance. I have used Google Drive to store the data collected by the multifunction sensor node, so that it can be accessed from an internet enabled mobile phone with easily available applications like "hello world" running over it.

Intelligent Home System

A.Multifunction Sensor Node

Smart home controller have been used in many cases, user can monitor and control the electrical device in home from distance through Internet [4]. ARM microcontroller acts as the contol unit, with multiple sensors that evaluates parameter variations against a set threshold and further actions are triggered by the controller. ARM based controller in a open source platform makes it easy for future expansion. Sensors are devices which detect intrusions or any variations. Sensors may be placed at the perimeter of the protected area, within it, or both. Sensors can detect intruders by a variety of methods, such as monitoring doors and windows for opening, or by monitoring unoccupied interiors for motions, sound, vibration, or other disturbances. Temperature sensors, accelerometer, gyroscope, proximity sensor and ambient light sensors are integrated with the microcontroller to perform the fundamental activity of detecting changes in the protected enviornment; such variations include temperature variations in HVAC system, opening or breaking of doors and windows, any suspicious activity like trying to access the gun safe and constantly checking if the lights have been switched off or not. Finally a compact sensor node which is portable and power efficient can be placed anywhere within the home enviornment.

B.Networking

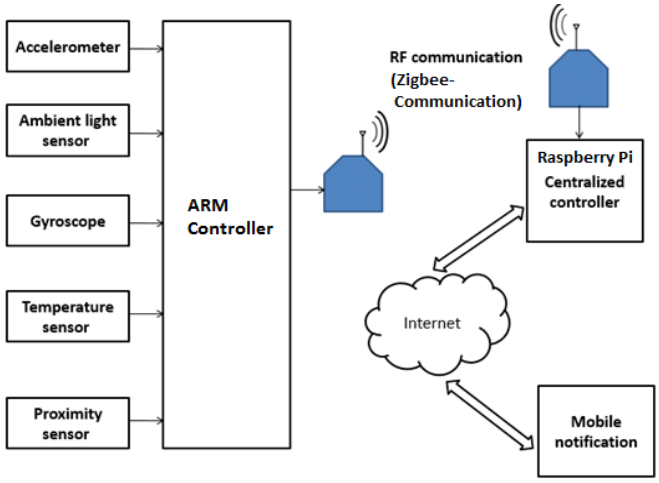

Figure 1: Block Diagram Repesentation of Home Intelligent System

The mulfunction sensor node is connected to a centrallised hub. The centrallised hub or centrallised controller can be laptop or in this case a Raspberry Pi which collects all the data from the ARM microcontroller and intiates push notifications to connect the system to cloud. Nuvoton board which is the development board used can be connected directly to the laptop via serial communication, this can be performed as a wireless operation too, through the Zigbee module.

C. Algorithm

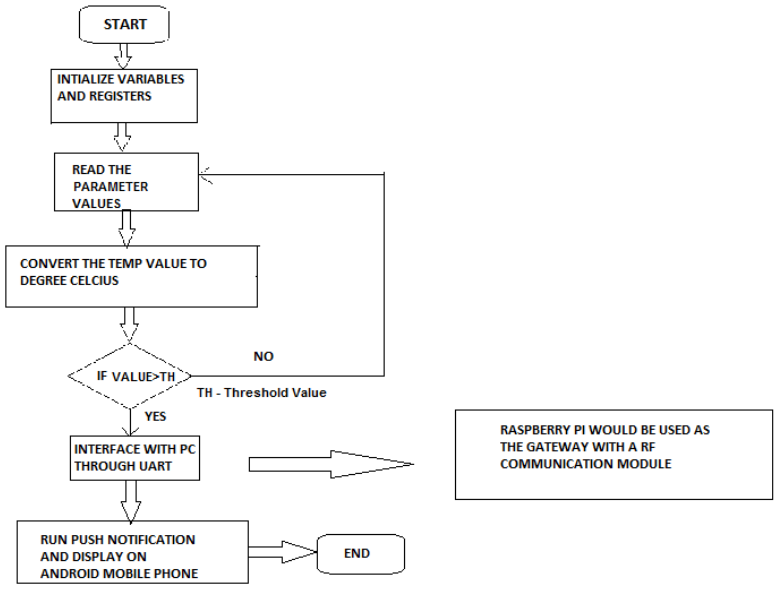

Figure 2: Program Flow of Home Intelligent System

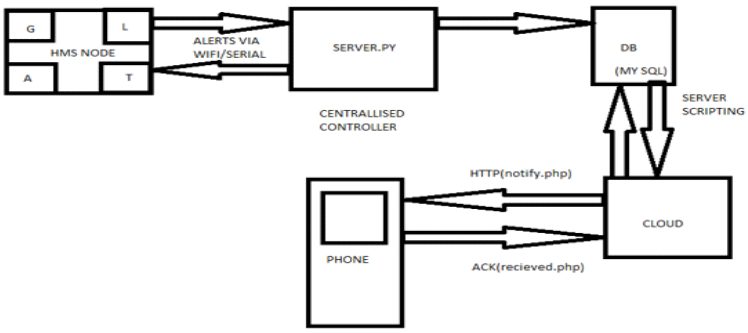

Figure 3: Working of Multifunction Sensor node for Home Intelligent System

Fig 2 illustrates how exactly program has to be coded in Microvision Kiel Platform, so that whatever disturbance the sensor node detects is evaluated against a predefined threshold and as and when a hike in the sensor reading aagainst the threshold is detected, alert is sent to the centrallised hub is via RF communication or a wired serial communication interface. Centrallised hub runs the server.py task which connects it to the Google cloud via server scripting, as shown in Fig 3,also an entry is made in the local database on the hub. Handshaking signals are initiated with the user's mobile phone and Google cloud to sent an alert to user's phone about the detected instance. Once the alert is recieved, an Acknowledgement signal to the cloud is sent whict terminates the connection and finally entry is erased from the local database.

Results

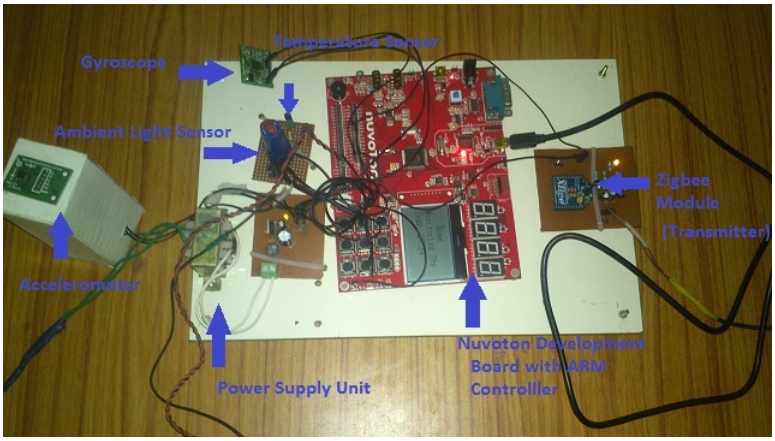

Figure 4: Experimental Setup for Home Intelligence System transmitting end

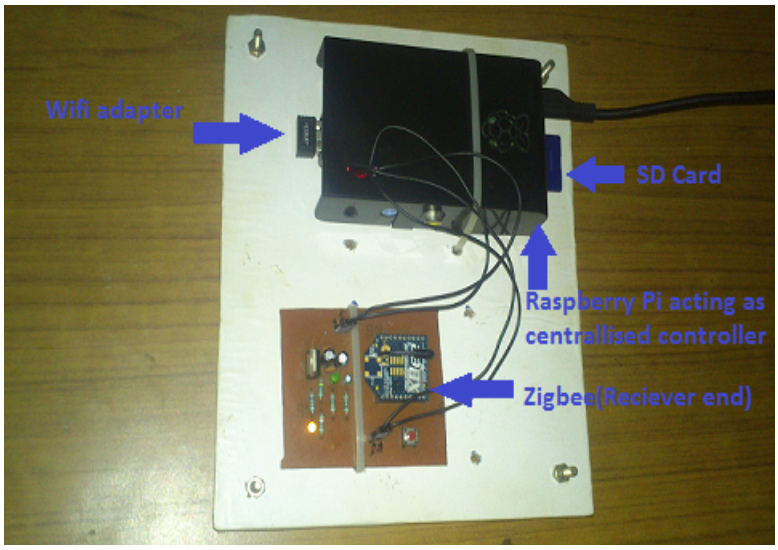

Figure 5: Experimental Setup for Home Intelligence System recieving end

Fig 4 shows Nuvoton Board connected to various sensors specifically temperature sensor, ambient light sensor, accelerometer and gyroscope using its general purpose input-output pins. The LCD panel displays current temperature readings and how the data collected by the multiple sensors is sent to the transmitter end of the Zigbee module, a blink of blue light is observed at the Zigbee transmitter whenever a parameter variation occurs and Fig 5 is the receiving end connected to the Raspberry Pi.

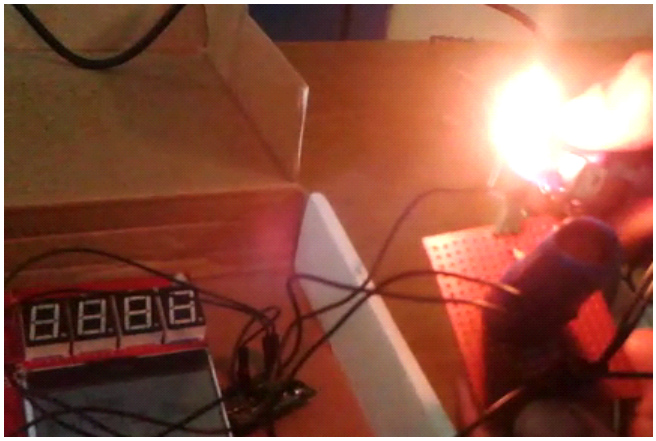

Figure 6: Testing the System for high temperature detection

Fig 6 shows the demo illustrating the working of intelligent home system on account of a rise in temperature reading. Here demo is provided by using a lighter to increase the temperature of the LM35 temperature sensor and eventually a notiiction is observed on the mobile phone as in Fig 7

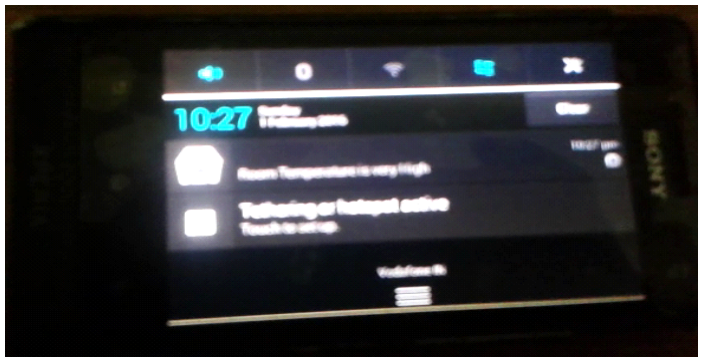

Figure 7: Alert displayed on the mobile phone

The mobile phone is connected with google server via python scripting, ie, the server.py task running on the centrallised hub which is either the laptop or the raspberry pi gateway, as shown in Fig 5 Hence whenever there is any kind of unintented change in the home enviornment, user recieves an alert on the mobile phone. Fig 6 shows such a circumstance where the temperature is made to rise beyond a threshold and as in Fig 7 an alert is recieved on users mobile phone.

Conclusion

The design and the implementation of a wireless home security system. Multi-function sensor and wireless transceiver modules are adopted. The system has a friendly user interface and employs some methods to reduce the power consumption. Communication of the system is complete wireless, which makes the system easy to install and use. The system is low cost, low power consumption and easily operable. The multifunction sensors are used to monitor the house environment and provide the information periodically. Many Wireless Technologies like RF, Wi-Fi, Bluetooth and Zigbee have been developed and remote monitoring systems using these technologies are popular due to flexibility, low operating charges, etc. Today Wireless Sensor Network are used into an increasing number of commercial solutions, aimed at implementing distributed monitoring and control system in a great number of different application areas.

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