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INTELLIGENT KITCHEN MODEL FOR SMART HOMES

Vu Trieu Minh; Riva Khanna

Abstract: *This paper represents the design and implementation of home automation system which basically includes three basic kitchen appliances which we use in our home daily such as refrigerators, stoves and microwave. These systems will not only help physically disabled but also is great help for people with busy schedules and hectic life styles which includes even students. It is done with the help of wireless networks, smart phones and internet. Easy interface would be provided from android applications which will control kitchen equipment with various sensors and barcodes. Here Arduino Uno module is used to do the same. It collects and processes the signals and send them wirelessly to another module, the raspberry pi, using a zig bee module. The raspberry pi runs an OpenHAB server using which the appliances are controlled with smartphones. Computational results/solutions from MATLAB are sent back to those autonomous mobile robots for their executions and interactions as in the real time.*
Key words: Wireless sensor network, X Bee modules, MATLAB graphical user interfaces, Microcontrollers, sensors

1. INTRODUCTION

Assistive domestics are a field in home automation particularly focused on the elderly and people with disabilities, aimed at making their lives a whole lot easier and comfortable. These systems can give them the sense of safety and ease of use by providing them with features like voice control and gesture controls for those who have disabilities.

The elderly and differently abled go through hard time working, cooking and moving around the kitchen and they often need to hire help to make their lives easier. Automatic kitchen gives them the choice of using technology to accomplish their needs instead of depending on others. As lives nowadays are getting excessively occupied and individuals for the most part don't have time for cooking and investing a lot of energy in kitchen .So appliances ought to be that cutting-edge as far as sparing time and remind them about vital things such as their food items in fridge is going to lapse soon so they can purchase a few staple goods soon. System like this is already available in the market like LG home chat which are using android interface to work on it however system provided by me facilitates some other advancement as it is not just chatting also weighing and barcode printer in the fridge gives user freedom to choose expiry date of certain items as it is very important to eat healthy food.

LG Home Chat incorporates the popular LINE application to allow users to receive recommendations and control settings when away from home. With an intuitive interface, Home Chat makes communicating with LG's smart refrigerator, washing machine or oven much like chatting with a close friend. For extra convenience, the Quick Button feature enables fast and easy access to each appliance's most commonly used functions. A smart home automated control system using android application and microcontroller is referred in [1]. A recent wireless sensor network using Arduino for environmental monitoring applications can be read in [2]. A smart home management

system can be designed as in a reference [3]. A development of a wireless sensor network using MATLAB and embedded microcontrollers is referred in [4]. A recent guide book for using android application can be read in [5]. Stability of the control system is referred in [6]. A real automated food ordering system with real time customer feedback is read in [7]. And a fault detection system is referred in [8].
This paper introduces the design of a new kitchen automation system using wireless, microcontrollers and MATLAB interfaces and monitor of kitchen in smart home. The contents of the paper are following: part 2 presents the hardware configuration, part 3 introduces the network connection, part 4 illustrates simulations and experimental results, and finally, part 5 briefs conclusions and recommendations.

2. HARDWARE CONFIGURATION

The sensors from the appliances collect necessary data like temperature, pressure etc., and these collected data are then transferred to the microcontroller. Here Arduino Uno module is used to do the same. It collects and processes the signals and sends them wirelessly to another module, the raspberry pi, using a zig bee module. The raspberry pi runs an Open HAB server using which the appliances are controlled with smartphones/tablets or any other device that can access the internet as a user interface device.

In this task I am going to build up an android application which I named as Kool kitchen.It helps distinctively capable individuals to remotely utilize their kitchen apparatuses. Likewise warning on advanced mobile phones offers them some assistance with updating about what is occurring in their kitchens. I will explain more about this application later in this report with all data and programming used.

2.1 Layout

The system diagram above is self-explanatory as this is a wireless system we need Arduino, zig bee and raspberry pi to connect to internet and used in phones later. Different kinds of sensors are used in my system like weighing sensor in fridge as shown in Fig 1.

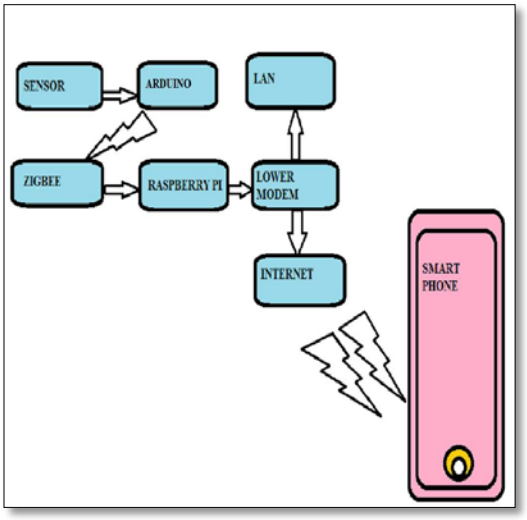

Fig.1. Home automation system

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For the experiment I am going to use temperature sensor. The temperature sensor as the name suggests is used to measure the temperature. It converts heat energy into electrical energy and gives a current signal as an output. In my system it is to be placed inside the oven, refrigerator, kettle etc., to measure the temperature of the food that is being cooked so that it can be displayed to the user who can use the data to get to know the status of the food, also this temperature is used to control the ON/OFF state of the appliance as pre-programmed in the system.

Arduino is the chip produced by a company called Arduino, which is an open source hardware and software company. It can be used to design and build digital devices that can be used to obtain data from sensors and this data can be used to control various devices and their operations.
They have a set of digital and analogue I/O pins which can be programmed to generate signals with the help of the integrated development environment specific to these Arduino boards.
The role of the Arduino Uno in this project is to get input from the sensors to get data about the system and this data is compared to the set values using the programs that have been loaded into the Arduino Uno. For example the program can be used to compare the current temperature of the food to the present value so that once it reaches the present value the appliance can be turned off and a notification can be given to the user that the food is ready.
The zig bee sends the data that is processed by the Arduino to the raspberry pi module wirelessly so that the location of sensors is not constrained by wiring problems. [4]
The Raspberry Pi is credit-card sized computer, without a display or a keyboard or a mouse. It has ports which plugs into a computer monitor or TV, and we can use a standard keyboard and mouse which can be plugged into the USB ports. It is very capable and in getting more and more popular these-days among electronic hobbyists and in prototype developments. It runs Open HAB software which is an open source server specifically designed for automation applications.
There are many types of systems and devices in the market and in order to make interaction between these devices easier we need a common middle ground to talk in. The open HAB server plays that role of a translator between systems that cannot otherwise speak to each other directly.
It is very important interfacing between Arduino and zig bee as our devices has micro controllers

Vcc to 5V (DC power supplier)
GND to GND (Ground)
RXD to RX (Receiver)
TXD to TX (Transmitter)

2.2 Kool Kitchen (Android Application)

Kool kitchen is the name given to the android application I am going to make through which we can control kitchen appliances like fridge microwave and stove.
I have designed logo for Kool kitchen. Kool kitchen is further divided into 3 subunits named as

- Fantastic fridge
- Smart stove
- Master microwave

As soon as we click on the icon of Kool kitchen app will take us to the new window from which user can chose devices they want to work with. So the user screen looks like the picture below. We can see in the pictures symbols for all the smart devices as shown in Fig 2.
For android application i have learnt android programming.[4]

Fig.2. App Installed in Phone

2.3 Fantastic Fridge

As the name suggests it's a fridge with fantastic features. The fantastic features involve information about items in their refrigerator like expiry dates, amount of food left in the fridge. The information will be provided with the help of an android app
For that we need a barcode reader in the fridge. Barcodes initially were examined by unique optical scanners called barcode Readers. Later applications programming

got to be accessible for gadgets that could read pictures, for example, cell phones with cameras. In this project I am going to make an android app called fantastic fridge which tells us about the expiry dates of remaining items and how much items are still left in the fridge.
Barcode printer will print date, year and month. So user can pick any dates for packed or cooked food.
Barcode reader will read that date and save that date in the data base and accordingly user will get notifications on their smart phones
For the items those has no expiry dates on them In the fantastic fridge there is barcode printer user can chose expiry dates like 1 day, 2 days for cooked food and 1 week for fruits and vegetables. All other dairy products like milk, butter, cream etc. soft drinks and medicines barcode will read the expiry dates and we get a notification on our android stating how much items is still left in the fridge and it's time to get groceries from the shop plus whether items are expired or not .

2.4 Smart stove

Smart stove is another advancement in the stove I am trying to make to help my targeted customers.
First advancement here in the smart stove we have some timers installed user can set their own timers and after that time the stove will turn off. Through using the above stated automatic system we can turn off and turn on and off our stove remotely.
Another advanced features that we can add to smart stove is some vessels attached with temperature sensors when the vessel temperature is of certain temperature stove will turn off automatically.
This system works in the same way Fantastic fridge works in which Temperature sensor is attached to microcontrollers and microcontrollers is attached to central hub which sends signals to smart phones and user will be able to control device remotely.

2.5 Master microwave

Using the above stated automatic system we can turn off and turn on and off our microwave remotely. Also as a help to physically challenged people master microwave will send a text / notification on smart phones when task is completed inside the microwave.
For that to happen we can use some position sensors or cameras.

3. NETWORK CONNECTION

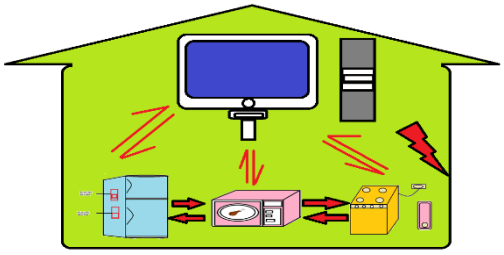

Fig.3. System with central control PC

The main idea here is to include a central hub as PC where microcontroller is attached to it as shown in Fig 3.
Here data will be saved and processed as user cannot use phone all the time system needs a central Hub to collect save and process data in a way user get the error message if the functioning is not proper for any of the system. Hence the work is divided into 3 main parts that is making android app. Application should download the data from the server. Connecting sensors to microcontrollers and get data in real time and Uploading data to the server

4. SIMULATIONS

Below is the Simulink model made for stove in which I have mentioned three things: stove, vessel and controller.
As vessel temperature should be controlled hence the model serves the purpose and stove will go off when the temperature increases from the given set temperature points as shown in Fig 4.

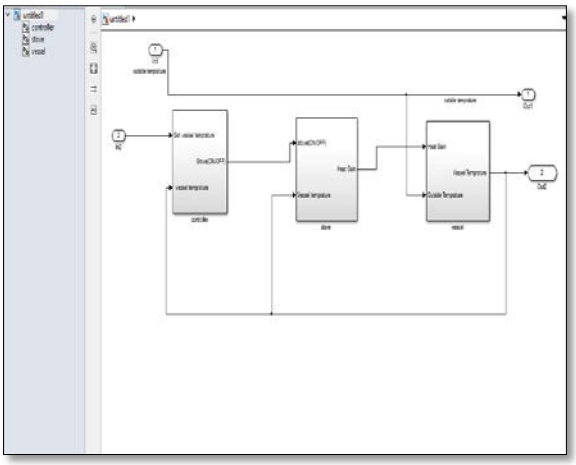

Fig.4. Simulink model to control stove

When the temperature rises and decreases from the given set point we see the variable that variation is shown below in the graph. Hence the set temperature of the vessel would be say 25 ℃ so variations are shown in Fig 5.

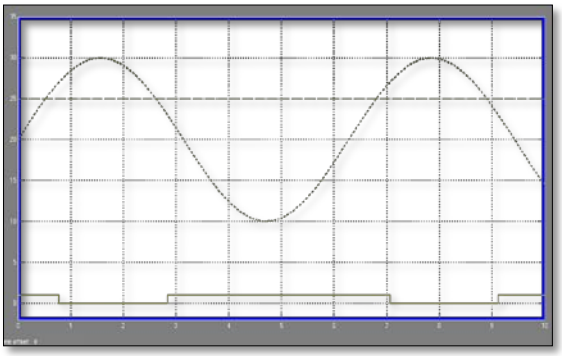

Fig.5. Temperature variations

For the smooth functioning of the model the set data should be fed into the controller to make necessary calculations and setting a set point. To simulate the stove and controller subsystems without the vessel subsystem, we need a signal for the changing vessel temperature. Using a constant block to set the controlled temperature and a sine wave block for a realistic outside temperature signal, the simulations are shown in Fig 6.

From about 0 to 1.5 hours, the stove is turned on. Heat gain is not constant but changes because heat gain is a function of the difference between the stove heat temperature and the vessel temperature. From 1.5 to 5.6 hours, the stove is turned off and the heat gain (top graph) is zero. The simulation confirms the expected behavior.

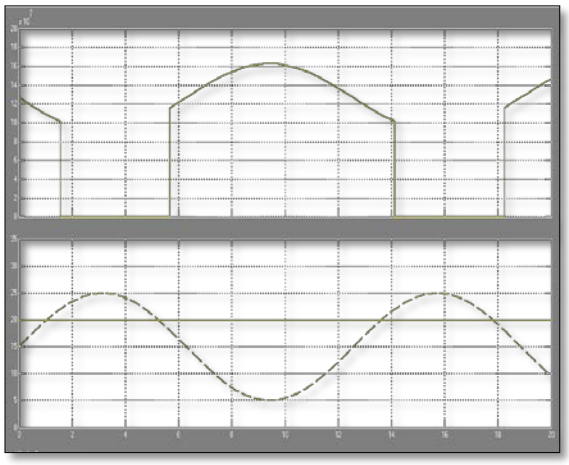

Fig.6. Changing vessel temperature

To simulate the stove and controller subsystems with the vessel subsystem, we need a signal for the changing outside temperature. Simulating the model allows you to observe how the controller setting and outdoor temperature affect the indoor temperature as shown in Fig 7.

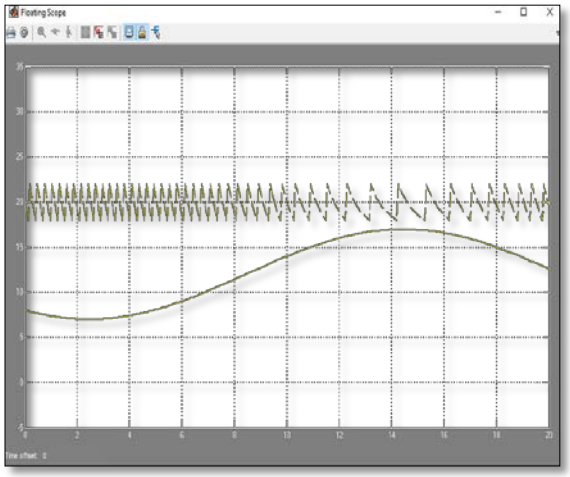

Fig.7. Changing vessel temperature

For the model to work on data .we need to feed data in the controller so that stove can get off when maximum temperature ceases .For that I made some measurements of temperature actually increasing in the vessel or pot. As 100 ℃ is the boiling point of the water and outside temperature and

temperature of vessel without stove is on would be 20 ℃. I have considered it as room temperature. The room temperature is taken 25 ℃ for the simulations

6. CONCLUSION

Home automation is the next step in the endeavour of the community of engineers to improve the quality of life, so that people can concentrate on the more important things in their lives. These systems combine all the electronics in any given home into a single system. The home automation systems are getting more and more popular these-days as they are becoming cheaper and more affordable for the masses. Their reliability has also improved in the recent years and with the advent of smartphones, tablets and the improved internet connectivity all over the world has made it possible for people to control the devices in their homes to be controlled from any corner of the world. This paper concludes that making the android application which enable user to operate his devices from distance. It is not only a help for differently abled but for students and people who are busy with hectic life styles. This works includes a new concept of fridge by which user can be reminded of food items in the fridge and their expiry dates. These days' retailers are just including prize in the barcodes information.

REFERENCES

1. Mohamed A., Ahmed F., Smart home automated control system using android application and microcontroller. *International Journal of Scientific & Engineering Research*, (2014) vol. 5(5), pp: 935-939.

2. Sheikh F., Xinrong L., Wireless Sensor Network System Design Using Raspberry Pi and Arduino for Environmental Monitoring Applications, *Procedia Computer Science*, (2014), vol. 34, pp. 103-110.

3. J.-Y. Son, et al, Resource-Aware smart home management system by constructing resource relation graph, *IEEE Trans. On Consumer Electronics*, (2011), vol. 57, pp. 1112-1119.

4. Minh V.T, Development of a Wireless Sensor Network Combining MATLAB and Embedded Microcontrollers, *Sensor Letters* (2015), vol. 13(12), pp.1091-1096.

5. Reto Meier, Professional Android 4 Application Development. ebook, *John Wiley & Sons, Inc.* (2012) ISBN: 978-1-118-10227-5.

6. Minh, V.T, Stability for switched dynamic hybrid systems, *Mathematical and Computer Modelling*, (2013), vol. 57(1-2), pp. 78-83.

7. Shweta S., Priyanka R., Madhura M., Automated food ordering system with real time customer feedback. *International Journal of Advanced Research in Computer Science and Software Engineering*, (2013), vol. 3(2), pp. 220-225.

8. Minh V.T, Fault detection and control of process systems, Mathematical Problems in Engineering, (2007), vol. 2007, Article ID 80321, 20 pages.

ADDITIONAL DATA

Vu Tried Minh (author)
e-mail: trieu.vu@ttu.ee
Riva Khanna (co-author)
e-mail: rivakh91@gmail.com

Department of Mechatronics,
Faculty of Mechanical Engineering,
Tallinn University of Technology,
Ehitajate tee 5, 19086, Tallinn, Estonia