Control Devices in the Home with the Android App Via SMS

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Abstract: *This paper presented the study of combination between embedded programming in ARM Cortex M4 and Android application. Based on this study, a controlled system for residential devices is designed including lighting devices, sensor systems for temperature, moisture, gas, flood, security and remote control that could be controlled remotely using a central board based on ARM Cortex M4. Furthermore, an embedded program is built in ARM board in order to communicate with GMS module for transmitting and receiving SMS to house owner's cell phone. Besides, the project has successfully implemented an Android application, which simulate the operation of residential devices, to help owner can control and monitor the devices status. The central board also can send the warning message to the owner in case of accident such as fire or thief.*

Keywords: *Smarthome, Microcontroller, ARM Cortex-M4, GMS, Android*

1. INTRODUCTION

Now a day, there are many solution to control residential devices such as control home via the internet, networking applications or SMS [2][3][4]. However, we could not maintain the internet connection at all time while cell phone network always work very well most of the time. Thus, using cell phone network is the most realistic and easy to use solution [1]. This study focused on solutions for home control via phone message (SMS). Those are solutions that can control devices to turn lights on or off as needed, control closing / opening the shutters, turn on / off the air conditioner, and open gates. Moreover, several sensors for gas detector, temperator indicator, thief detector are equiped to send the warning message to the owner when the exception event happen. Besides, the system provides the remote monitor and manipulation functions to help the owner can know anything happen at home while they work far from home or travel for a long time. In order to do that, the study developed a mechanism for home communication through SMS and Android application to notice the information from the sensors of the house to its owner. Then an embedded program was built for user to communicate with their house through text messaging and Android application that are able to access the house information and control the devices in the house such as turn on the lights, turn on the air conditioner before you return home, etc.

The major contribution of this study is to build a controller board to optimize the operation of the microcontroller and synchoronize devices with board in real-time. The board is combination of microcontroller and I/O peripherals that can receive signals from the sensors, send commands to power devices, transmit or receive via SMS. Simultaneously, the Android application must be built to support user can easily see the information the sensors in the house and control the device intuitively. If the user does not have an Android phone, they can also control and receive information by text message for the pre-defined syntax.

2. SYSTEM DESIGN

In order to make the system work with the described functions, the proposed system is design as consists of a central control board and 3 node boards located in various rooms that communicate via RF. The central control board receives control signals from SMS through a GSM kit with SIM card mounted on it. Upon receiving the signal from GSM module, center board will analyze the data according to the pre-defined structure to obtain the control signal or request and transmit this signal to the node board through RF module to perform corresponding jobs that the system requires. System diagram is presented as shown below.
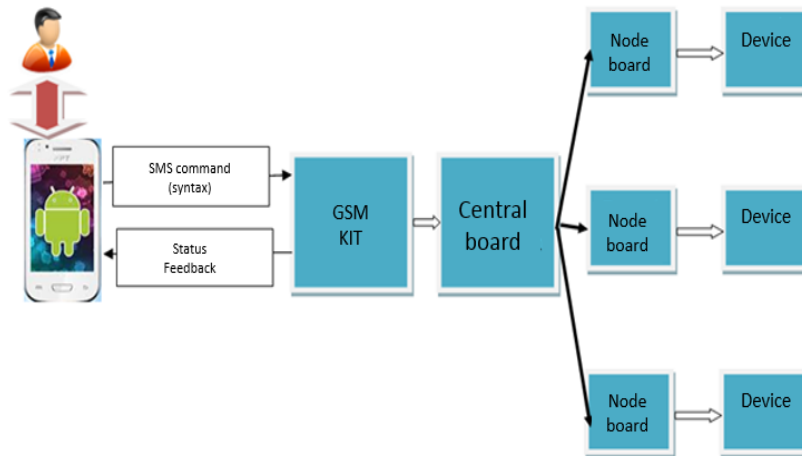
Fig1. *Design diagram of system*

In addition, the research group has designed an Android application so that users can interact visually with devices in house. This application will receive control commands and converted into an SMS message to send to your system. If Android phones are not available, the user can also send the message with right syntax to control home or check the status of the sensor.

3. SYSTEM IMPLEMENTATION

A. Hardware design

In this section, the design and implementation of control circuit is presented including the central controller circuit, the node controller circuit, power circuit, modeling overview for connecting the control circuit with the module.

Center circuit will make communication with GSM module to interact with users through a message, in addition the central circuit also communicate with nodes in the house to collect data such as temperature, humidity, security and device status. Microcontrollers are used in the central control circuit is STM32F407VGT6 [6] that was onboard chip in Discovery KIT STM32F4. This is 32-bit microcontrollers ARM Cortex-M4F, 1 MB Flash, 192 KB RAM.

GSM module that groups used in this paper is SIM900A Module, which is a GSM / GPRS ultra-compact, designed for the global market. Sim900A work at 900MHz EGSM 2 band GSM, DCS 1800MHz as a terminal with a single-core processor powerful, enhance important features based on ARM926EJ-S processor.
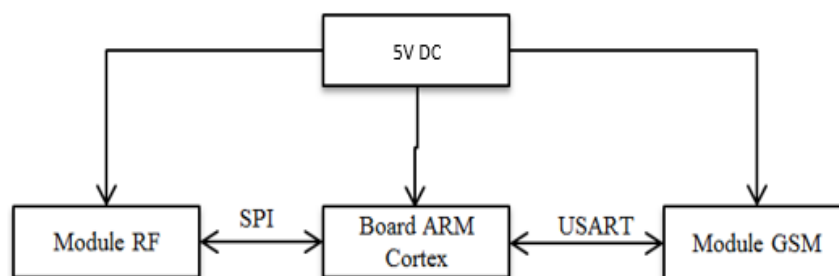
The model diagram of central control board

Fig2. *Design diagram of central circuit*

The node controller circuit

At the node, controller circuit is responsible for weather data collection, inquiry of security and equipment condition in order to send to the central circuit to interact with users. In addition, the circuit at node also communicates with the power circuit to control devices in the home when there is interaction between people via SMS from application on Android. Using 89C52 microcontroller to save costs, the circuit communicate with the central board via RF module. In the node board, EPROM has been added more to save the state of the device when power is lost. Node board diagram is shown in Figure 3
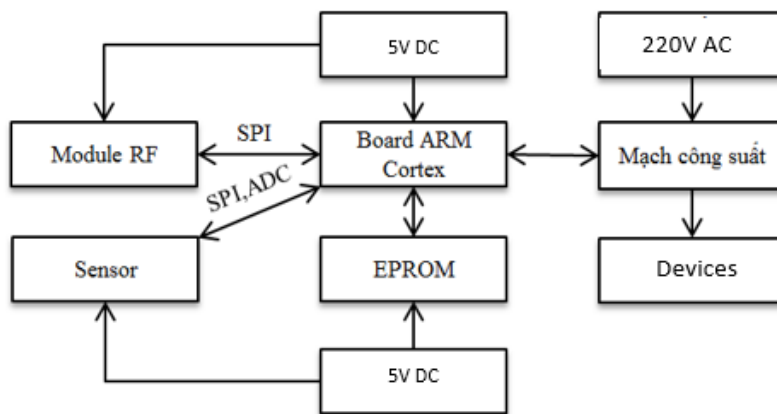
Fig3. *Hardware design diagram of node board*

Power circuit

Power circuits has the responsibility to receive the control signal at a level of DC voltage from the node controller circuit, which transform into signals to control devices with high level voltage or AC voltage. 817C Opto is used to separate the pin of microcontroller with voltage of Triac and MOSFET to avoid feedback current from the equipment. Power circuit is shown in Figure 4.
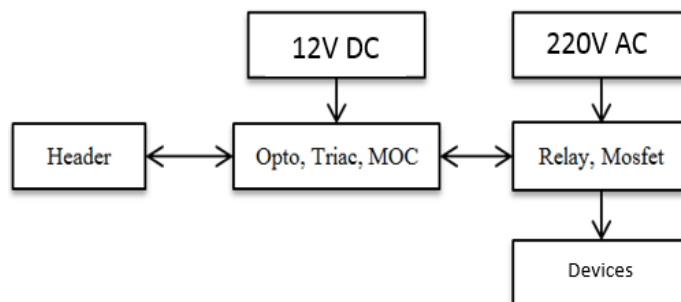

Fig4. *Hardware design diagram of power circuit.*

B. Design of Embedded Software

In the proposed design, embedded software includes embedded software for the central controller circuit and embedded software for node controller circuit.

In central controller circuit, the algorithms and communication solution with GSM module were built to extract and process the data from the packet that users interact from your Android application. Depend on this the system will give the control signal to the control circuit in the node, Figure 5.
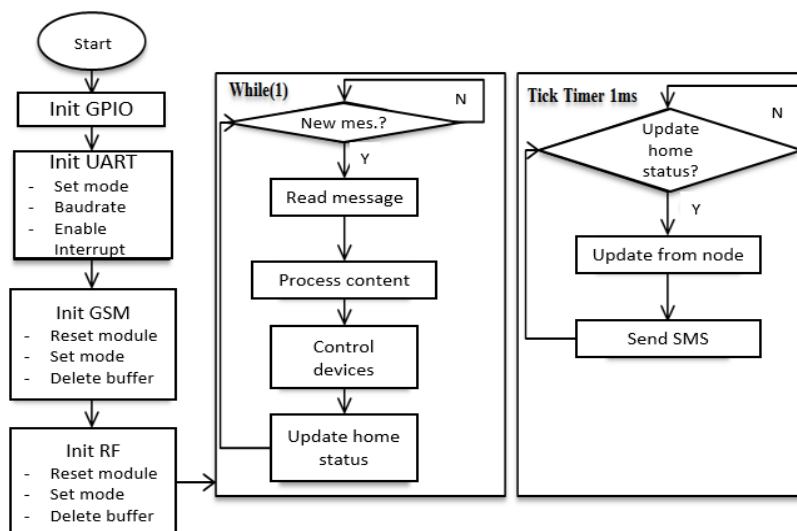

Fig5. *Flowchart algorithm of embedded software center circuit.*

Table3.1. *GSM module commands*

Command	Detail
AT{0D}	Initialize and test module.
AT+CMGF=1{0D}	Select Text mode module.
ATZ{0D}	Reset module.
AT+CMGDA= "DEL ALL"{0D}	Delete all messages on the SIM.
AT+CMGD=1{0D}	Delete message number 1 in SIM.
AT+CMGR=1{0D}	Read the message in SIM number 1.
AT+CMGS="SĐT"{0D} ND SMS{1A}{0D}	Send a message to a phone number with SMS ND.

The command order for communication with GSM module:

B1: Send command "AT" => Module returns "OK" means that the module is ready, otherwise resubmit or hardware testing.

B2: Send command "AT+CMGF = 1", selecting the operating mode of the module is textmode.

B3: Send command "AT+CMGDA = "DEL ALL"", deleting the message in memory of the module, to create memory space for receiving the next message.

B4: Module change to standby to perform the command message from the user control via smartphone apps. When the module receives a new message, it will return signal messages stored in memory.

B5: When a new message appears, send the command "AT+CMGR=1", to read the message content and message processing for control equipment as required. After Finishing of processing, sending commands "AT+CMGD=1", to delete messages to create memory space to receive subsequent messages.

Step 6: Check the status of the nodes in EPROM to know what equipment works, sending messages backwards smart phone to update the operating status of the device. Send command *"AT+CMGS="phone number" {0D} NDTN SMS{1A}{0D}",* Smartphone process messages content and updates status on the interface of device to interact with the user.

In the node controller circuit, unique algorithm were constructed to communicate with environmental sensors, security sensors, communicating with EPROM for storing the status of the device when power is lost and giving complete control equipment signals, Figure 6.
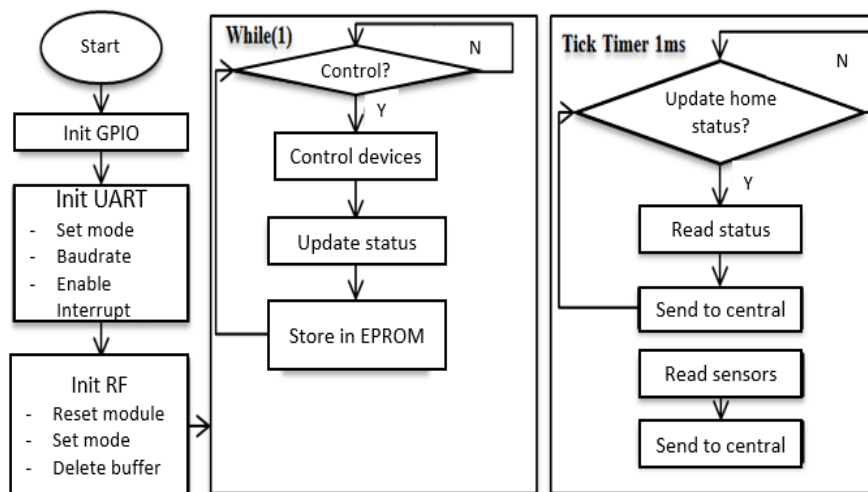

Fig6. *Flowchart algorithm of controller node*

C. Design of Android Application

In this section, the research group focus on application programming solutions on Android operating system, applications interact with people with an visually interface and easy to use for users. In addition, the application has the responsibility to communicate with central controller circuit via SMS to perform sending commands and displays the status of your house through the packets that the central controller sends the user to remote monitor your house visually, Figure 7.

Fig7. *Control interface in Android app.*

Receiving messages from the central board. This section utilized the Object SmsManager group in Android to conduct the checking whether board messages coming from the central board or not. By analysis of the text message and telephone number, which is received from central board t, the display informations can be extracted.

Sending a message to the central board. In this section, the Object SmsManager is also used to perform the transmit messages task to the central board. When a user interacts with the simulator building systems on smart phones, the events that user interact with is processed into command chains via Object SmsManager to send a message to the central board. Based on that, the central board will give control device signal and read status which is returned to smart phones from central board to interact directly with users.

4. RESULTS

The controlled system for residential devices has been successfully developed using android apps via SMS. After writing and compiling programs, embedded binary file will be loaded into STM32F4 kit. The KIT is connected with central control board, simultaneously connect with GMS module and RF module as Figure 8

Fig7. *Central control board*

An Android application will recognize the user's interaction as the on/off light to turns signal into SMS and send to GMS module at center board. In Figure 9 describes the controller sends a signal to open some of the lights system.
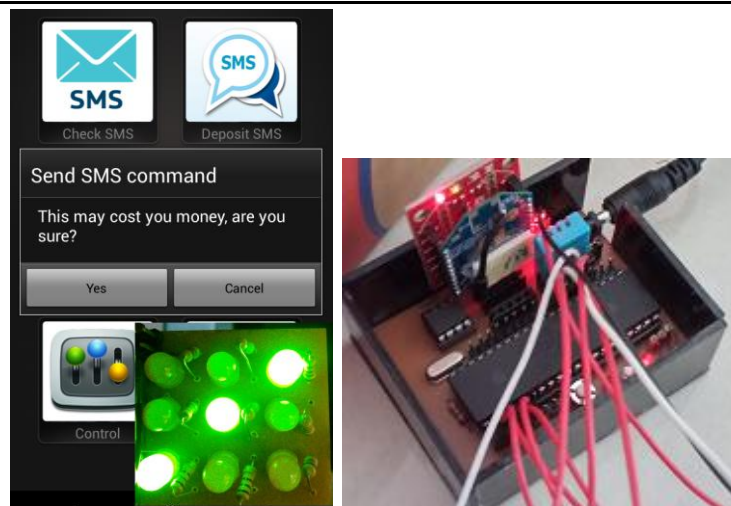
Fig8. *Android application (left) và node board*

5. CONCLUSION

This paper presented the controlled system for residential devices in Smarthome with Android phones via SMS. The research team has designed the entire system from the hardware, embedded software and applications on Android. Results of the study showed that the application of the system into existing homes with low cost is workable. Moreover, users can control the house when no internet and can also just use a regular phone.

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