Mobile SMS Based Controller with Message Feedback

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***Abstract*:** Due to the development in telecommunication, researchers are able now to control –almost- any device from a distance. This paper presents a controlling strategy using cellular mobile devices. The first objective is to build an interface circuit between the device to be controlled and a controlling mobile unit. This controlling mobile unit acts as a receiver of orders from any mobile or phone in order to control any device via Bluetooth. A message is then sent back as an SMS given details about the status of the system. The order is translated in the controlling mobile unit by Dual Tone Multi Frequency (DTMF) decoder as a code to the control circuit that controls the device.
This paper focuses on programming a microcontroller using a high level language. The PIC family of microcontrollers was chosen because of its low power consumption which makes this microcontroller popular in portable application. This proposed strategy provides security to the system from any fault by automatically activating an alarm SMS to the system manager informing him about the system status.

***Keywords*:** SMS, control, communication, security, mobile, PIC.

1. Introduction

The widespread use of information technology has dramatically improved both the quality and the efficiency of different services offered to people [1].
The large deployment of wireless networks and the increasing use of handheld devices like the personal digital assistant (PDA), and the mobile phone have encouraged developers to build different kind of applications and systems in all domains [2]. For example, IR remote control is an application installed in mobile phones which can be used as a remote control via Infra-red, this application can be used in a small areas and needs a line of sight. The evolution of micro-electronics and communications technologies brought many innovations in different automation areas, in particular in domestics, where the technology of industrial processes was adapted to routine domestic tasks [3].
The rapid increase in the residential demotic solutions is being noticed lately, because of the users attention for the need of personalized management for their properties and equipment available in the houses [4].
Bluetooth technology provides an unlicensed band that is ISM (Industrial Scientific Medical) band which ranges from 2.4 GHz to 2.4835 GHz enable the goals of global applicability, low power and high aggregate capacity to be met [5]. This is suitable for a wireless home or office environment and industrial applications. Bluetooth wireless technology is a short-range communications system intended to replace the cables connecting portable and/or fixed electronic devices. The key features of Bluetooth wireless technology are robustness, low power, standardized protocol, Upgradeable and low cost [6].
In this paper, a cellular mobile device is used as a controller by building an interface circuit between the device and mobile unit. This controlling mobile unit acts as a receiver of orders from any mobile or phone in order to control any device via Bluetooth [5, 6]. A message is then sent back as an SMS given details about the status of the system. The order is translated in the controlling mobile unit by Dual Tone Multi Frequency (DTMF) decoder as a code to the control circuit that controls the device [7, 8].

2. System Description

Figure 1 shows the flow of sending messages using the Global System for Mobile (GSM) module, the manager sends an SMS message from a mobile programmed previously in the PIC. When the status of any element in the system changes, the system manager receives a message from the GSM terminal.

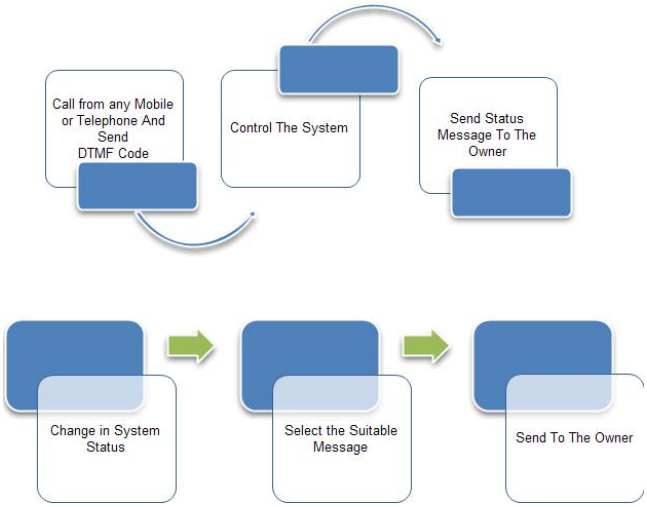


Figure 1. Flow of sending a message

The microcontroller used in this paper is the PIC 16F877A and the program was written using C language. The PIC is used as the brain of the system because it plays a major role between the sender and the controller when executing an order; it also organizes the reply from the controller to the sender. The Dual-Tone Multi-Frequency DTMF IC used in this system is the MT8870. It is used to analyze the signal that is taken from the speaker of the mobile. DTMF adds the horizontal frequencies (upper band) and vertical ones (lower band) from the keypad of a mobile. The keypad consisting of four rows and three columns, which means we need 12 keys to appoint the numbers from 0-9 in addition to (*) and (#) keys as shown in the following table:

Table 1. Frequencies of a keypad to generate a wave of DTMF

Symbol		Tone B [Hz]			
		1209	1336	1477	1633
Tone A [Hz]	697	1	2	3	A
	770	4	5	6	B
	852	7	8	9	C
	941	*	0	#	D

To generate a DTMF tune representing number (1), two frequencies one low (697Hz) and one high (1209Hz) need to be added . The output of the DTMF is a code consisting of four digits. The operating or stopping of the system depends on the arrangement of these digits. DTMF Decoder is a program used to decode DTMF dial tones found on telephone lines with touch tone phones. It is also used for receiving data transmissions over the air in amateur radio frequency bands.

A BCD to Decimal Decoder (7442-j) was used to control the signals from the DTMF, and to know which part is selected for controlling. This BCD-to-decimal decoder consists of eight inverters and four-input NAND gates. The inverters are connected in pairs to make BCD input data available for decoding by the NAND gates. Full decoding of input logic ensures that all of outputs remain off for all invalid input conditions (10–15).

A relay is used to drive the control voltage; it acts as an electrical switch. The PIC is protected from voltage spikes by photo couplers (Opto couplers). It is also used as a controlling switch and as a buffer circuit. The schematic diagram of a simple Opto-isolator is shown in Figure 2.

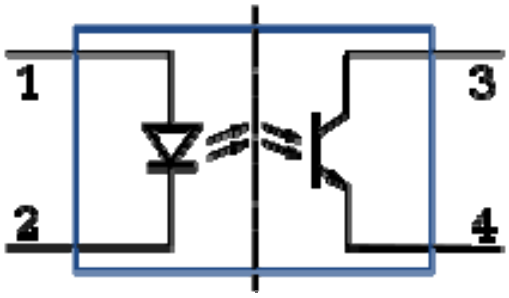


Figure 2. Schematic diagram of an opto-isolator

3. Circuits and Components

3.1 Regulated voltage

The purpose of the regulator is to insure a constant output of 5 volts.

The input goes to pin 1 in LM8050, and the output is taken from pin 2, while pin 3 is common. The output of LM8050 passes through a charge and discharge capacitor stage, and then a smoothing circuit is used to decrease the ripple voltage. The output voltage is used as the supply voltage for all the circuits in the system.

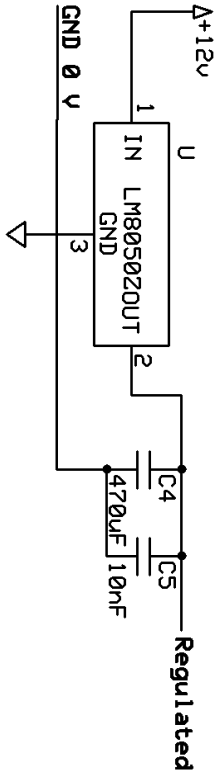


Figure 3. Regulator circuit.

3.2 DTMF circuit

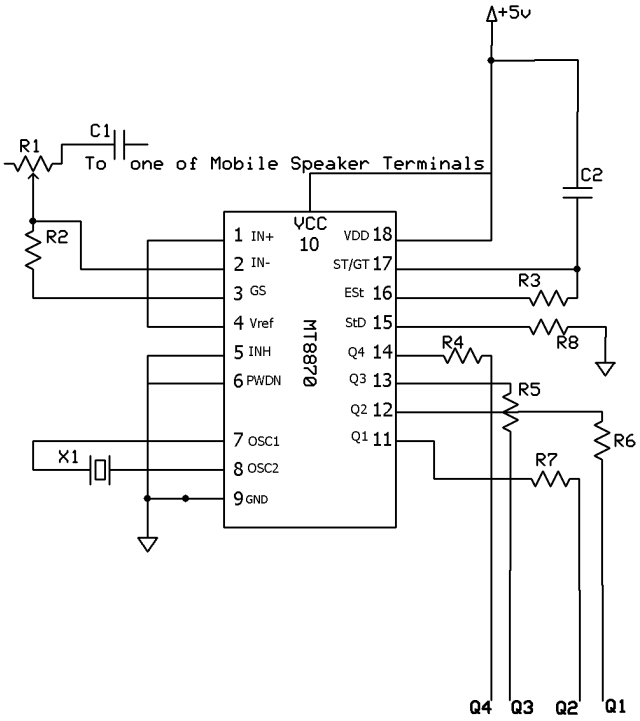


Figure 4. DTMF circuit.

Figure 4 shows a DTMF circuit diagram, the purpose of this circuit is to analyze the sound frequency which is generated from the mobile speakers when pressing any number on the keypad on the caller phone. The input of this circuit is taken from mobile speaker, and the second terminal of the speaker is connected to DC ground of the circuit. The potentiometer here is used to control the speed of the analysis and response.

After analyzing input frequency, the circuit output is taken from 4 pins, i.e., 11,12,13,14 or Q4, Q3, Q2, Q1; it is a 4 bit binary number. The frequency of the MT8870 is 3.58MHz which is generated by crystal X1.

3.3 Decoder

Figure 5 shows a 7442-J BCD to decimal decoder, the purpose of this decoder is to convert the 4 bits binary code, to active low on the pin referred to by the binary number. The inputs of this IC are the 4 bits output from DTMF circuit, connected at pins: 15, 14, 13, 12 or A0, A1, A2, A3,

Figure 5 shows that there is an indication LEDs, which is used to represent the load status, when the LED is ON, the load is connected. The 10 outputs are active low, the outputs that represent numbers: 1, 2, 3, 7, 8 and 9 were used. The control signal to drive the relays was also tracked.

3.4 Control and drive circuit

The strategy is to control any system remotely by DTMF and decoding circuit. But it should be done manually and the controller should always be on standby.

There are 3 relays to turn the loads on, with self continuity, and 3 relays to turn the first three relays off as shown in figure 6. The driving signal of the relays comes from the push-buttons, and the decoder output.

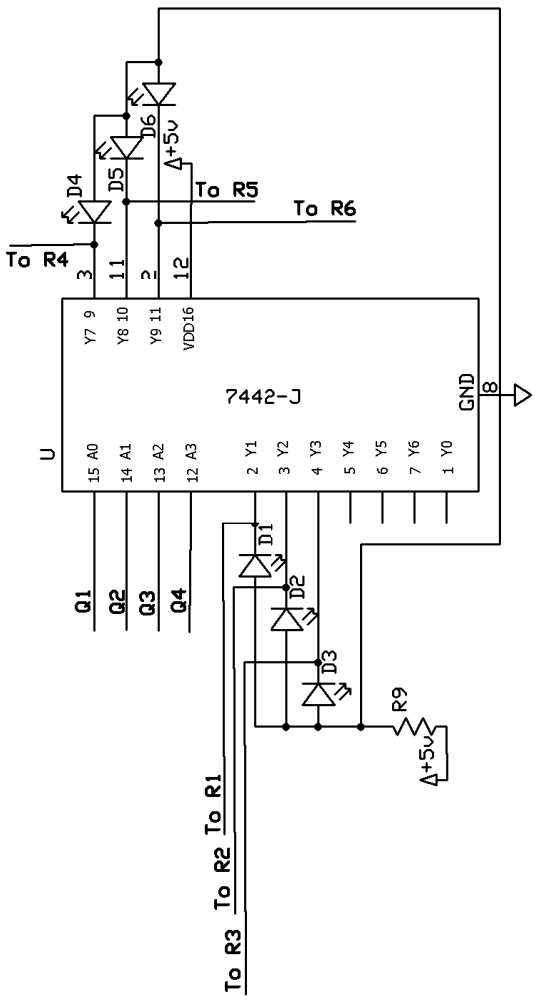
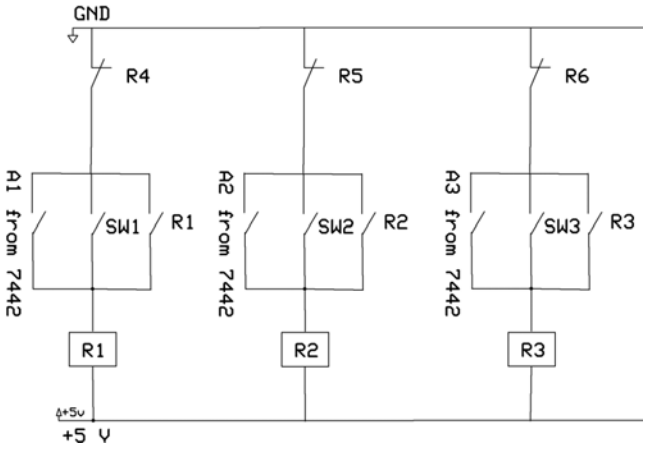


Figure 5. Decoding circuit.



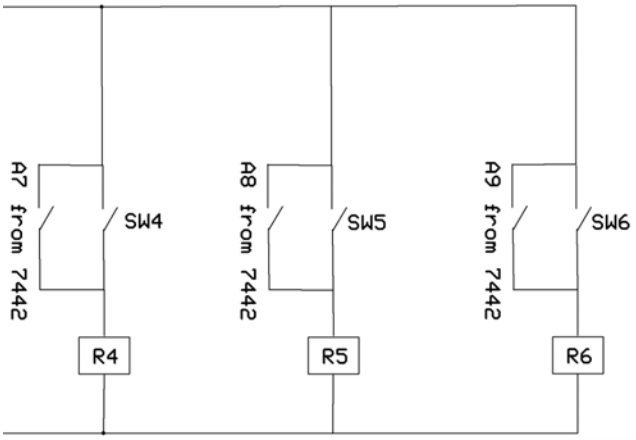


Figure 6. Block diagram of control circuit.

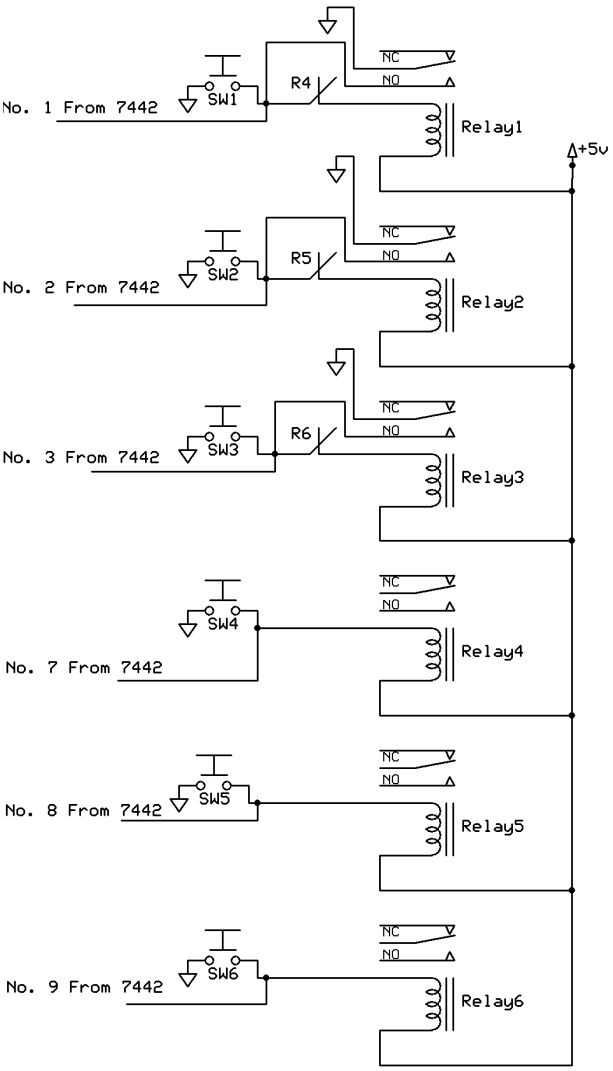


Figure 7. Control and drive circuit.

In order to make buffering between D9F communication port and the PIC, the IC MAX232 was used. Using the D9F makes it possible to program and reprogram the PIC while it is connected to the circuit, making the process faster.
The PIC operations and the registers status may be remotely monitored by connecting the circuit to the computer using the RS-232 cable, which is connected to the serial port (COM1 or COM2).
D8 is an indication LED, when the system is not working or idle, D8 flashes, while it stays ON when the system is busy.
The flashing of D7 means that the PIC is being programmed by computer, so it is not ready.

3.5 Complete schematic diagram

When a call comes to the mobile, 5 volts will appear at the terminals of the mobile's vibrator. These terminals are connected directly to Opto coupler number 8. It activates the send switch by creating a short circuit at the SEND switch, acting as an auto answer operation.
When the call is answered, the voltage at the vibrator terminals will be zero, so the opto coupler goes to the off mode thus enabling the caller to press preset numbers, to control the output, the tones of these numbers to the speakers of the mobile and from the speakers, to the DTMF input through terminal C1
Pin C1 blocks any DC voltage, and the frequented signal passes to pins 1 and 2 of the MT8870. This IC analyzes the signal, and sends the binary code to the 4 pins at the output (11, 12, 13 and 14), for example if the caller presses number 1, binary (0001) will be passed to the output pins (11, 12, 13 and 14). These outputs will be used as the inputs to the BCD-Decimal Decoder which in turn activates a single output connected to relay 1
When the Relay is active, Opto coupler 1 is active, sending a 5 volt signal to the PIC, indicating a change in the status of the system which in turn activates the appropriate message, This is done by creating a short circuit at the mobile switches.

4. System Software

Figure 9 shows a flowchart of the whole programming structure for the controllable system. The only sensor used is a simple switch that is normally open, which means it will be off all the time unless it is triggered. Once the sensor detects any instruction due to the activation of the switch or detection of motion, the PIC microcontroller receives the appropriate tunes generated by the pressing of the numbers on the keypad
of the mobile through the DTMF decoder. The generated tones are analyzed by the PIC and a message is selected and sent to a mobile number which is saved in the PIC.

The software used to design and write the programming code is C language. The code is compiled to generate hex. File which is used to program the PIC microcontroller.

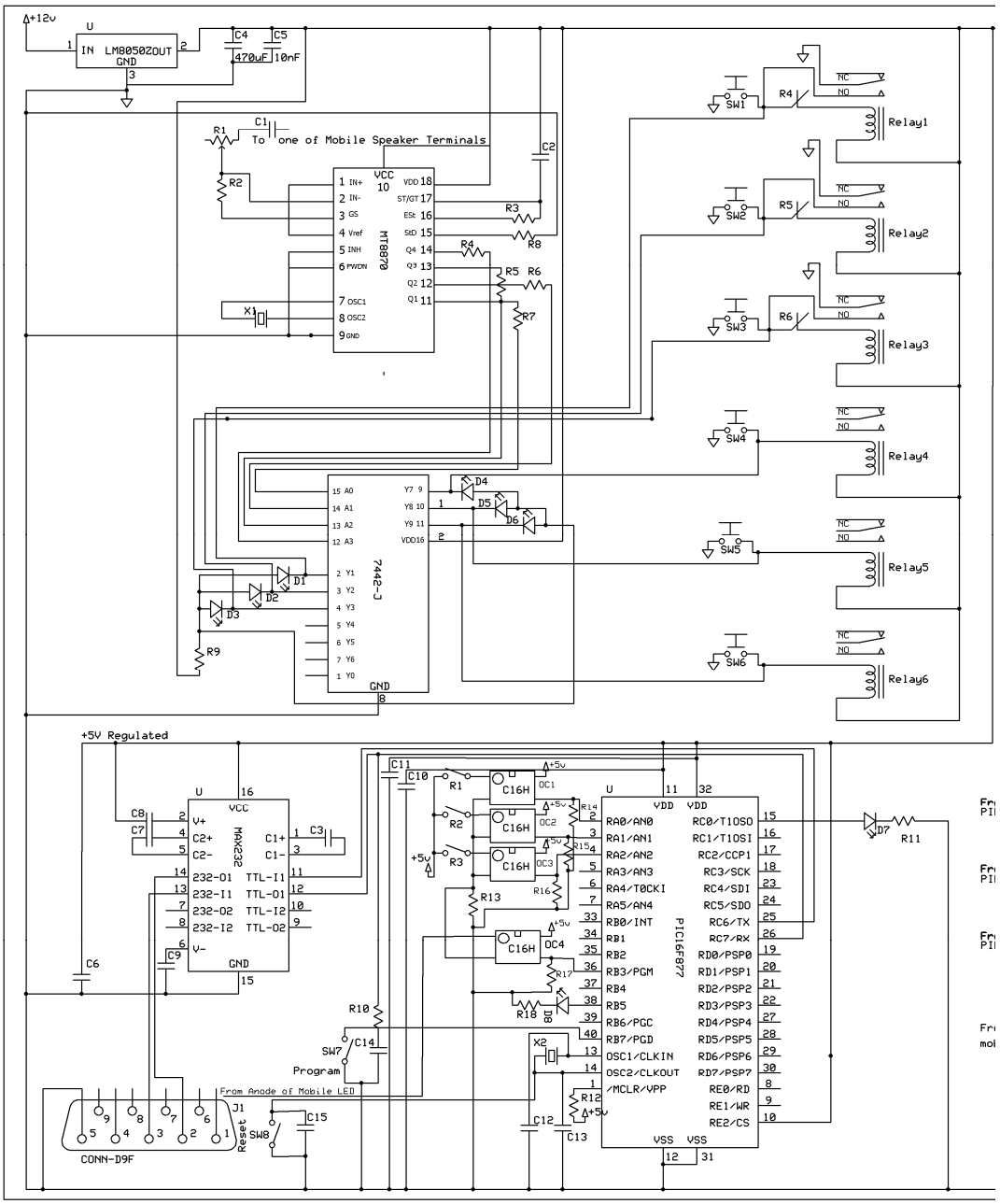


Figure 8. Schematic diagram

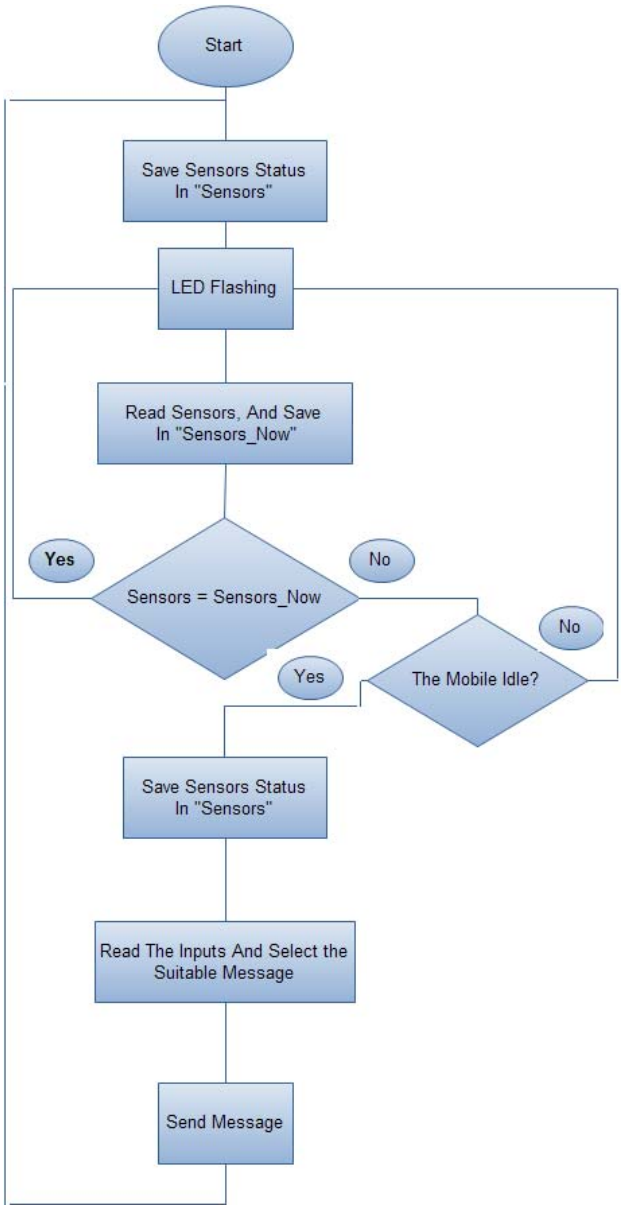


Figure 9. Flowchart of the system

5. Conclusion

An integrated System was built capable of controlling any electrical system, and also sends a feedback message in the form of an SMS showing the status of the system.

References

[1] Mutamed Khatib, Farid Ghani, "Block Transmission Systems in Synchronous Multiuser Communications", International Journal of Latest Trends in Computing IJLTC, Volume 2, Issue 1, pp. 72-79, March 2011

[2] Fontelo P, Ackerman M, Kim G, Locatis C., " The PDA as a portal to knowledge sources in a wireless setting", Telemed J E Health, Vol 9, No. 2, pp.141-147, 2003.

[3] Mafalda Seixas, João Palma, "Remote Alarm and Command System for Residential Domotics Trough GSM-SMS", 9th Spanish Portuguese Congress on Electrical Engineering, 30th June 2nd July, 2005 Marbella, Spain.

[4] Pragnell, M., Spence, L. and Moore, R., The Market Potential for Smart Homes, York Publishing Services Ltd, 2000.

[5] J. Y. Khan, J. Wall, M. A. Rashid, "Bluetooth-Based Wireless Personal Area Network for Multimedia Communication," Electronic Design, Test and Applications, IEEE International Workshop on, pp. 47, The First IEEE International Workshop on Electronic Design, Test and Applications (DELTA '02), 2002.

[6] Sailesh Rathi, "Blue Tooth Protocol Architecture," Dedicated Systems Magazine, Embedded Internet - 00q4 - p. 28 , 2000

[7] Peersman, G., Cvetkovic, S., "The Global System for mobile Communications Short Message Service", IEEE Personal Communications, June 2000, pgs 15-23.

[8] Collesei, S., Di Tria, P., Morena, G., "Short Message service based applications in the GSM network", Proc. 5th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, 1994, pgs 939-943.

[9] ETSI TS 100901. Digital cellular telecommunications system (phase 2+); Technical realization of the Short Message Service (SMS) Point-to-point (PP), 3GPP TS 03.40 version 7.50 release 1998.

[10] Peacock, W., Nokia F-Bus Protocol, http://www.embedtronics.com/nokia/fbus.html

[11] Intel Corporation, MCS 51 Microcontroller Family User's Manual, 1994.

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Arafat Zaidan received his B.Eng. in Electrical & Electronic Engineering from University of Leicester in 1993, and the MPhil/PhD in Digital Control Engineering, University of Salford in 2000. The research was primarily concerned with deriving mathematical models and implementing a pole placement controller for a powered orthosis He was a control System Engineer with research experience in modern control strategies and plant supervision, and worked for five years at the Hashemite University in Jordan as an assistant professor in the department of Mechatronics. Currently working as an assistant professor in the Department of Electrical Engineering, Palestine Technical University (Kaddorie), Tul Karm, Palestine. Dr. Arafat Zaidan has a number of publications to his credit in various international journals and conference proceedings. He is a member of IEEE, Palestinian Engineers Association.

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