Electrical Appliances Control Prototype by Using GSM Module and Arduino

Tigor Hamonangan Nasution, Muhammad Anggia Muchtar, Ikhsan Siregar, Ulfi Andayani, Esra Christian, Emerson Pascawira Sinulingga

[1]Electrical Engineering Department
University of Sumatera Utara
Jalan Almamater, 20155, Medan, Indonesia
e-mail: tigor.nasution@usu.ac.id

Abstract—**The development of remote control technology has grown rapidly along with the development of communication technology nowadays. The simplest communication technology available is by using GSM protocol. In this paper, a prototype of electric appliance control tool via SMS by using GSM is proposed. GSM protocol was chosen because it does not depend on mobile devices' platform. GSM SIM 900 and Arduino for controlling a relay module were utilized here. Relay module worked in accordance with orders given through SMS and the mobile device then received the feedback of the command. For testing purpose, ten (10) different types of input string as a command control was proceed. Relay worked according to orders sent from the input string submitted and feedback messages from the command given previously was provided.**

Keywords-Arduino; GSM module; electrical appliances control; SMS

I. INTRODUCTION

Communication technology involving mobile devices and machines is growing rapidly in both industrialized and globalized world [1], [2]. The communication technology is typically used for controlling and monitoring. The communications protocols used in current technology includes internet protocol, GSM, and small-sized digital radio with low power protocols. [3], [4]. Selection of the protocol depends on the tools that we want to monitor or control, cost, effectiveness, as well as the distance of communication. In this paper a prototypes of electric appliance control with via SMS using GSM protocol was proposed.

The control of electrical appliance by using mobile devices is the basic concept of a Smart Home because it can connect a variety of devices just by using heterogeneous communication protocols [1], [3]. In the previous researches, there were few studies regarding the control of cordless power tools. There was a research on the remotely control system to the home electric appliances by using voice recognition [5]. Communication was done in these studies by using multiple Programmable Micro Remote Controller (PMRC). There were also studies that controlled some equipment in hospitals by using Infrared Remote (IR) Controller [6]. In addition, there are some studies that use computer networks to conduct controlling and monitoring [7]-[9].

GSM protocols control has also been applied to control and monitoring system with multiple devices. The previous research used the GSM protocol for motor drive circuits and LCD (Liquid Crystal Display) [10]. Research was carried out by using the modules SM5100B. Beside using a GSM module there was also a research by using Arduino to read the electric meter [11] and also applied for control and monitoring of water systems [12], [13]. There is also research to monitor electrical distribution transformers [14]. The using of GSM module is also applied in some applications the Internet of Things (IOT) [15]-[19].

In contrast to previous studies, here we designed a prototype to control electrical appliance via SMS using GSM SIM module 900 and Arduino. Controlling is done by a relay module via SMS controller. In addition, the controller also sends status messages from the relays. Electrical equipment settings via SMS was design in order to make the setting does not depend on spesific platform of mobile devices.

II. MATERIALS AND METHOD

A. Arduino UNO

In the design of prototypes we use Arduino UNO. Arduino UNO is one of popular Arduino that uses ATmega328 [20]. Arduino UNO has 14 input / output digital pin (6 of which can be used as PWM outputs), 6 analog inputs, an oscillator crystal 16 MHz, a USB connection, a power jack, an ICSP header, and a reset button [21]. It can be seen in Fig. 1. The characteristics of the Arduino UNO can be seen in Table I.
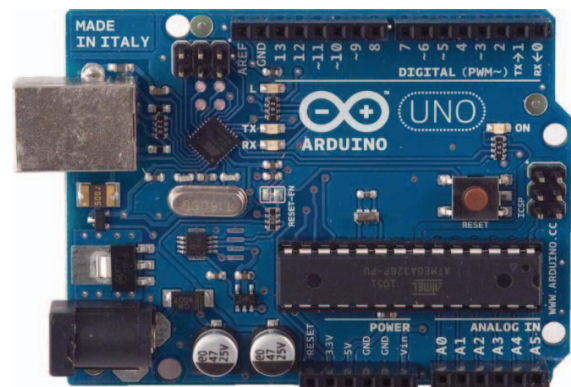

Figure 1. Arduino Uno

TABLE I . ARDUINO UNO CHARACTERISTICS

Mikrokontroler	ATMega328
Operation Voltage	5 V
Input Voltage	7 – 12 V (recommended)
Input Voltage	6 – 20 (limit)
I/O	14 pin digital input / output (6 pin for PWM) dan 6 pin only for analog input
Current	50 mA
Flash Memory	32 KB
EEPROM	1 KB
Speed	16 Hz

B. SIM900 GPRS/GSM Module

SIM900 widely used in GSM protocol communication [22, 23]. SIM900 is a complete Quad-band GSM / GPRS module in a SMT type and designed with a very powerful single-chip processor integrating AMR926EJ-S core [24]. A GSM module SIM900 has been interfaced with the 32-bit ARM processor-based LPC2148 microcontroller. It is connected to LPC2148 through a USB to RS232 driver. The module contains a SIM card holder, RS232-based serial port for connection, an antenna for sending / receiving signals to the SIM and an LED as a status for power, signal and incoming call. Featuring an industry-standard interface, the SIM900 delivers GSM / GPRS 850/900/1800 / 1900MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption [23]. It can be seen in Fig. 2.
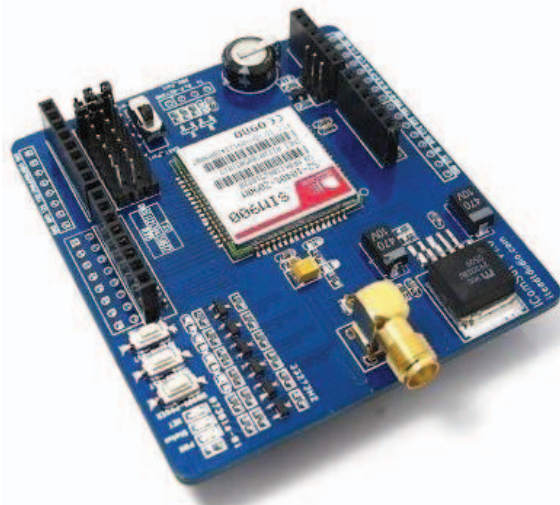
Figure 2. SIM 900 GPRS/GSM module

C. RM54OC Relay Module

Relay Module is a module that is very practical for use as a main switch relay for 4 channels project with microcontroller based electronic circuits. This module turns on / off other electronic devices that are powered by 240 VAC electrical AC or DC high-voltage devices (up to 28 VDC), such as High Power DC motors. It has a maximum current of 7 Ampere for each channel in [25]. The figure of RM54OC Relay Module can be seen in Fig. 3.
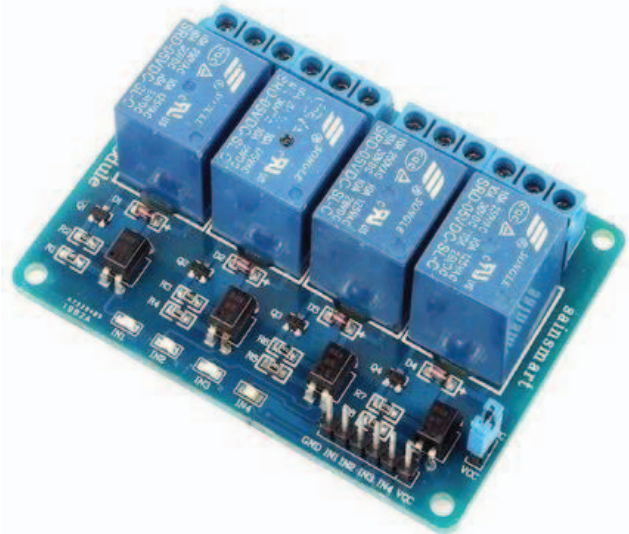
Figure 3. RM54OC relay module

D. Prototype Design

The design of the prototype consists of two stages: the design and programming of SMS controller circuit and microcontroller. The block diagram of system can be seen in Fig. 4. SIM900 GPRS / GSM Module will be connected to pin Rx/Tx of ATmega328 that contained in Arduino. SIM900 GPRS / GSM Module is used to receive and send text messages to mobile devices. RM54OC Relay Module will be connected to the I/O Arduino pin. RM54OC Relay Module will receive the orders from the Arduino to turn on or off. Schematic SMS controller circuit can be seen in Fig. 5.
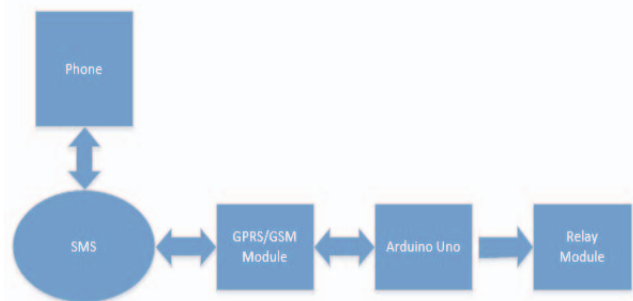
Figure 4. Block diagram of system

Microcontroller programming is used to write the programming code to translate input string obtained from SIM900 GPRS / GSM Module to turn on or turn off the relay. Beside that it is also used for writing code to send AT commands to SIM900 GPRS / GSM module that will send SMS to mobile devices in response to commands sent. Previous predetermined input string that is used to control relays as well as feedback from Arduino message informing that the control has been carried out.
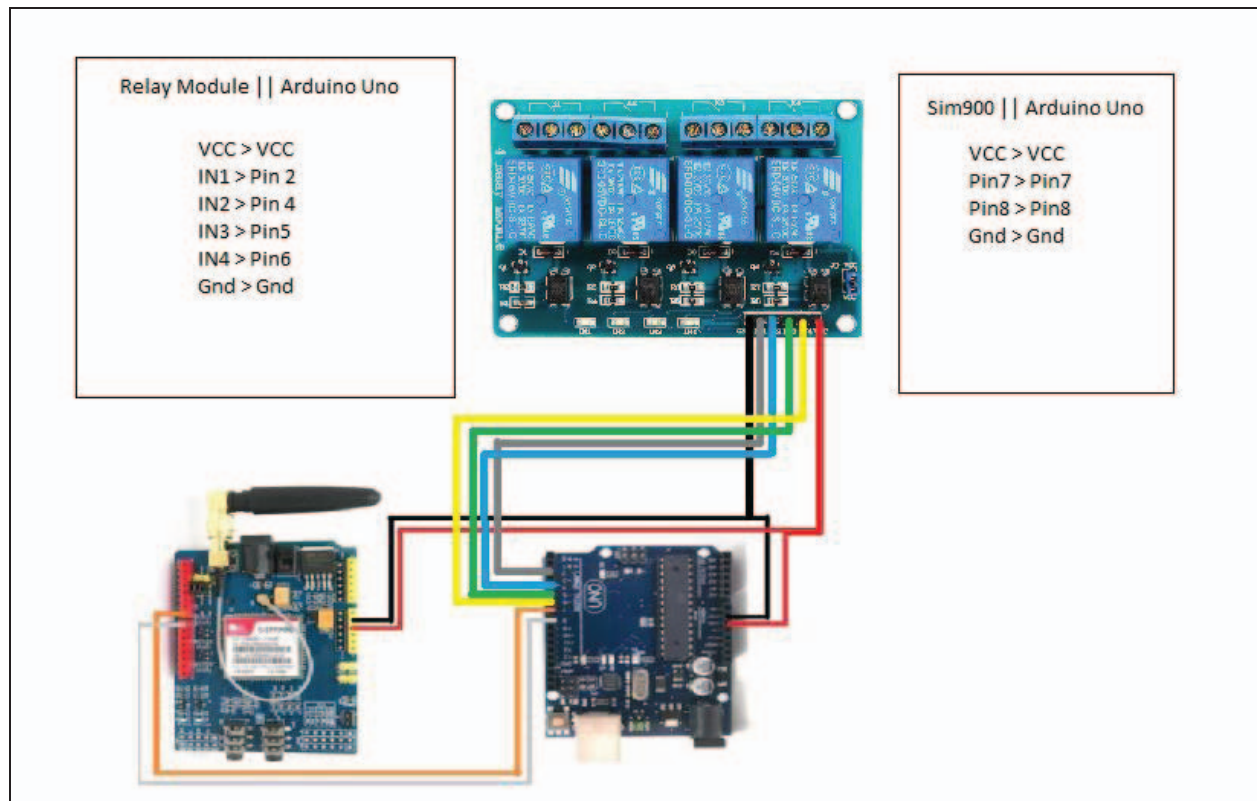
Figure 5. The design of the prototype

III. RESULT AND DISCUSSION

The system consists of an Arduino microcontroller as a control, SIM900 as SMS gateway, Relays as outputs and phones as input. The working principle is Arduino will receive input in the form of a string of data from mobile phones via SMS gateway. Then Arduino will process the data and control relay in accordance with the data. If the relay is ON, the electrical equipment such as lights, fans, and others will be ON as well and also if the relay off the electrical equipment will be off as well. Previous predetermined input string that is used to control the relay. There are 10 types of input string is used for the control and feedback messages obtained. This can be seen in Table II.

Testing was done by sending a SMS to each input string listed in Table II below. An analysis whether the relay works in accordance with the order of the input string was done. Another review was proceed on the mobile devices to check whether there was a message given as the feedback of earlier command. As the result, it was found that the relay worked normally according to the orders from the submitted input string and it was able to provide the feedback messages from the previously given command.

IV. CONCLUSIONS

From the conducted prototype design, it can be seen that the prototype worked as expected. By using SIM900 GPRS / GSM Module and Arduino, a relay module controlled by SMS can be designed. Prototypes can also provide feedback messages from the command given previously. Furthermore, these prototypes can be applied to control the actual electrical equipment.

TABLE II. SMS FEEDBACK FROM ARDUINO

No	String Data Input	Relay Output	SMS feedback from Arduino
1	"rl1on"	Relay 1 *On*	"Relay 1 On Boss"
2	"rl2on"	Relay 2 *On*	"Relay 2 On Boss"
3	"rl3on"	Relay 3 *On*	"Relay 3 On Boss"
4	"rl4on"	Relay 4 *On*	"Relay 1 On Boss"
5	"rlallon"	All Relay *On*	"Relay all on Boss"
6	"rl1off"	Relay 1 *Off*	"Relay 1 Off Boss"
7	"rl2off"	Relay 2 *Off*	"Relay 2 Off Boss"
8	"rl3off"	Relay 3 *Off*	"Relay 3 Off Boss"
9	"rl14off"	Relay 4 *Off*	"Relay 4 Off Boss"
10	"rlalloff"	All Relay *Off*	"Relay all off Boss"

friends, without whom I was nothing; they not only assisted me financially but also extended their support morally and emotionally

REFERENCES

[1] A. Alheraish, "Design and Implementation of Home Automation System," *IEEE Transactions on Consumer Electronics*, vol. 50, no. 4, pp. 1087-1092, November 2004

[2] J. J. Baviskar, A. Y. Mulla, A. J. Baviskar, N. B. Panchal, and R. P. Makwana, "Implementation of 802.15.4 for designing of home automation and power monitoring system," in *Electrical, Electronics and Computer Science (SCEECS), 2014 IEEE Students' Conference*, Bhopal, 2014, pp. 1-5.

[3] Heldon Jos ´ e Oliveira Albuquerque and Gibeon Soares de Aquino Jr., "A proxy-based solution for interoperability of smarthome protocols," in *2014 Eighth International Conference on Complex, Intelligent and Software Intensive Systems*, Birmingham, 2014, pp. 287-293.

[4] R. S. A. Campoverde, J. C. C. Hidalgo and P. E. V. Tapia J. C. M. Contreras, "Mobile applications using TCP/IP-GSM protocols applied to domotic," in *2015 XVI Workshop on Information Processing and Control (RPIC)*, Cordoba, 2015, pp. 1-4.

[5] Noriyuki Kawarazaki and Tadashi Yoshidome, "Remote Control System of Home Electrical Appliances Using Speech Recognition," in *8th IEEE International Conference on Automation Science and Engineering*, Seoul, 2012, pp. 761-764.

[6] Sumit Binnani and Hari Om Bansal, "Electronic aid for elder and sick people IR-remote controlled switch board for changing state of electrical appliances," in *International Conference on Recent Advances and Innovations in Engineering (ICRAIE-2014)*, Jaipur, 2014, pp. 1-4.

[7] G. Cipriani, D. La Cascia, V. Di Dio, A. Lipari, and R. Miceli, "Electrical Distribution Substation Remote Diagnosis and Control System," in *16th International Power Electronics and Motion Control Conference and Exposition*, Antalya, 2014, pp. 1300-1305.

[8] Yogita Pandurang Dhole and Vijayshree A. More, "Embedded Ethernet microcontroller prototype for different parameter monitoring and control," in *2015 International Conference on Energy Systems and Applications (ICESA 2015)*, Pune, 2015, pp. 429-431.

[9] P. Primiceri and G. Cavalera P. Visconti, "Wireless monitoring and driving system of household facilities for power consumption savings remotely controlled by Internet," in *016 IEEE Workshop on Environmental, Energy, and Structural Monitoring Systems (EESMS)*, Bari, 2016, pp. 1-6.

[10] A. A. AbdelQader, M. A. Al-Jezawi and M. AbuMahfouz A. Mghawish, "Multi function control system using GSM modem based SM5100B Module," in *2012 International Conference for Internet Technology and Secured Transactions*, London, 2012, pp. 515-518.

[11] Noor-E-Jannat, M. O. Islam and M. S. Salakin M. M. Rahman, "Arduino and GSM based smart energy meter for advanced metering and billing system," in *2015 International Conference on Electrical Engineering and Information Communication Technology (ICEEICT)*, Dhaka, 2015, pp. 1-6.

[12] A. H. Awang, N. N. S. Bahri and A. M. M. Zaimi N. S. Ishak, "GSM activated watering system prototype," in *2015 IEEE International RF and Microwave Conference (RFM)*, Kuching, 2015, pp. 252-256.

[13] A. Corralejo, A. Ramirez-Molina, J. A. T. Rangel, C. Martinez-Hernandez and M. A. Juarez L. A. Gama-Moreno, "A Design of a Water Tanks Monitoring System Based on Mobile Devices," in *016 International Conference on Mechatronics, Electronics and Automotive Engineering (ICMEAE)*, Mexico, 2016, pp. 133-138.

[14] M. A. E. A. E. Hayati and S. F. Babiker, "Design and implementation of low-cost SMS based monitoring system of distribution transformers," in *2016 Conference of Basic Sciences and Engineering Studies (SGCAC)*, Khartoum, 2016, pp. 152-157.

[15] T. Triantoro, F. R. Batubara and F. Fahmi, "Image based water gauge reading developed with ANN Kohonen," *2014 International Conference on Electrical Engineering and Computer Science (ICEECS)*, Kuta, 2014, pp. 74-78.

[16] R. S. A. Campoverde, J. C. C. Hidalgo and P. E. V. Tapia J. C. M. Contreras, "Mobile applications using TCP/IP-GSM protocols applied to domotic," in *2015 XVI Workshop on Information Processing and Control (RPIC)*, Cordoba, 2015, pp. 1-4.

[17] A. Nait-Sidi-Moh, D. Durand and J. Fortin D. G. Zanfack, "Modeling business entities and physical workflow in the context of Internet of Things: The GSM-IoT framework," in *2015 Third World Conference on Complex Systems (WCCS)*, Marrakech, 2015, pp. 1-7.

[18] J. Gozalvez, "New 3GPP Standard for IoT [Mobile Radio]," *IEEE Vehicular Technology Magazine*, vol. 11, no. 1, pp. 14-20, March 2016.

[19] B. Siregar, A. B. A. Nasution and F. Fahmi, "Integrated pollution monitoring system for smart city," *2016 International Conference on ICT For Smart Society (ICISS)*, Surabaya, 2016, pp. 49-52.

[20] Michael Margolis, *Arduino Cookbook*, 2nd ed., Shawn Wallace and Brian Jepson, Eds. California, United States of America: O'Reilly Media, Inc., 2011.

[21] F. Ramon Lara and M. Dolores Redel F. Javier Jimenez, "API for communication between Labview and Arduino UNO," *IEEE Latin America Transactions*, vol. 12, no. 6, pp. 971-976, September 2014.

[22] M. A. Gaffar and K. M. Salim S. Shahidi, "Design and implementation of digital energy meter with data sending capability using GSM network," in *2013 2nd International Conference on Advances in Electrical Engineering (ICAEE)*, Dhaka, 2013, pp. 203-206.

[23] Rishikesh, V. Nagar, S. Dwivedi and B. Choudhury A. Pramanik, "GSM based Smart home and digital notice board," in *016 International Conference on Computational Techniques in Information and Communication Technologies (ICCTICT)*, New Delhi, 2016, pp. 41-46.

[24] SIMCOM Wireless Solutions. (2017, January) SIMCOM. [Online]. http://simcom.ee/modules/GSM-gprs/sim900/

[25] vcc2gnd. (2017, January) vcc2gnd. [Online]. http://www.vcc2gnd.com/sku/RM54OC