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Design and Development of SMS Based Platform for Controlling Stepper Motor

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Abstract*: *In this modern era, the access and control of devices/ appliances through the ICT enabled tools/ platform from a remote location is becoming very popular all over the world. It is seen that numbers of home appliances in our home are motor enabled and therefore the demand to control the same remotely is a matter of concern. This work is about the design aspects of an ICT based platform that can control the speed of stepper motor as well as other operations like start, stop, direction of rotation etc. from a remote location without physically accessing the motor. The world is witnessing the rise of GSM network in terms of its coverage area as well as its popularity around the world. Hence, GSM infrastructure has been chosen in this work such that an SMS based platform can be designed and developed to control the stepper motor remotely. To implement the platform, one GSM modem is connected to the PC for receiving the user actions/ commands in form of SMS from a reference cell phone with the help of AT commands and then the PC is connected to a microcontroller using RS 232 serial communication. AT commands are some standards for configuring and controlling the GSM modem. The microcontroller receives the control signal from PC based on the user's command and the microcontroller accordingly drives the stepper motor. In this work, database of the actions/ command for each user along with time of occurrence has been maintained to extract the behaviour of the users, so that the system can make the provision to learn and predict the specific user actions and behave accordingly in a proactive way in near future.

Keywords: GSM modem, SMS, AT command, My Sql, Stepper Motor, P89V51RD2 microcontroller, LCD

I. INTRODUCTION

In this modern time of information and communications technology, mobile devices are playing a crucial role in terms of making a switching system controllable from remote place and therefore numbers of rapid innovation processes towards the development of reliable, simple, user-friendly, cost-effective and fault-tolerant systems have been coming up to meet the need of different aspects at different levels. In this regard, the wireless technology is the key technology to achieve as well as to accelerate the innovation process in terms of being the platform to access from remote location. Bluetooth is a wireless technology standard using ISM band 2.4 GHz, that can be used for forming the personal area network to access and control the devices available in an environment remotely. As Bluetooth technology is robust, low-powered and low-cost, it seems to be very useful for the devices to connect and communicate with each other. Another standard INSTEON, is a technology used for connecting lighting switches and load without extra wiring, makes the home automation paradigm successful one. INSTEON is a dual-band mesh home area networking platform designed by Smart Labs, Inc, used for enabling devices such as light switches, thermostats, motion sensors, etc. Again, Wi-Fi also can be made as a platform to design a system with remote access enabled.

All the devices available in an environment can form a Wi-Fi network to exchange the data and control signals for making the devices accessible from remote place. Infrared technology is also available with us for the computing devices to communicate via short-range signals. Not only wireless technology, but there are wired technology also that can be used as a platform for establishing a system with remote access enabled terminals.

Using power line communication technology, one can use the existing electrical power wiring within a home for home automation like remote control of lighting and appliances without installation of additional control wiring. X10 can be used as a protocol for communication among the electronic devices used for home automation. In this work, SMS technology has been chosen as a carrier for user commands to a dedicated computer and then from the computer commands have been forwarded to the microcontroller for the task as given by the user. SMS stands for Short Message Service, is a text messaging service over GSM using standardized protocols. GSM is an infrastructure for mobile communication and it stands for Global System for Mobile Communication. For sending and receiving SMS through a GSM modem and also to configure the GSM module, AT commands are required. AT commands are set of commands that have been standardized to communicate with terminal equipments such as GSM modem, mobile phone etc. There are four types of AT commands and they are Set Commands, Read Commands, Test commands and Execute Commands.

II. MOTIVATION AND OBJECTIVES

This work is to design and develop a system framework that allows the user to remotely control and monitor a stepper motor though SMS. To monitor the status of the motor and as well as to retrieve the behaviour of a particular user of the motor, special focus has been given in this work to preserve the details of the user actions as database transaction so that actions can be made proactive in the future time. The preservation of the user behaviour related to the actions performed by the user will ultimately become a milestone for developing a smart environment, where services from the environment are proactive and intelligent in nature.

III. RELATED WORKS

A. Deswal and et al. [4] did a project is to implement control of remote devices through cellular networks. Over the GSM network, they tried to send SMS for controlling the remote device. This control was implemented by interfacing a nokia 3310 mobile phone with microcontroller where the microcontroller receives bytes from the nokia phone and decodes them based on the user specification. In that work, two way communications have been established between phone and microcontroller via Fbus protocol. They also considered the security aspects also in their work. V. Bhaskar and T. Gowri Manohar [5] also discussed the design aspects of an embedded device which can control up to 8 devices and also monitor and control speed of a motor and also perform necessary operation like start, stop, reverse the rotation etc., by sending a specific SMS message from a mobile phone. To implement this, a GSM modem is connected to a programmed microcontroller which would receive the SMS from a reference cell phone. Here the system is capable of controlling the motor by receiving control message from an authorized mobile number. Again, P. Chandra and et al. [6] also have done a work based on SMS to monitor and control the speed of a motor. They interfaced the mobile unit with microcontroller so that it takes the responsibility of reading the received commands in the form of SMS and performs the predefined tasks such as motor start, stop, motor direction and speed control. In their work, low cost, secure, ubiquitously accessible, auto-configurable, remotely controlled solution for automation of different motors has been introduced.

IV. PROPOSED FRAMEWORK

The proposed framework consists of different modules like GSM module, Software module and Microcontroller module. GSM module is used to receive the incoming SMS that are sent by the users. The software module comprises of the java program used for communication with the GSM Modem and to communicate with the microcontroller. The software module also deals with the database operations maintained in the system for keeping the records of the user-wise actions along with time of the occurrences. Again, the module comprises of the microcontroller (P89V51RD2), LCD and the stepper motor. The microcontroller performs the task of receiving the commands sent by the computer, checking what action is to be performed by the motor and controlling the motor according to the specified action. The microcontroller also writes data to the LCD whenever an action is performed by the motor. The LCD then displays the current status of the motor.

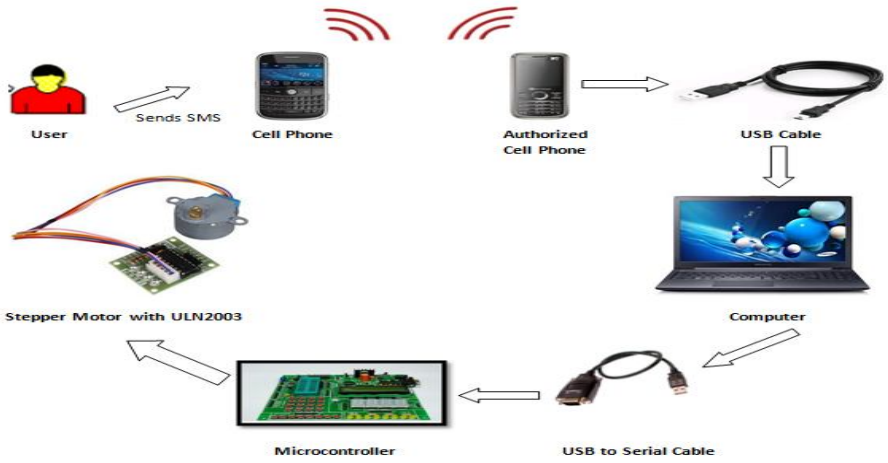

Fig. 1 Proposed prototype framework

A. Architecture of the Framework

The architecture of the proposed framework given in the fig-1 consists of-

1) A GSM modem that receives the message from a remote user.

2) A PC that communicates with the GSM modem as well as with the microcontroller via serial ports.

3) A microcontroller that is used to control the motor.
4) A MAX 232 converter to convert the voltage levels of the microcontroller to RS 232 levels.
5) A Stepper motor that performs specific actions such as start, stop, rotate clockwise or anticlockwise, run with a particular speed.
6) A motor driver to convert the voltage levels between the microcontroller and the motor.
7) A LCD that is used to display the status of the motor.

First of all, users send a SMS containing the command to the GSM modem connected to PC and the format for the message is given as follows-

*B. Username: Password: Action**

the format of the message itself, it is seen that user name and password must be given followed by the command/ action details required to drive the motor. Moreover, for security reason, authentication process is enabled in the system, as the users have to send the message through registered mobile. After arrival of the message at the GSM modem, the computer gets the message through AT commands and tries to verify and decode the message. Verification is done through registered mobile number, user name and password. During the decoding of the message, if the action part is found to be valid, then the computer send the required command based on the action part to the microcontroller. Although command is same with the action part, the command representation is different to the microcontroller so that microcontroller can understand the same. The microcontroller after getting the command from the computer checks what action is to be performed by the motor and accordingly, it instructs the motor to perform that specific task. The microcontroller then acknowledges the LCD to display the status of the motor. Finally, an acknowledgement is sent to the remote user about the action performed by the motor.

C. Work flow chart

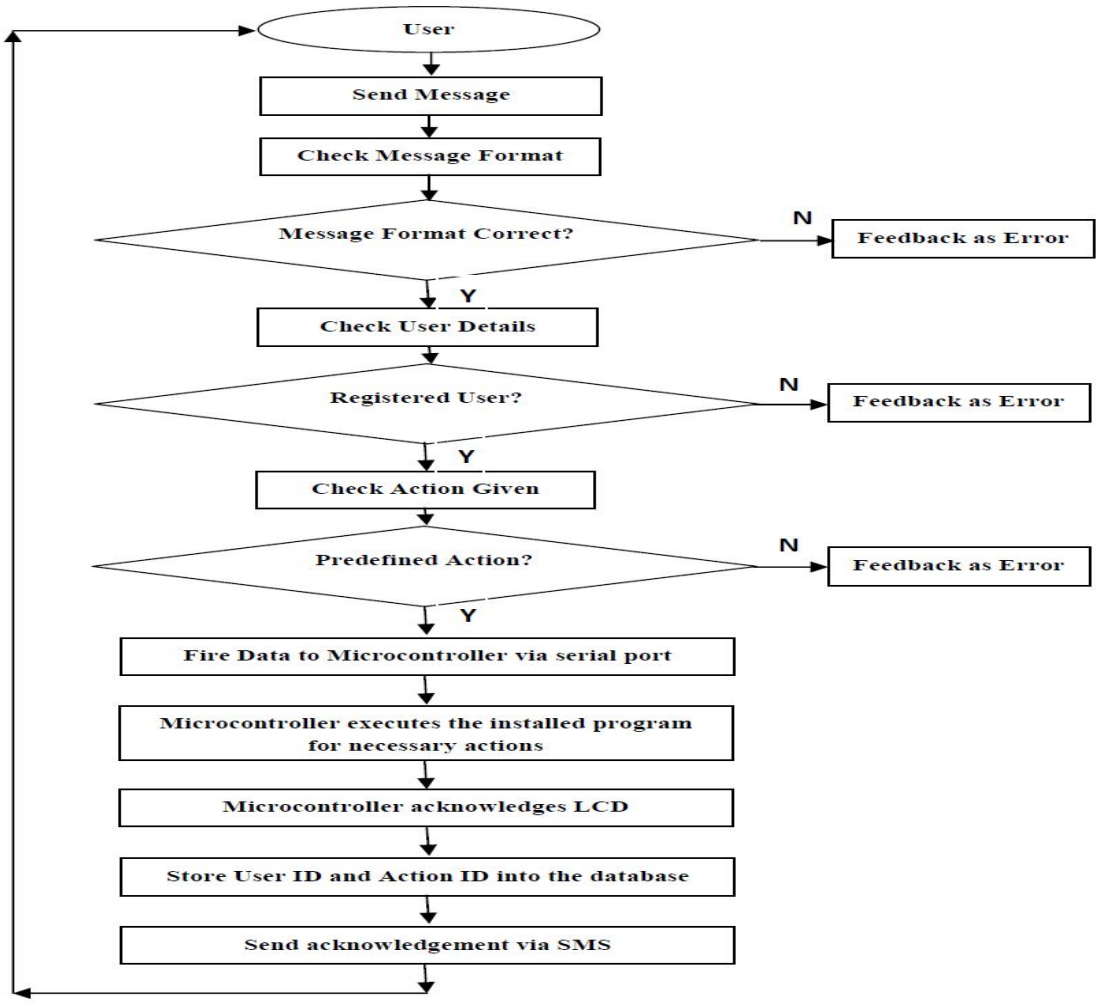

Fig. 2 System flow diagram

D. Technical Specifications

Technical specifications for the tools and technologies used in this work have given in the table- I as follows-

TABLE I

S. No.	Technical specifications		
	Components	Specifications	Descriptions
1	GSM modem	Micromax X360 handset	It is used to receive the messages sent by the remote user.
2	Microcontroller	P89V51RD2	It is an 80C51 microcontroller with 64 KB Flash and 1024 bytes of data. It is used to control the Stepper motor.
3	Voltage converter	MAX 232	It is used to convert the TTL logic levels of the microcontroller to the RS232 levels and vice versa.
4	LCD	16 x 2	It can display 16 characters per line and there are 2 such lines. It is used to display the status of the motor.
5	Stepper motor	Unipolar	It is a brushless DC electric motor that divides a full rotation into a number of equal steps. A unipolar stepper motor is interfaced with the microcontroller by six connections with the help of a motor driver.
7.	Motor driver	ULN2003	Since the 8051 lacks sufficient current to drive the stepper motor windings, we must use this driver to energise the stator.

V. IMPLEMENTATIONS

In this work, the prototype of the proposed framework involves different software tools as well as hardware tools at different levels of implementation stages. The implementation stages are – sending the SMS, reading the SMS using AT command, verifying the format of the message command, writing over the serial port of the microcontroller, introducing databases for action log, microcontroller programming, instructing the stepper motor according to the specification, interfacing with LCD, acknowledging the status etc. Some of the important stages are mentioned in the following-

A. Data Flow Diagram and Relational Schema

My Sql database named Motor Control with three relational schema USER, ACTION and ACTIONLOG is created to store the details of the registered users in order to provide security against unauthorized access, and also to store the details of the actions performed by a motor for each authorized user. In the following fig- 3, DFD of the system is given.

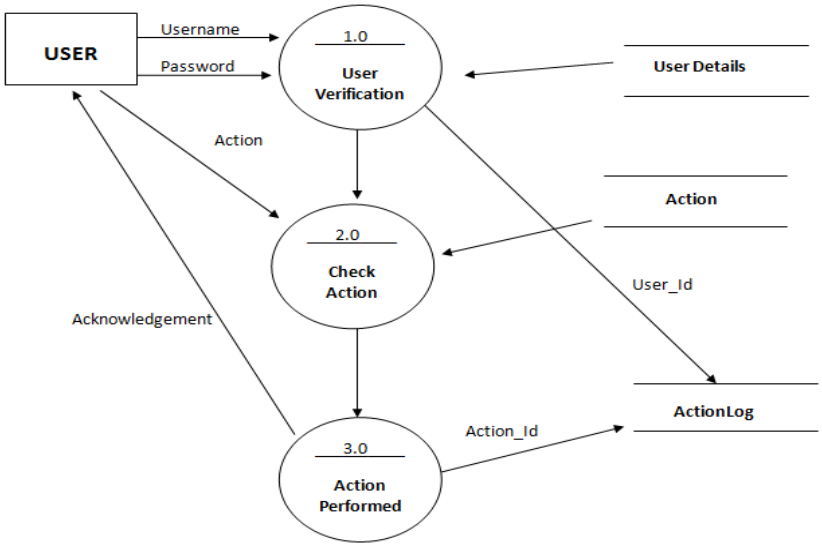

Fig. 3 DFD of the system

B. Reading Message with AT Commands

Java programming implementation has been performed to read the messages using AT commands and the steps for the same are as follows-

1) The serial port parameters are configured properly.
2) Open the Input Stream and Output Stream of the serial port.
3) "AT+CMGF=1" is written to the Input Stream to read in text mode.
4) "AT+CNMI=1,2,0,0,0" is written to the Input Stream to read the GSM Modem recent message.
5) Add serial event listener to check the arrival of message at the Input Stream.
6) If the message arrives, read the message.

C. Writing to Microcontroller Serial Port

After validating the username and password, the computer checks which action is to be performed by the motor and accordingly, it writes a specific command to the serial port of the microcontroller. The steps for writing data to the serial port of the microcontroller are-

1) The action part of the message is converted to uppercase and stored in a String Action.
2) If Action=START, computer writes S to the serial port of the microcontroller.
3) If Action=STOP, computer writes T to the serial port of the microcontroller.
4) If Action=SPD1, computer writes 1 to the serial port of the microcontroller.
5) If Action=SPD2, computer writes 2 to the serial port of the microcontroller.
6) If Action=SPD3, computer writes 3 to the serial port of the microcontroller.
7) If Action=SPD4, computer writes 4 to the serial port of the microcontroller.
8) If Action=SPD5, computer writes 5 to the serial port of the microcontroller.
9) If Action=CW, computer writes C to the serial port of the microcontroller.
10) If Action=ACW, computer writes A to the serial port of the microcontroller.

E. Reading the Command and Sending Actions to Motor from Microcontroller

After the microcontroller receives the command from the computer, it transfers the data from the SBUF to a safe place. The steps performed by the microcontroller to read the commands are-

1) Checking whether Receive Interrupt RI=1.
2) If RI=1, SBUF has the byte.
3) The contents of SBUF are stored in a Character variable c.
4) RI is cleared.

The status of the motor (ON or OFF) is initialized with a variable Status, the speed of the motor is initialized with a variable Speed and the direction is initialized with a variable Direction. Initially the motor has the status Stop and the speed of the motor is initialized to a specific value and the direction is set in the clockwise direction. The steps to fire command to the motor are-

7) Initializing Status=0;
8) Initializing Speed=50;
9) Initializing Direction=1;
10) If c=S, Status=1 and the motor starts.
11) If c=T, Status=0 and the motor stops.
12) If c=1, Speed=100 and the motor is set to speed1.
13) If c=2, Speed=75 and the motor is set to speed2.
14) If c=3, Speed=50 and the motor is set to speed3.
15) If c=4, Speed=25 and the motor is set to speed4.
16) If c=5, Speed=10 and the motor is set to speed5.
17) If c=C, Direction=1 and the direction of the motor is set in the clockwise direction.
18) If c=A Direction=2 and the direction of the motor is set in the anticlockwise direction.

F. Acknowledging the LCD

The microcontroller writes data to the data pins of the LCD whenever an action is performed by the motor to display the current status of the motor. The steps for acknowledging the LCD are-

1) Initialize the LCD.
2) SMS BASED MOTOR SPEED CONTROL SYSTEM is written to the LCD.
3) If RI=0 then
a) If c=S, then Start is written to the data pins of the LCD.
b) If c=A, then Anticlockwise is written to the data pins of the LCD.
c) If c=1, then Speed 1 is written to the data pins of the LCD.
d) If c=2, then Speed 2 is written to the data pins of the LCD.
e) If c=3, then Speed 3 is written to the data pins of the LCD.
f) If c=4, then Speed 4 is written to the data pins of the LCD.
g) If c=5, then Speed 5 is written to the data pins of the LCD.
h) If c=C, then Clockwise is written to the data pins of the LCD.
i) If c=T, then Stop is written to the data pins of the LCD.
4) LCD is cleared.

VI. RESULTS

In order to control the motor, the command message must be in the form-
Registered_User_ Name : Registered_ password : command* ; i.e. #vaskar:Pass12:Spd1*
Some of the pre-defined command are – Start, Stop, Spd1-for speed 1, Spd2-for speed 2, Spd3-for speed 3, Spd4-for speed 4, Spd5-for speed 5, CW-for clockwise, ACW-for anti-clockwise, etc.

In order to make the System work, the connection of the system must be made in the above way. The cell phone must be connected to the computer through the USB cable of the respective cell phone. This is followed by the connection between computer and the microcontroller through the USB-to-Serial Cable. The details of the proposed developed prototype framework has been given in the fig. 4 as follows-

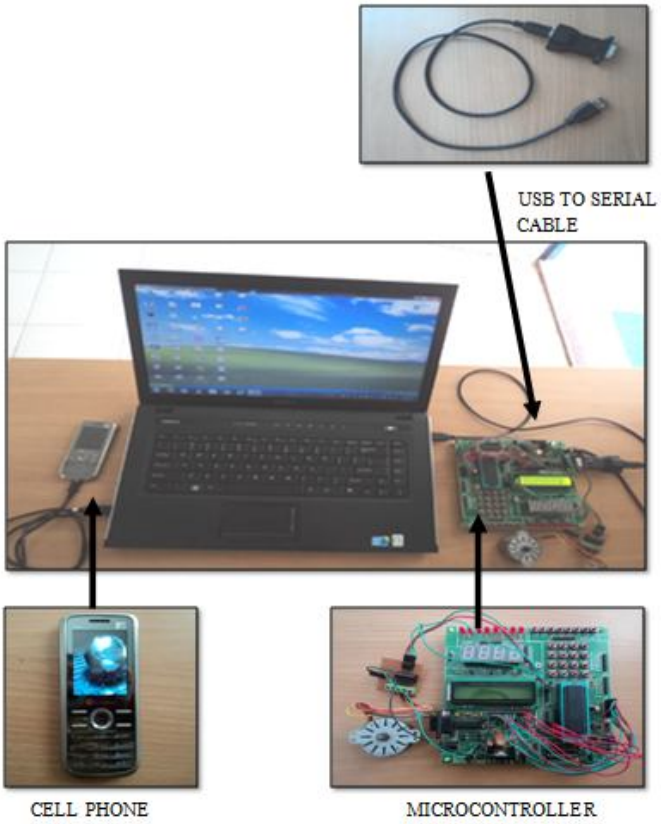

Fig. 4 Photograph of designed prototype system

The system is also capable of checking the format the message. If the message format given by the user is correct one, then only the system will proceed further for checking the user verification else a message will shown as given in the fig. 5 as below-

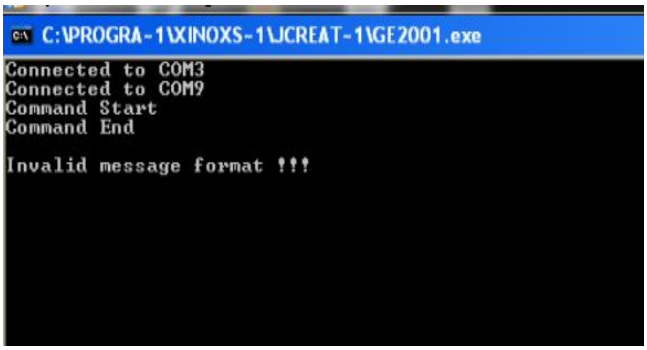

Fig. 5 Screenshot for invalid message

Once the START command for starting the motor is given, the state of the motor has been given in the fig. 6. The motor can be rotated in any of the predefined speed starting from speed1 to speed5. Considering Speed 3, the photo of Microcontroller response is given in the fig. 7. Again, the motor can be rotated either in clockwise direction or anticlockwise direction. Considering Anticlockwise direction, once the command will be fired, then the state of the Microcontroller response is given in the fig. 8.

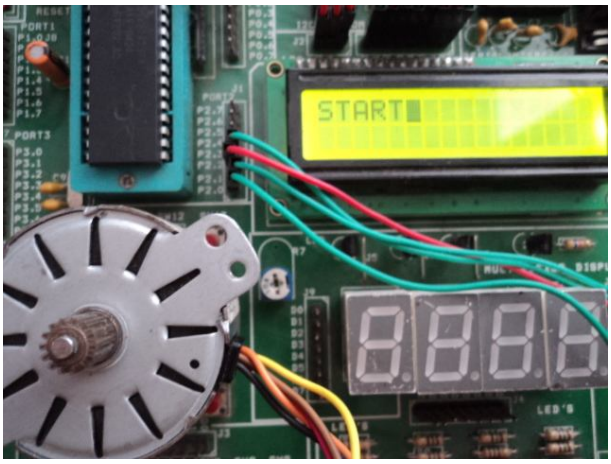

Fig. 6 Microcontroller response for START command

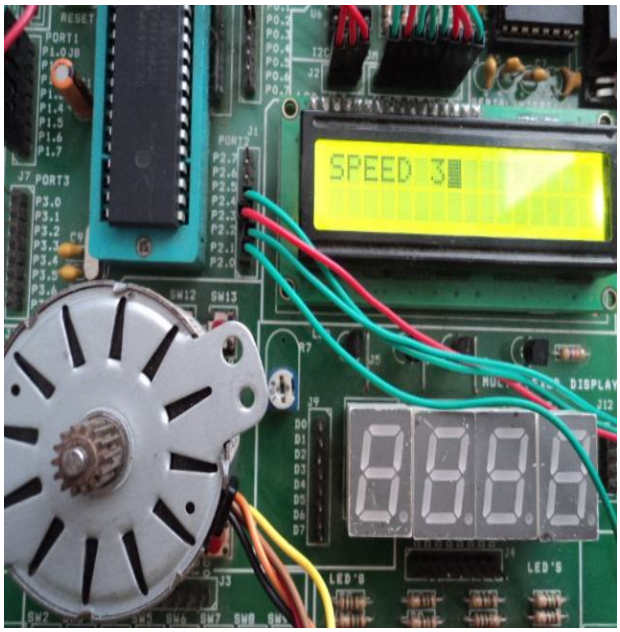

Fig. 7 Microcontroller response for SPD3 command

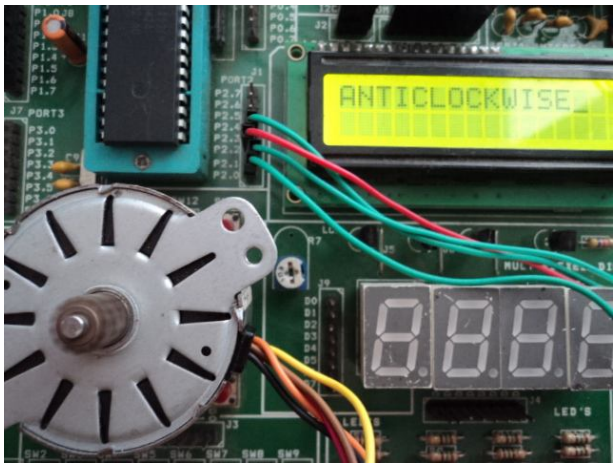

Fig. 8 Microcontroller response for ACW command

Along with the microcontroller response, an example screenshot of the computer about the status of the stepper motor has been given in the fig. 9. The example has been considered when the stepper motor runs at speed 3 after getting the command SPD3 from the user. The computer is always synchronized with the status of the stepper motor and all the actions performed over the motor are also reflected in the database available at the computer.

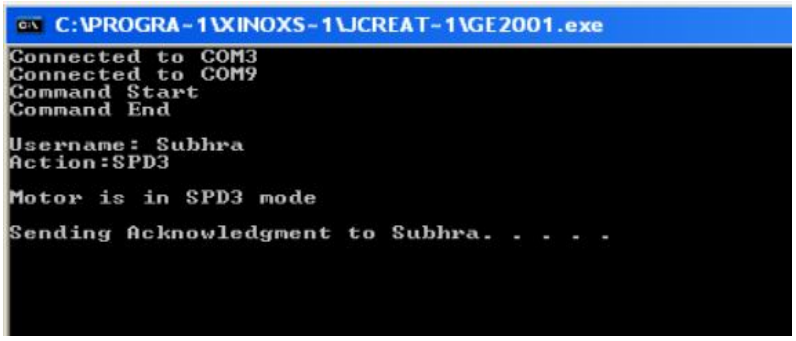

Fig. 9 Screenshot of computer after the command SPD3

VII. CONCLUSIONS

In this work, a prototype system for GSM based stepper motor control framework has been designed and developed. This work is a very useful application of information and communications technology in terms of making control of the motor based home appliances automated one through simple SMS over GSM. The work also considered the security aspects of the control of the motor by providing the user name and passwords to the users. Although the system is found to be quite beneficial in terms of its uses, the system can be enhanced to a better version by the inclusion of voice based command to operate the system. Moreover, the system can be designed in such a way that whenever any abnormal conditions occurred in the system, it can be configured to send the alert message to the users through SMS. Finally, it is claimed that this work is going to be a platform for different applications in different domains as per the requirements and can help a lot in terms remote control paradigm.

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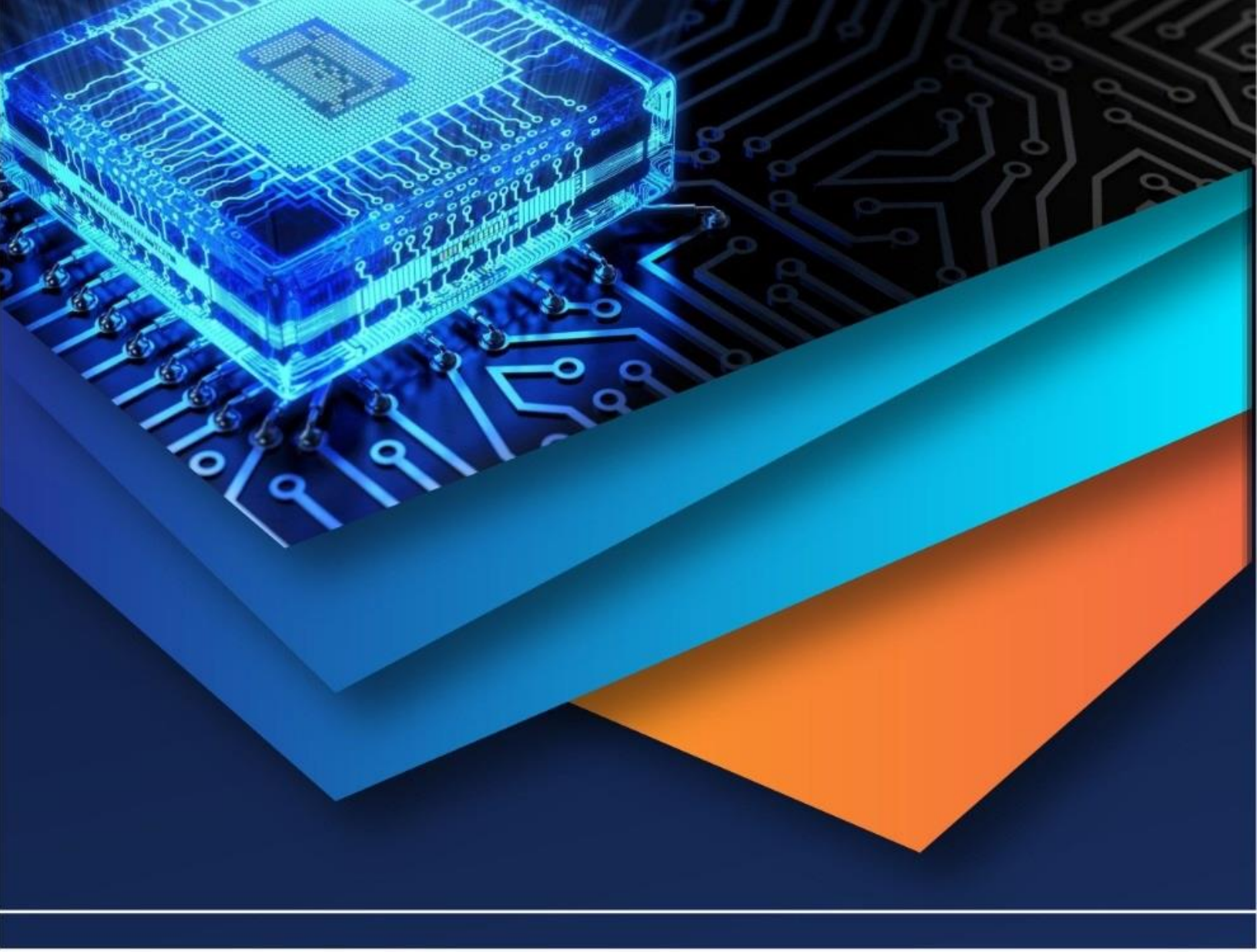

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