Three Phase Motor Controlling Using GSM

Rikshith U. Uchil[1*], Vivek George[2], Yogish[3], Ganapathi Sharma[4]

[1,2,3]*Student, Department of Electronics and Communication Engineering, Srinivas Institute of Technology,*
Mangalore, India
[4]*Assistant Professor, Department of Electronics and Communication Engineering, Srinivas Institute of*
Technology, Mangalore, India
*Corresponding author: rikshithrikki48@gmail.com

Abstract: **In India agricultural field play a crucial role in economic development. That is the way to concentrate on that point. Farmers facing a variety of problems. Electric power supply not available in 24 hours. The farm aloof from his house, hence to on and off the motor automatically using our project, is about making this system efficient and dynamic. This automatic control is for controlling the motor from a far off place, look over its operating conditions; get feedback from the motor itself. So here our target is to regulate the motor from the distant place by mobile SMS and also get feedback by SMS while it's in ON or OFF condition. This provides the event of mobile phones as an overseas control application for the induction motor pump which is employed in agriculture. In India because of the frequent power cuts and abnormal voltage conditions in India, it is necessary to distribute water efficiently to the fields during normal conditions. This can be followed by exchanging the data between the user phone and GSM within the sort of messages. This technique is developed with Micro controller which is connected to the GSM and also the motor. This Micro controller includes the protection against over-current, dry running and single phasing. In this project, it's expected that this application provides easy accessibility to the motor to an excellent extent.**

Keywords: **Agriculture, GSM, Irrigation system, Motor controlling, SMS.**

1. Introduction

India is basically an agriculture country, and all its source depends upon the agriculture output. With the drastic development of agriculture in India, many automatic technologies have been introduced into agriculture field and production. As a survey, we can see that the total rainfall in a particular area may be either insufficient or ill-timed. In order to get maximum yield, it is essential to supply the optimum quantity of water and maintain the correct timings of water supply. So this is possible only through a symmetric irrigation system by collecting water during the periods of excess rainfall and releasing it to the crop as and when it is needed. The irrigation is the science of planning and designing an efficient, low cost, economic irrigation system tailored to fit natural conditions. By construction of the proper and good distribution system, the crop field may be increased because of controlled water supply.

2. Literature Survey

From many time, different and various technologies and techniques have been used for monitoring and controlling. Earlier it absolutely was purely SMS based. But many of the uneducated farmers were unaware of SMS. Gradually, the IVR system came to existence, which made motor monitoring voice-controlled. This technique overcomes the limitation of pure SMS based system. However, it doesn't provide any fault detection like exercise, over-voltage, under-voltage etc. During this literature review on motor controlling using IVRS and SMS by some authors and some main observation.

A. GSM based motor monitoring and speed control

Presently GSM Based Motor Monitoring and Speed Control is on the market. During this paper, the author studied design aspects of an embedded device which used specific SMS message from a mobile phone to regulate devices. It could control 8 devices using an identical method. For ON and OFF switching of the devices where no wired connection is obtainable, this controller is proved to be very handy. The system is implemented by connecting GSM modem to a micro controller.

This Micro controller is programmed to receive the SMS from a reference mobile phone. These controlling signal from received SMS is extracted and is converted to the micro controller preferred format. For monitoring and transmission of the control signals to the modem, a PC is utilized which uses serial communication through RS232 to establish the communication. Same can also be accomplished by interfacing an LCD to the micro controller. The AT commands were used for controlling the functionality of modem (Global Systems for Mobile Communication). This is often preferred, thanks to its simplicity in both transmitter and receiver design. It can operate at 900 or 1800MHZ band, is faster, more reliable and globally network.

An authorized mobile number is wont to the control motor by sending it to control message. The micro controller controls the general operation of this technique, acting as the heart of this technique. The system is often alert for receiving SMS from a valid number. As soon as the message is received, it's displayed on the LCD (Liquid Crystal Display).

![IJRESM logo]

International Journal of Research in Engineering, Science and Management
Volume-3, Issue-8, August-2020
journals.resaim.com/ijresm | ISSN (Online): 2581-5792 | RESAIM Publishers

186

In this project, the working is analyzed by the writer such as working of the motor. It also performed necessary operation like start, stop, reverse the rotation. This method is that the only SMS based and poses limitation because the bulk of farmers are still uneducated and not alert to the SMS system. Not must to be defined. Don't use abbreviations within the title or heads unless they're unavoidable.

1) Interactive Irrigation System through Mobile using IVRS Response

This paper was advancement as compared to earlier where the motor was controlled using SMS service. During this paper, IVR response was used for ON/OFF control of the motor. It's a cellphone-based device remote control system for switching on/off and monitoring the water pumps, by using which a farmer or some person will be free from such a large amount of routine problems related to timely irrigation, saving plenty of water, electricity, fuel, time, making it cost-effective. The way it works is, Motor Pump is connected to the device. Mobile is kept near device which might trigger the motor pump to start out and stop. Whenever power comes at the field, an automatic call is created from the system to the user to point power status. Here person must just call to Mobile kept just about the Motor pump and should press his code to begin or Stop the Motor with IVR response. He can even know whether the ability is present or not and know the motor status. Speech and Dual Tone Multiple Frequency [DTMF] comparison was studied. Studies conducted earlier just compared these two modalities. However, the speech system employed in this study was a totally functioning linguistic communication system. Working professionals were considered and took a part during this study, instead of college students. Results indicate that (a) DTMF was more practical and efficient for linear tasks, whereas speech was better for nonlinear tasks; (b) Majority of users preferred speech to DTMF; (c) the speech found to be a more accurate, more efficient, and it is easier to use than DTMF; and (d) user preference for a selected modality was better predicted by user performance in nonlinear tasks instead of linear ones. Users continuous preference for a speech modality other than DTMF, even after experiencing fairly high recognition errors discussed within this paper. The study conducted has theoretical, furthermore as practical, implications for the look of speech user interfaces and interactive voice response applications. The issue regarding designing of IVR interfaces for the developing world was addressed in the paper.

2) GSM based device control

Another system is GSM Based Device Control. As per the study, this system will be operated through a voice call such that by pressing a key the motor will become on and off accordingly. This system will also send SMS to the user giving the present status of the motor. The advances in the technologies related to wireless communication have led to the emergence of several engineering designs to aid human requirements. Agriculture play a significant role in developing country like India, therefore implementing mobile

communication for facilitating farmers is the basic idea of this project. This system overcomes the limitation of pure SMS based system. However, it does not provide any fault detection like a dry run, over-voltage, under-voltage etc. It also lacks a Unique Mobile Identification Number feature. As a result, the password needs to be entered every time for controlling the motor. This unnecessarily wastes both time and money of farmer.

Survey of farms in which it has the induction motor was done. Farmers were asked their problem which they faced while working on the farm. So the main problem of the farmer is the proper operating of the motor.

- The motor can damage by over/under voltage & current
- If the dry sensing condition is not sensed, then also the motor can damage
- Load shedding
- Distance between farm & farmer's house

3. System Requirements

A. Hardware requirements

- GSM Module (SIM 800 or SIM900a model)
- Arduino UNO or Arduino NANO
- Relays 12V (module)
- Three-phase motor starter (5HP)
- Mechanism for Switching (12v DC motor and Linear mechanism for Switching)
- Feedback Circuit (Transformer, rectifier, voltage regulator)

B. Software requirements

- Arduino IDE

C. Theory related hardware

1) GSM module: SIM 900A

Fig. 1. GSM Module(SIM900A)

We know GSM Module is particularly a GSM Modem which connected to a PCB with differing types of output taken from the board, such as TTL Output (for Arduino, 8051 and other micro controllers) and RS232 Output to interface directly with a PC (personal computer). The board also will have pins or

International Journal of Research in Engineering, Science and Management
Volume-3, Issue-8, August-2020
journals.resaim.com/ijresm | ISSN (Online): 2581-5792 | RESAIM Publishers
187

provisions to connect mic and speaker, to require out +5V or other values of power and ground connections. These forms of provisions vary with different modules. We are from India and most of the mobile network providers during this country operate within the 900Mhz band. If you're from another country, you've got to test the mobile network band in your area. A majority of U.S. mobile networks operate in 850Mhz band (the band is either 850Mhz or 1900Mhz). Canada operates totally on 1900 Mhz band.

GSM modules are manufactured by different companies. All of them have different input power supply specs. In SIM900 GSM module requires a 12 volts input. So we feed it employing a 12V,1A DC power supply. We can see GSM modules which require 15 volts and a few other types which require only 5 volts input. They differ with manufacturers. If you're having a 5V module, you can be the power it directly from Arduino's 5V out.

We are using SIM900A GSM Module; this implies that the module supports communication within the 900MHz band. SIM900A could be a quad-band GSM/GPRS module that works on frequencies 900MHz GSM, 900MHz EGSM, 1800MHz DCS, and 1900MHz PCS. It also has features like GPRS multi-slot class 12/class 10 (optional) and supports CS-1, CS-2, CS-3, and CS-4 GPRS coding schemes.

It has one UART port. It also has one USB port which will be used for updating firmware and for debugging. Audio channels are there, which include a microphone input and a receiver output. SIM900A has one SIM card interface. It integrates TCP/IP protocol.

The module is typically connected to +4.0V standard power supply. It can work on +4.5V regulated power and any higher voltage may damage the module. And the power source should be able to deliver a peak current of 2A. The UART interface is established as shown in figure. All you need to do is connect RXD of module to TXD of Arduino and TXD is connected to RXD of ARDUINO. The ground of controller and module must be connected for voltage reference. Here AUDIO IN is connected to MIC and AUDIO OUT is connected to a speaker or headset. And at last we need to connect a working GSM SIM card to the module. On powering module the net light will blink periodically to state successful connection. And GSM is connected.

Applications:
- Cellular Communication
- Robotics
- Mobile Phone Accessories
- Servers
- Computer Peripherals
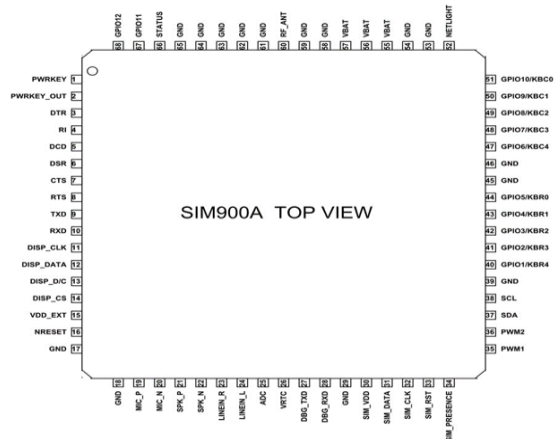
SIM900A Pin Diagram:

Fig. 2. Pin diagram

2) Arduino UNO

Fig. 3. Arduino Uno

The Arduino is a micro controller board which is supporting the ATmega328P. It has 14 digital input/output pins (of which 6 is additionally used as PWM outputs),6 analogue inputs, a 16 MHz ceramic resonator (CSTCE16MOV53-RO), a USB connection, an influence jack, an ICSP header and a button. It's containing everything that needed to support the micro controller; simply, to attach Arduino to a computer with a USB cable or power it with an alternate current-to-DC adapter or battery to induce it to be started.
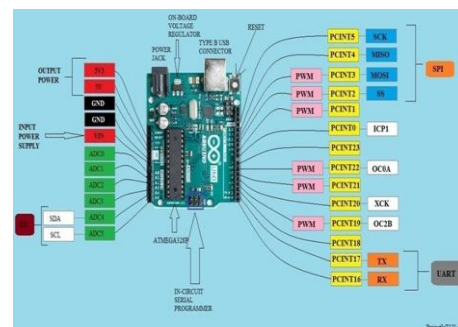

Fig. 4. Arduino pin diagram

International Journal of Research in Engineering, Science and Management
Volume-3, Issue-8, August-2020
journals.resaim.com/ijresm | ISSN (Online): 2581-5792 | RESAIM Publishers

188

3) Relay 12V

Fig. 5. Relay module

The 12-volt relay is an electro-mechanical switching device which controls the AC devices through the DC power. It's used as a switch. Current flowing through the coil of the relay creates a flux which attracts a lever and changes the switch contacts. The most advantages of employing a relay as a switch are that, they supply electrical isolation between inputs with the assistance of magnetic coupling and also we can handle an oversized power employing a relay. There are different types of relays are available and that can be categorized in various forms. As an example, relays will be SPST, SPDT, DPST, DPDT etc. SPDT stands for Single Pole. A relay will switch one or more poles, each of whose contact can be thrown by energizing the coil in one among three ways:

- Normally-open (NO)contacts connect the circuit when the relay is activated: the circuit is disconnected when the relay is inactive. It is also called a Form A contactor" make" contact. Normally-open(NO) can also be distinguished as" early- wake" or NOEM, which means that the contacts will close before the button or switch is fully engaged.
- Normally-closed (NC) contacts disconnect the circuit when the relay is activated; the circuit connected when the relay is inactive. It is a so-called Form B contactor" break" contact. NC contacts could also be distinguished as "late-break" or NCLB, which suggests that the contacts will stay closed until the button or switch is fully disengaged
- The change-over (CO), or double-throw (DT), contacts control two circuits: one normally- open contact and one normally-closed contact with a typical or common terminal. It's often called as Form C contactor "break before make" contact (transfer). If this sort of contact utilizes a "make before break" functionality, then it's called a Form D contact.
- These are the subsequent distinguishes:
- SPDT-Single Pole Double Throw. The typical or common terminal connects to either of two other. Including two for the coil, this type of relay has five terminals in total.
- DPST- Double Pole Single Throw. The DPST have two pairs of terminals. Such as two SPST switches or relays actuated by one coil. Including two for the coil, such relay has six terminals in total. The pole is also

Form A or Form B (one amongst each).
- DPDT- Double Pole Double Throw. The DPDT has two rows of change-over terminals Equivalent to two SPDT switches or relays actuated by one coil. This type of relay has eight terminals, including the coil.
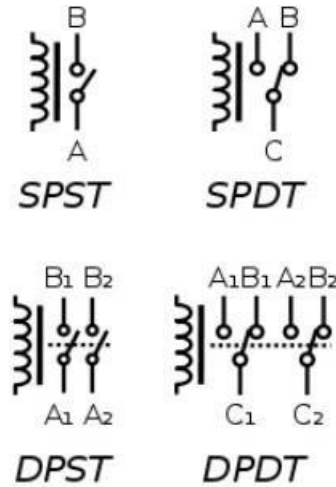

Fig. 6. Types of relays

Features of Relay 12V:
- Max Current: 5A AC/DC (max).
- Max Voltage: 250V AC/30V DC.
- Nominal Voltage: 12V
- Coil resistance: 270Ω.
- Coil Current: 44.4Ma.
- Operating Voltage: 8.6 to 21.6V
-

4) Three phase motor starter

Fig. 7. Three phase motor starter

The star-delta starter could be a common verity of three-phase induction motor starters generally utilized in low starting torque motors. The motor starters are the types switches (either electro-mechanical or solid-state) that are designed to begin and stop the motors by providing the mandatory power to the motor and preventing the motor to draw excess current, etc. The starter delta motor starter could be a style of reduced voltage starter and it's also the foremost commonly used one. This star-delta starter will start a motor with a star connected starter winding.

So when the motor reaches about 80% of its full load speed, it'll begin to run during a delta connected starter winding. This

International Journal of Research in Engineering, Science and Management
Volume-3, Issue-8, August-2020
journals.resaim.com/ijresm | ISSN (Online): 2581-5792 | RESAIM Publishers

189

star-delta starter could be a sort of reduced voltage starter. We are employing it to scale back the starting current of the motor without using any external device or apparatus. This can be an enormous advantage of a star-delta starter because it typically has around 1/3 of the inrush current compared to a DOL starter. This starter mainly containing a TPDP switch which stands for Triple Pole Double Throw switch. This switch changes starter winding from star to the delta. At the starting condition of starter winding is connected within the style of a star.
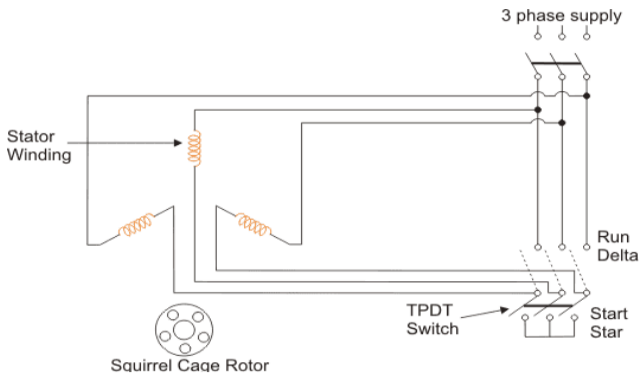

Fig. 8. Star-Delta Starter

Advantages of star-delta starter:
The advantages of star-delta starters include:
- Inexpensive
- No heat is produced, or tap changing device must be used, hence efficiency increases.
- Starting current reduced to 1/3 of direct online starting current.
- Produce high torque per ampere of line current.

Disadvantages of star delta starter:
The disadvantages of star-delta starters include:
- Starting torque is reduced to 1/3 of full load torque.
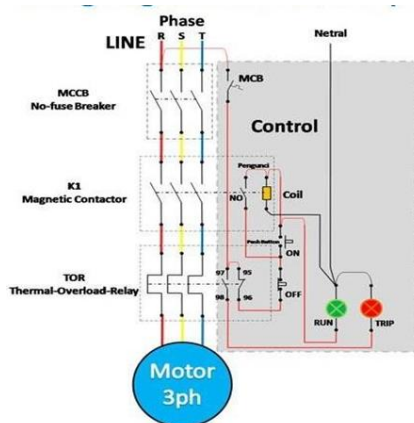- A specific set of motors required.

Fig. 9. Wiring Diagram of DOL Starter

Application of star delta starter:
- The star-delta starter is highly suitable to applications

where the desired starting current is low and where the line current draw must be at the minimum value.
- These star-delta starters aren't suitable for applications where the high starting torque delivery is required. For this kind of applications, a DOL starter should be acquired instead.
- If the motor is just too heavily loaded, there'll not be enough torque to accelerate the motor up to speed before switching over to the delta position. Example application for a star-delta starter could be a Centrifugal compressor.
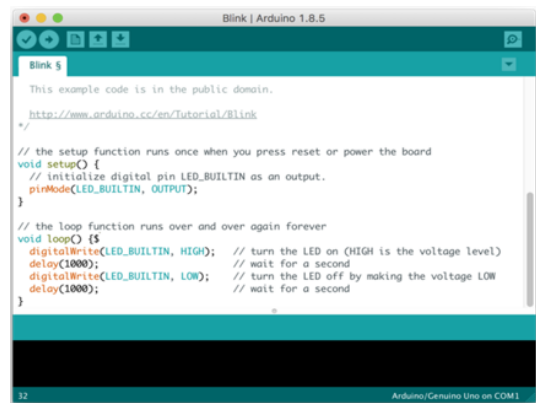
D. Theory related to software

1) Arduino IDE

Fig. 10. Arduino IDE

The Arduino integrated development environment may be a cross-platform application that's written in functions from C and C++. Arduino is employed to writing and uploading programs to Arduino compatible boards, but also, with the assistance of 3rd party cores, other vendor development boards.

The ASCII text file or source code for the (Integrated Development Environment) IDE is released under the GNU General Public License, version 2. An Arduino IDE supports the languages C and C++ using special rules of code structuring. This Arduino IDE supplies a software library from the wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and also the main program loop, that is compiled and linked with a program stub main() into an executable cyclic supervisor program with the GNU toolchain, also included with the IDE distribution.

4. Project Implementation

The overall idea behind this project is to use the present GSM infrastructure. So, all the operation involves the GSM system also. So when we send an SMS, it goes through the GSM system. Any sent SMS is received if we use a SIM card and GSM module. To work any GSM modem, we've got to use the AT commands to control them. As an example, if an SMS arrives the GSM modem sends the serial data in ASCII format.

International Journal of Research in Engineering, Science and Management
Volume-3, Issue-8, August-2020
journals.resaim.com/ijresm | ISSN (Online): 2581-5792 | RESAIM Publishers

190

We are able to read these data if we connect the modem with the serial port of the microcontroller at the baud rate of 9600. Because the microcontroller gets to know that an SMS has arrived, it is sent a correct AT command to read the SMS. The reading of SMS returns the mobile number of the sender, the time more information. During this project, we are able to switch On & Off 3-Phase motor pump through mobile by using GSM. If 3 Phase supply is Ok GSM will provide a message to mobile & mobile will display the message "3Phase is Ok". If we send message "Pump On" to GSM Module through mobile, the relay circuit will put on the pump with the assistance of starter. As these pump is functioning on 3 Phase power supply so out of three-phase if any phase is braked, the pump will immediately off & GSM will inform the status of three Phase supply to the mobile. Then mobile will display the message "Pump Off". The general setup including microcontroller and GSM are at the motor side and therefore the user will behave the transmitting system which may be mobile.

5. Hardware Implementation

Fig. 11. Main block diagram

A. Feedback System

Fig. 12. Feedback block diagram

In the case of feedback circuit in will provide feedback about whether the motor got connection or not. So for this we are using three feedback circuits in this project. For each phase, that is R,Y,B with a neutral line from the main supply. So here, for this circuits we use three each transformer to convert each phase

voltage to 12v. Then this voltage is converted to 5-volt DC and then it is fed in to ARDUINO board as an input to it. So totally 3 such inputs will be given to the Arduino from the feedback circuits. Then we rectify the voltage and after which the voltage is converted to DC voltage.
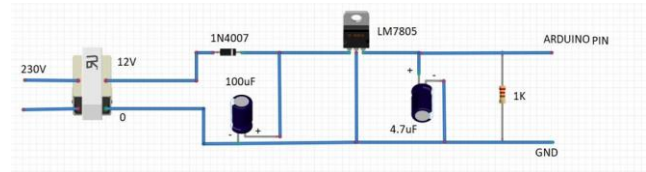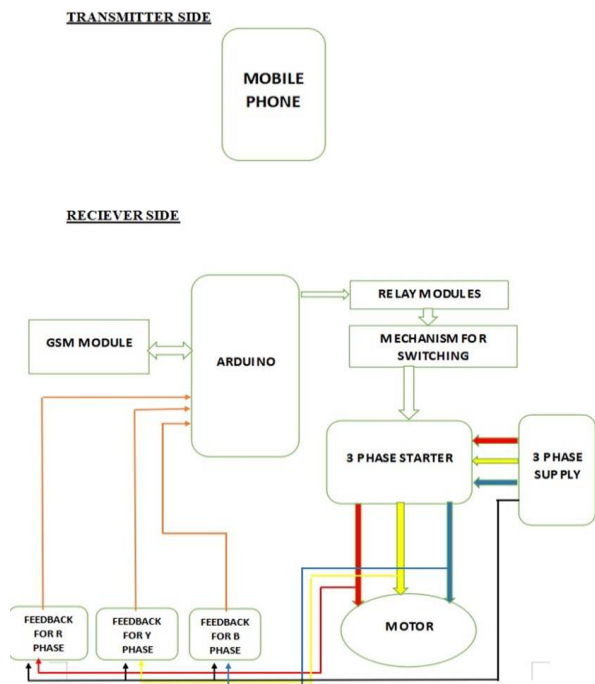

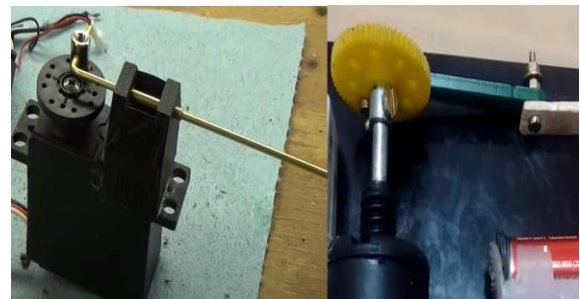Fig. 13. Feedback circuit

B. Mechanism for switching

Fig. 14. Mechanism for switching

As we are stating that we are making this project for automatic switching of 3 phase motor. So that we can do this bypassing the starter connection internally. That can be done by removing center red color wire and connecting NO AND NC of the starter to the NO and NC of the 2 relay modules. So this will be called as a remote connection of the starter. But the disadvantage of this system is the internal connection will be bypassed. And overload relay in the starter may get damaged.

- In such situation we can make automatic switching system by providing linear pushing mechanism for pushing the push button switch which is available in the starter.
- Here we can use a servo motor with high torque or a dc motor with low rpm and high torque.
- So as we can see in the above figure we have servo and motor, and we use either of one.
- Hence to the shaft of the motor we connected a circular object and to the diameter edge we will connect a free moving system, that we can connect a rod for linear movement.
- For stable movement we can add another block from a certain distance from the shaft of the motor.
- As the motor rotates in a forward or backward direction the circular object will be constant regardless of the movement of the rotation of the shaft.
- And the free rod will be moving front and back in a stable position.
- Depending upon the torque and speed of the motor, the mechanism will push the switch for particular amount of time.

International Journal of Research in Engineering, Science and Management
Volume-3, Issue-8, August-2020
journals.resaim.com/ijresm | ISSN (Online): 2581-5792 | RESAIM Publishers

191

- Here we are using 30RPM motor with 10kg/N torque, so in a minute the rotation of the shaft will be 30. Hence we will conclude that it will push the switch for 30 times.
- So for pushing switching only once we can make the program according to that.
- For maintain the ON/OFF of the system we will use relay for such case.
- This mechanism system will be attached to the starter externally in accordance with the position of the switch present in the starter.

C. Implementation

1) Booting the GSM module

- At first insert the SIM card to the GSM module and lock it properly.
- Then connect the adapter to GSM module and turn it ON.
- Now wait for some time (for 1 minute) and see ensure the blinking rate of 'status LED' or 'network LED' (the GSM module will take a little bit of time to establish a connection with mobile network)
- And once the connection is established successfully, the status/network LED will blink continuously for every 3 seconds. Now you can make a call to the mobile number of the sim card inside the GSM module. If you hear a ring back, the GSM module has successfully established a network connection.

2) Connecting GSM MODULE to Arduino

- There are two ways of connecting the GSM module to Arduino.
- In any case, the communication between Arduino and GSM module is serial. Then we have to use serial pins of Arduino (Rx and Tx).
- Then if you are opting with this method, you may connect the Tx pin of GSM module to Rx pin of Arduino and Rx pin of GSM module to Tx pin of Arduino. Like GSM Tx –> Arduino Rx and GSM Rx –> Arduino Tx.
- Now connect the ground pin of Arduino to ground pin of the GSM module. Now you made 3 connections and the wiring is over.
- Now you can load different programs to communicate with the GSM module and make it work.
- Note: The problem with this connection is that, while programming Arduino uses serial ports to load a program from the Arduino IDE.
- When these pins are used in wiring, the program will not be loaded successfully to the Arduino. In such a case, you have to disconnect wiring in Rx and Tx each time you burn the program to Arduino.
- And once the program is loaded successfully to the Arduino, we can reconnect these pins and have the system working.
- To avoid this difficulty, we are using an alternate method in which two digital pins of Arduino are used for serial communication.
- The library replicates hardware functions and handles the task of serial communication.

6. Software Implementation

A. Explanation

- In the case of project workflow we first of all we are initializing the pin for particular devices. So here 3pins are initialized to setup as a feedback path inputs.
- One of the pin will be set as an output pin for triggering the relays. And the we will be setting up the system for that pin and setting delay for the operations.
- Then we will setup the mobile input for the programmed to understand to which destination a corresponding message has to be send.
- The message sent by the user can be decoded to ascii value for computer understanding.
- Then we are setting up the feedback mode. For that we can do like this. At the output side of the starter we have connected the feedback circuit for each phase lines. Then these phase lines voltage is converted to DC 5 voltage.
- So there will be 3 phase lines, so totally 3 feedbacks we are providing to the input side for Arduino. And this input will be compared to each other.
- Such as if three phase lines are high then we assure that motor is activated.
- If anyone of the phase line is not high, then motor will be deactivated. This acknowledgement will be sent to the user through GSM to the mobile phone.
- Whenever user send "motor on "message to the GSM, then the Arduino will process to turn on the relay which is connected to the start mechanism. And it will switch on the starter which is eventually starts the motor. And the acknowledgement will be sent to the user about the status of the motor.
- Whenever user send "motor off "message to the GSM, then the Arduino will process to turn on the relay which is connected to the stop mechanism. And it will switch off the starter, which will stop the motor. And acknowledgement will be sent to the user about the status of the motor.
- So if we want to check whether the system is working fine or not then we can send "test". So if system is fine then it will return with an acknowledgement to the user.

7. Testing and Result

A. Problem faced during implementation

1) Error in GSM connection establishing

While booting the connection of the GSM with mobile

International Journal of Research in Engineering, Science and Management
Volume-3, Issue-8, August-2020
journals.resaim.com/ijresm | ISSN (Online): 2581-5792 | RESAIM Publishers

192

network it will not establish the connection. Sometimes it will take much time to establish the connection with the mobile network.

2) Less force in mechanism

At first we were using motor with 100rpm and which is low torque for pushing switch. And eventually switch is not pressing in that situation.

B. Solution to the problem

1) While booting of the GSM to establish the connection with mobile network.

- First off all we have check whether the SIM is inserted properly to the SIM slot or not. If at all SIM inserted properly also and connection not established, then try to press the SIM. So that contacts of the SIM will touch correctly.
- Try to power on and off, so the GSM will reboot to establish the connection.

2) In the case of mechanism we need some amount force to push the push button switch. So we have to use less RPM and high torque motor. Such 30rpm motor will be good match for this.

C. Result

We observed that when we send "Motor ON "message to the GSM through the mobile phone, Arduino will turn ON the motor and when we send "Motor OFF", the Arduino will turn off the motor. And we also got an acknowledgement regarding the status of motor.

8. Conclusion and Future Scope

Hence the developed system enhances the water distribution in the field optimally. This system ensures that the protection of motor against overloads, overheating and phase imbalances. This is also providing an automated restarting if normal conditions are re-established. The uniform distribution of water at the regular intervals, reduction in labor cost, prevention of unwanted water spillage, minimization of occurrences of motor faults and intimation to the user about the completion of a task are the major advantage of this system. The use of the mobile phone has become more common among the farmers and hence used. The system proves to be a great boon to farmers whose pump sets are located far away from their homes due to the capability of remote control using a cell phone and intimation about any abnormal conditions.

If there is a problem with the GSM range in some area, then controlling a three-phase motor using GSM becomes difficult. Zigbee can be used at such places. If the user wants to see the current operation and status live, then Digital Camera can be used. LCD Display can be added to display the parameter. And also we can add up the mechanism for switching. So more effective mechanism we can use solenoid for the mechanism purpose. It will push the switch easily and there may not be needed any additional setup. So we can reduce the cost of the project.

References

[1] Mahesh M. Galgalikar, and Gayatri S. Deshmukh, "Real-time automation of agricultural environment for modernization of Indian agricultural system," in International Journal of Computer Applications, Volume 1, 2010.

[2] Vasif Ahmed and Siddharth A. Ladhake, "Innovative Cost Effective Approach for Cell Phone based Remote Controlled Embedded System for Irrigation," Intl. Conf. On Communication Systems and Network Technologies, pp. 419-422, 2011.

[3] Vasif Ahmed and S. A. Ladhake, "Design of Ultra Low Cost Cell Phone Based Embedded System for Irrigation," Intl. Conf. on Machine Vision and Human-machine Interface, Kaifeng, China, 24- 25th April 2010, pp. 718-721.

[4] R. R. Jadhav, Prathmesh P. Pandit, Shubham D. Pal, Vineet H. Risbud, "Three Phase Motor Control Using GSM", International journal of innovative research in electrical, electronic instrumentation and control engineering, volume 3, Issue 5, May 2015.

[5] Wani Suraj R, Ghaywat Vivek V, Naik Akshay D, Mandlik Sachin B, "IVR System for three phase motor protection, Control and Alert system using GSM", International journal of engineering and computer science, volume 4, Issue 2, Feb. 2015.

[6] https://www.homemade-circuits.com