



Design a Remote Control System for a Three-Phase Pump using Mobile Text Messages

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تصميم نظام تحكم عن بعد للتحكم بمضخة ثلاثية الطور باستخدام الرسائل النصية

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Abstract:

This paper contributes to the development of the agricultural irrigation and water supply systems in Libya. The purpose of this paper is to design a three-phase pump protection and control system. The user can remotely send orders from his mobile phone (on/off) as well as monitor the pump status by receiving messages showing the pump mode and giving information on the types of faults that may occur. This system depends on the Arduino UNO panel and the SIM 900 GSM GPRS module, as well as the protection devices over load relay and Phase sequence relay. practical experience has shown the effectiveness of this system when operated to control a three-phase pump to lift water from groundwater wells. This system contributes to increased comfort, safety and security in addition to flexibility, as well as access to the system at any time anywhere. On the other hand, it is an effective medium to help and support disabled people.

Keywords: Three Phase Pump, Arduino UNO, SIM 900 GSM GPRS, Current Sensor ACS712

الملخص

تساهم هذه الورقة في تطوير شبكات الري الزراعي وإمدادات المياه في ليبيا. الغرض من هذه الورقة هو تصميم نظام حماية ومراقبة لمضخة ثلاثية الطور. يمكن للمستخدم إرسال الأوامر عن بُعد من هاتفه المحمول (تشغيل/إيقاف) وكذلك مراقبة حالة المضخة عن طريق تلقي رسائل توضح وضع المضخة وإعطاء معلومات عن أنواع الأعطال التي قد تحدث. يعتمد هذا النظام على لوحة Arduino UNO ووحدة SIM 900 GSM GPRS، بالإضافة إلى أجهزة الحماية المتمثلة في over load relay و Phase sequence relay. أظهرت التجربة العملية فعالية هذا النظام للتحكم بمضخة ثلاثية الطور لرفع المياه من آبار المياه الجوفية. يساهم هذا النظام في زيادة الراحة والسلامة والأمان بالإضافة إلى المرونة، فضلاً عن الوصول إلى النظام في أي وقت ومن أي مكان. ومن ناحية أخرى، فهي وسيلة فعالة لمساعدة الأشخاص ذوي الإعاقة ودعمهم.

الكلمات المفتاحية: مضخة ثلاثية الطور، لوحة Arduino UNO ، SIM 900 GSM GPRS ، حساس تيار ACS712

Introduction

To control a three-phase motor using an Arduino Uno and GSM technology, relevant references include studies on utilizing Arduino Uno microcontrollers for motor control and GSM communication. One study demonstrated the operation of a three-phase induction motor via a smartphone using Bluetooth and Arduino Uno R3 [1], and others focused on the design and implementation of Arduino-based control systems for motors, showcasing the reliability and efficiency of controlling three-phase induction motors with GSM modules [2,3,4,5,6,7]. Additionally, researches on control systems using SMS through the Internet of Things (IOT) based on Arduino Uno highlights the integration of GSM technology for motor control applications [8].

These references collectively emphasize the feasibility and practicality of employing Arduino Uno microcontrollers in conjunction with GSM modules for motor control applications. By leveraging the capabilities of Arduino Uno boards and GSM communication, it is possible to develop efficient and reliable

systems for controlling three-phase motors remotely, enhancing the flexibility and accessibility of the motor control system. In this paper, an integrated control system including power and control service is designed to operate a three-phase pump that works with 1 to 10 horses manually or remotely while ensuring feedback from the system that gives information on the operating mode and information on errors that may occur as well as information on the number of operating hours. Where the control circuit is formed Arduino UNO, current sensor, 5v Relay and SIM 900 GSM, the power circuit consists of a contractor, over load relay and phase sequence relay.

System Description and Block Diagram

A. Over Load Relay

The overload relay is an essential component utilized for the detection of overload conditions. Its primary function is to safeguard the motor, motor power circuit, and associated components from excessive heating and overloading. Integrating within the motor starter, the overload relay constantly monitors the current flowing through the circuit. If the current surpasses the predetermined limit for a specific duration, the overload relay will activate a trip mechanism. Consequently, power to the motor is severed, and the contactor is de-energized. Manual resetting is typically required for overload relays, although certain models possess an automatic reset feature that activates after a predetermined time interval.



Figure 1: Overload Relay.

B. Phase Sequence Relay

Is a protective relay, it has 3 terminals to connect the 3-phase supply cables. In addition, they have three terminals (NC, Common, NO) or more based on the complexity of the control circuit. The required 3-phase supply is applied from the source to the phase sequence relay

- Phase failure
- Phase Imbalance
- Incorrect Phase Sequence



Figure 3: Phase sequence relay.

C. Magnetic Contactor

A magnetic contactor is a device or switch that operates magnetically and closes or opens the electric circuit when needed. A contactor has three main parts; Coil or Electromagnet, Frame and Contacts.



Figure 2: Magnetic Contactor.

D. the UNO Arduino Panel and SIM 900 GSM GPRS chip

Arduino UNO board is a microcontroller-based open-source electronic prototyping platform used to develop various projects. It consists of a flash memory of 32 KB, out of which 0.5 KB is used by its bootloader. It also consists of 2 KB of SRAM and 1 KB of EEPROM. It has 14 digital I/O pins, from which 6 pins can be used as PWM (pulse width modulation) outputs and 6 pins can be used as analog inputs. The microcontroller board, coupled with SIM900 GSM/GPRS shield, enables wireless communication and data transfer between the server and the circuit being devised. Arduino and SIM900 GSM/GPRS shield together establish a set of preferred SMS configurations. The configuration includes pin setups, baud rate, preferred carrier operator, SMS tools, and protocols. The SMS tools include a custom data input tool and a merging application for displaying and presenting the received SMS. After a successful configuration, the control circuit expects some external commands from a mobile phone (server) related to a three-phase motor. These commands are received as SMS and are sent to the microcontroller in the form of AT commands. Based on these AT commands,

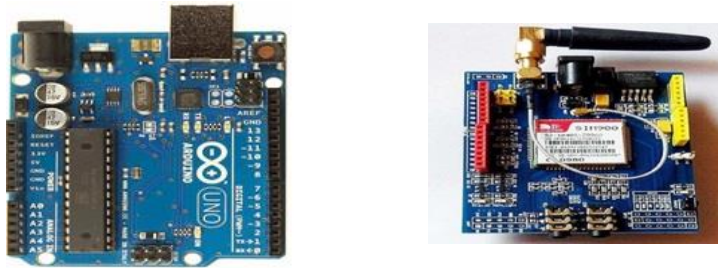


Figure 4: The UNO Arduino Panel and SIM 900 GSM GPRS chip.

E. Current Sensor ACS712

The Allegro ACS712-30A bi-directional hall-effect current sensor chip, which senses both positive and negative flowing currents in the -30 to +30 amp range, is the basis of this current sensor board. The board runs at 5V DC, and the output voltage that results from the current flowing through the sensor is adjusted to start at 1/2V_{cc} (or 2.5V) when there is no current flow and move up or down 100mV per amp depending on whether there is positive or negative current flowing through the sensor.

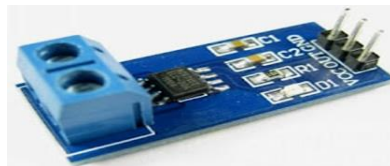


Figure 5: Current Sensor ACS712



Figure 6: Relay module.

F. Relay module

A relay is an electrically operated switch that can be turned on or off, letting the current go through or not, and can be controlled with low voltages, like the 5V provided by the Arduino pins. Controlling a relay module with the Arduino is as simple as controlling any other output. This relay module has one channel. There are other models with two, four and eight channels. This module should be powered with 5V, which is appropriate for use with an Arduino.

Block diagram of the proposed system as in Figure 7. It consists of two parts, first part is power circuit which contains the circuit breaker, phase sequence relay, contactor, over load relay and 3Phase Pump, this circuit connects the 3ph Power Supply with the pump, as shown in Figure 8. And second part is control circuit which drives contactor as shown in Figure 9. This system can be operated manually via the Push Button, also it can be operated automatically remotely by text messages via mobile phone, based on the board of SIM 900 GSM, the Arduino UNO board, Relay module 5v and current sensor ACS712 board, as shown in Figure 9

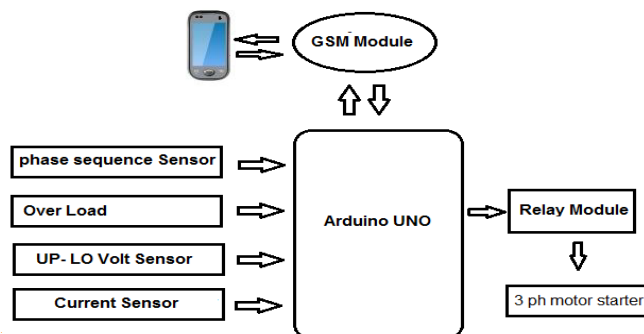


Figure 7: Block Diagram of Proposed System.

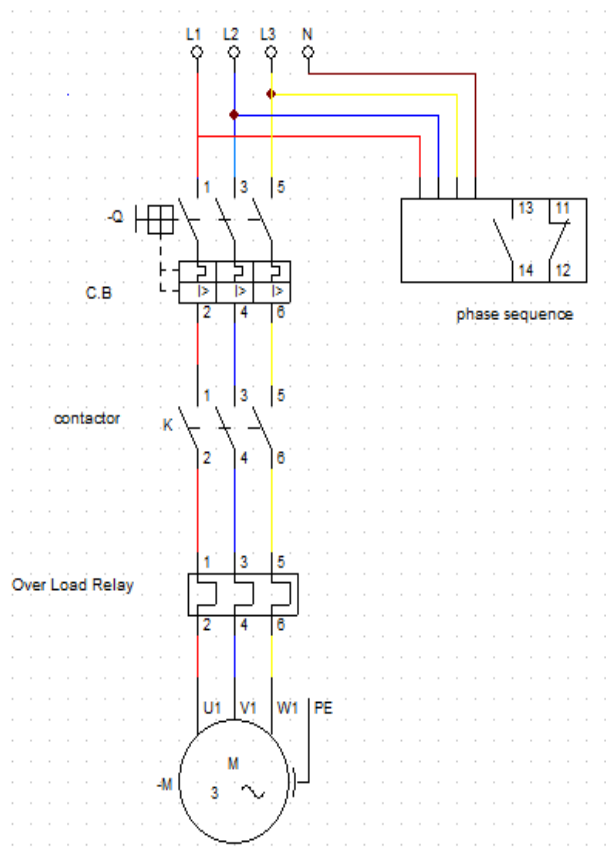


Figure 8: Power Circuit.

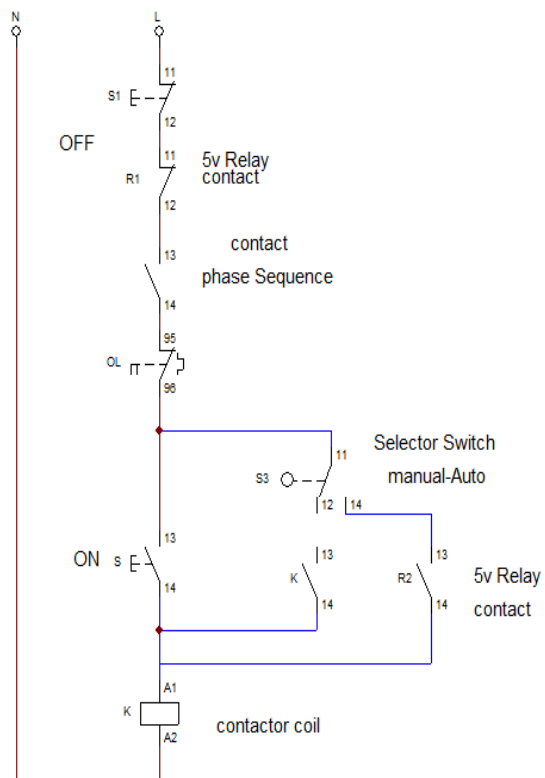


Figure 9: Control circuit.

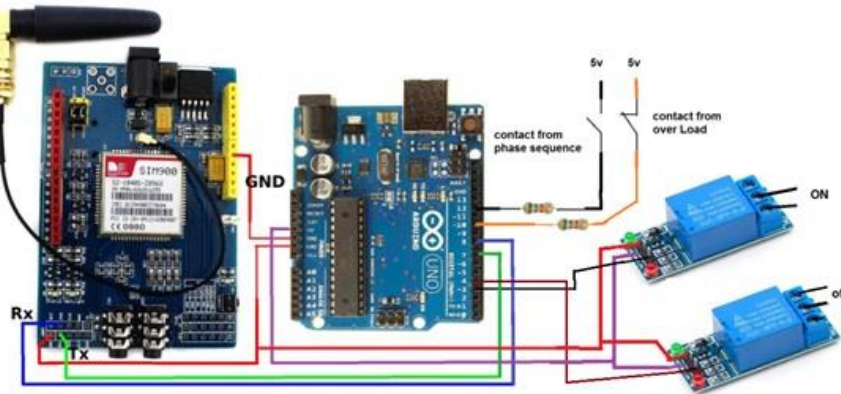


Figure 10: Control Circuit with SIM 900

The Software Implementation

The overall working of the program that is uploaded to the Arduino can be described in a flow-chart as shown in Figure 11. Arduino C Software (IDE) has been used.

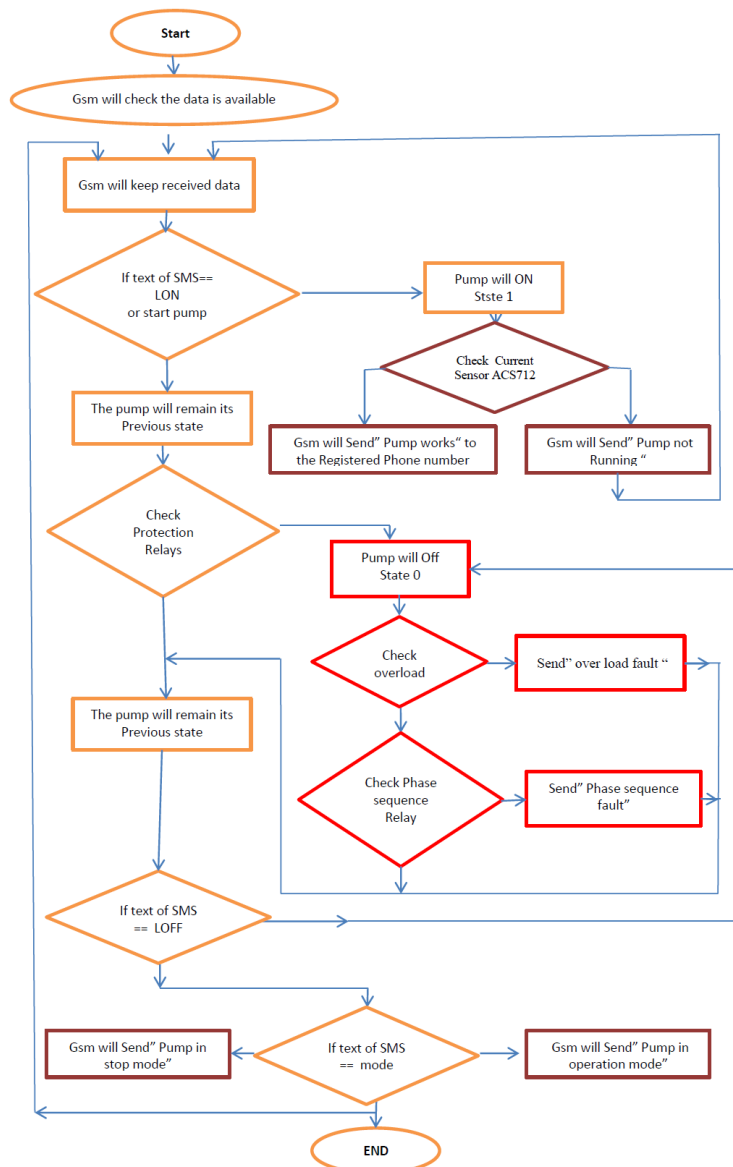


Figure 11: Flow chart of the system

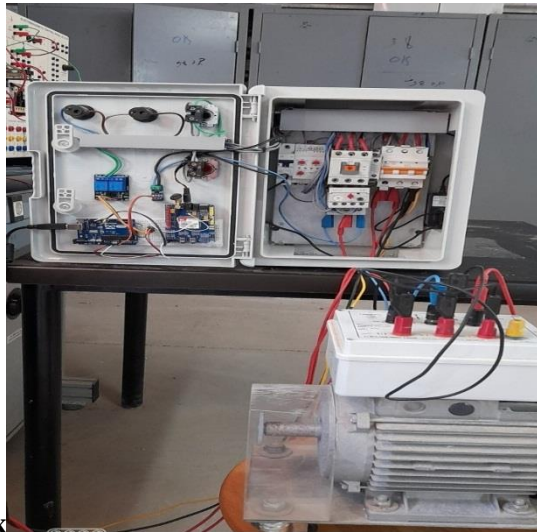


Figure 12: Final design

<p>Figure 13: ON/OFF state</p>	<p>Figure 14: Faults state</p>	<p>Figure 15: System state</p>

Conclusion

All the main as long as GSM services were available, a system that could remotely control a submersible pump (10 HP) with text messages was designed and implemented in this study. The pump's protection is provided by protection devices in the circuit. These devices are Circuit Barker, phase sequence and overload relay. Using our practical experience. We observed that the time it takes to turn on and off is not exceeding several seconds. Our development of a wireless operating system has enabled us to control and protect the pump at a low cost and make it easy to use.

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