A

PROJECT REPORT ON

"GSM BASED MULTI-PARAMETER INDUSTRIAL MOTOR CONTROL & MONITOR"

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Electronics and Communication Engineering Department Faculty of Engineering and Technology (Co-Education)

In partial fulfillment of Final semester project

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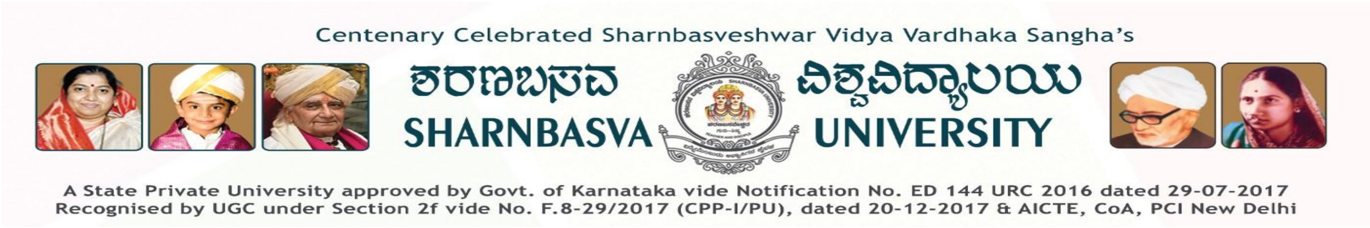

CERTIFICATE

This is to certify that the project work entitled **"GSM BASED MULTI-PARAMETER INDUSTRIAL MOTOR CONTROL & MONITOR"** is bonafide work carried out by **SAIKIRAN CHANDAPUR (USN: SG21ECE070), SHASHANK WALI (USN: SG21ECE081), SHRINIVAS KULKARNI (USN: SG21ECE089), PAVAN (USN: SG22ECE507),** in partial fulfillment of **B.Tech 8th Semester in Electronics and Communication Engineering,** Faculty of Engineering and Technology (Co-Education), **SHARNBASVA UNIVERSITY, Kalaburagi** during the year 2024-2025. It is certified that, she/he has completed the project satisfactorily.

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Any achievement does not depend solely on the individual efforts but also on the guidance, encouragement and co-operation of intellectual, elders and friends. A number of personalities, in their own capacities have helped us in carrying out his friends. A number of personalities, in their own capacities have helped us in carrying out this seminar work. I would like to take this opportunity to thank them all.

First of all, I would like to express our immense gratitude to Dr. SANNABASANAGOUDA DOLLEGOUDAR, Registrar, Sharnbasva University, Kalaburagi for his help and inspiration during the tenure of the course.

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ABSTRACT

In industrial and agricultural sectors, the efficient and safe operation of electric motors plays a vital role in ensuring smooth workflows and preventing equipment failure. This project, GSM-Based Industrial Motor Control and Monitoring System, is designed to provide both real-time monitoring and remote control of essential motor parameters such as voltage, current, temperature, and phase status. By using an Arduino Mega microcontroller, a GSM module, a 20x4 LCD display, and sensors like ZMPT101B for voltage, ZMCT103C for current, and a temperature sensor, the system keeps track of motor health continuously. To simulate varying sensor inputs, potentiometers are used during testing.

One of the core features of this system is its ability to automatically shut down the motor if any parameter crosses the predefined safe operating thresholds. This helps prevent long-term damage to the motor and reduces the risk of accidents. Alongside this, the GSM module allows users to receive status updates and issue commands such as "motoron", "motoroff", and "status" through SMS, making remote control simple and effective. Manual operation is also supported using a physical switch, adding a layer of flexibility.

The project aims to improve the safety, reliability, and usability of motor-based systems, especially in remote or unattended locations. It can serve as a cost-effective solution in various industrial and agricultural applications where motor performance and uptime are critical. The system not only ensures preventive maintenance but also empowers users with control and insight—anytime and from anywhere.

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CHAPTER-1

INTRODUCTION

Electric motors serve as the foundation of industrial automation, powering a wide range of machinery across manufacturing units, processing plants, and commercial systems. Their smooth and efficient operation is critical to maintaining high productivity, reducing downtime, and ensuring system reliability. However, motors are vulnerable to various issues such as overheating, overvoltage, overcurrent, phase loss, and unstable operating conditions. These faults, if undetected, can lead to sudden breakdowns, costly repairs, and even dangerous situations. Traditionally, motor monitoring has relied on manual inspection and scheduled maintenance, which can be inefficient and often misses early signs of failure.

To address these challenges, there is a growing need for an intelligent, automated monitoring solution that can detect faults in real time and take appropriate actions to protect the motor. This project presents a GSM-based industrial motor control and monitoring system designed to do exactly that. It enables continuous observation of crucial motor parameters such as voltage, current, temperature, and phase presence using dedicated sensors.

The system is built around an Arduino Mega microcontroller, which collects and processes data from the sensors and displays the live readings on a 20x4 LCD screen. To enhance functionality, a GSM module is integrated, enabling remote access and control through SMS commands like "motoron", "motoroff", and "status". It also supports manual operation using a physical ON/OFF switch, offering flexibility in different usage scenarios. By combining real-time data tracking with both manual and remote control options, this project aims to offer a robust, user-friendly, and practical solution for motor management in various sectors.

Figure 1 Industrial Motor

CHAPTER-2

LITERATURE SURVEY AND PROBLEM STAMEMENT

2.1 LITERATURE SURVEY

2.1.1. V. Bhaskar and T. Gowri Manohar (2011) "GSM Based Motor Monitoring and Speed Control"

This paper presents a GSM-based system that allows users to control motor operations remotely via SMS, aiming to minimize physical labor and enable remote access. The system comprises a GSM modem, microcontroller, and motor driver unit. SMS commands are interpreted by the microcontroller, which controls the motor accordingly, while response messages provide real-time feedback on motor status. The authors emphasize cost-effectiveness and simplicity, making the design accessible in rural or infrastructure-limited environments. Though lacking sensor feedback or automation, the system provides a foundational framework for future development in remote motor control. Its practical application lies in agriculture and water management, where motor operations must often be performed in inaccessible or hazardous areas. Future improvements could include integrating safety features, sensor modules, and IoT capabilities. Overall, the paper lays the groundwork for scalable, low-cost solutions to motor control challenges in rural engineering settings.

2.1.2. Korukanti Ashray, Ramesh K., Anita M., and Sravan P. (2022), "GSM Based Motor Control System with Water Level Monitoring"

This paper introduces an integrated GSM-based motor control and water level monitoring system for agricultural irrigation. The design enables users to switch motors ON/OFF via SMS while receiving real-time water level data through ultrasonic or float sensors. The system includes a GSM module, microcontroller, relay interface, and water level sensor to manage irrigation remotely and efficiently. Notifications are sent to the user indicating motor status and tank levels, helping prevent water overflow or dry running. A key contribution is its dual functionality—control and environmental monitoring—making it valuable in rural settings where labor and connectivity may be limited. The setup is scalable and energy-efficient, with potential for future upgrades such as IoT connectivity and solar-based power systems. This solution enhances irrigation management, reduces manual labor, and supports sustainable farming by automating decisions based on resource availability. The paper makes a strong case for GSM-based automation in resource-constrained agricultural environments.

2.1.3. Sourav Nandi and Soumya Mondal (2020), "Design and Implementation of GSM Based Pump Controller for Agricultural Irrigation"

Nandi and Mondal present a GSM-based irrigation pump controller featuring multi-user authentication and secure command processing via SMS. The system enables remote pump operation by verifying each user's identity using password-protected messages, ensuring only authorized personnel can control the pump. The architecture consists of a GSM module (SIM900), microcontroller (ATmega), and relay control for the pump. Status updates are sent back to users for confirmation. The system is especially useful for community farms where multiple users share irrigation infrastructure, promoting efficient scheduling and reduced manual labor. Emphasis is placed on secure communication, access control, and system scalability. Although it does not incorporate environmental sensors or automation features, the research lays groundwork for secure, user-managed GSM systems. The authors suggest future integration with sensors and cloud platforms for data-driven control. This work highlights the importance of user access management in shared agricultural systems and supports the broader goal of precision irrigation through secure remote control.

2.1.4. R. Priyadharsini, A. Pradeep, M. Prakash, and M. Kirubakaran (2020), "An Automatic Irrigation System Using IoT Devices"

The system utilizes water level sensors, temperature monitors, and safety mechanisms to prevent dry run, overload, and phase imbalance. A GSM module transmits SMS alerts and allows motor control from distant locations. The microcontroller processes sensor data and automates motor operation based on predefined thresholds, ensuring optimal irrigation.

This design offers a high degree of reliability by protecting motor components and minimizing human error. Real-time monitoring ensures irrigation only when needed, improving water use efficiency. It also reduces dependence on manual intervention, making it ideal for remote or labor-scarce regions. The authors emphasize that integrating IoT with GSM communication improves responsiveness and maintenance, paving the way for fully autonomous irrigation systems. This work significantly contributes to precision agriculture through its combination of automation, safety, and connectivity.

2.1.5. N.B. Shaikh (2019), "Real-Time Wireless Monitoring for Three Phase Motors in Industry: A Cost-Effective Solution using IoT"

This paper addresses industrial motor monitoring by proposing a GSM-enabled, IoT-based system for tracking the performance of three-phase induction motors. Key parameters such as temperature, current, and fault status are monitored and transmitted wirelessly. The system aims to enable early fault detection and reduce reliance on physical inspections. It utilizes a combination of embedded sensors, GSM communication, and a microcontroller to provide real-time condition monitoring.

The low-cost design suits small and medium-sized industries, where high-end SCADA systems may be unaffordable. The integration of GSM ensures operability even in locations with minimal internet access. The authors highlight improved motor lifespan, lower downtime, and reduced maintenance costs as major outcomes. The system provides alerts for abnormal conditions, facilitating preventive maintenance and improved operational efficiency. This study exemplifies how affordable technology can enhance reliability and safety in industrial motor management.

2.1.6. R. S. Suryawanshi, A. R. Thorat, and A. V. Joshi (2018), "Motor Control and Protection using Hybrid Network"

This paper presents a GSM-based hybrid motor protection system designed to detect voltage. The system includes sensors for fault detection, a microcontroller for data processing, and a GSM module for alert generation. When a fault is detected, users receive SMS alerts allowing timely action to prevent motor damage.

The hybrid network incorporates both wired and wireless components, increasing the reliability of communication. Designed primarily for industrial use, the system emphasizes safety, real-time monitoring, and ease of integration into existing motor control panels. Its proactive alert mechanism reduces the risk of equipment failure and associated downtime. The authors argue that this hybrid approach ensures more consistent fault detection and response than purely wired or wireless systems. The work effectively merges protection circuitry with GSM communication to improve industrial motor reliability.

2.1.7. M. Karthik, K. Lakshminarayanan, S. Aravindh, and P. Gokul (2017), "Wireless Nodes Assisted Micro-Irrigation System: an IoT Approach"

The system uses wireless nodes distributed across the field to gather data on soil moisture and environmental conditions. This data is transmitted to a central microcontroller, which uses the information to control irrigation motors automatically. GSM modules provide real-time remote monitoring and allow manual override via SMS.

The system enhances irrigation efficiency by delivering water based on real-time conditions, conserving energy and reducing water wastage. Its decentralized architecture allows scalability across varied land sizes. The integration of wireless sensors with GSM ensures continuous operation even without Wi-Fi connectivity. The authors highlight benefits like reduced labor, energy savings, and improved crop yield. This paper demonstrates how combining GSM with IoT-based sensing can transform traditional irrigation into a fully automated, intelligent process.

2.1.8. Enku Yosef Kefyalew & Jiang Dening (2014) – "Motor Overload Control based on GSM System"

This paper presents a GSM-enabled system designed to monitor and control motor overload conditions in industrial environments. The architecture incorporates a GSM modem, microcontroller, sensors, contactors, and a database interface. When an overload condition is detected—via current or temperature sensors—the system notifies operators through SMS and logs the event for later analysis. An operator can send an SMS command to remotely shut down the motor if needed. The study also discusses the software integration using VisualBasic.NET and a GUI that displays real-time motor statuses. By allowing predictive intervention and centralized data logging, the system aims to reduce breakdowns, repair costs, and downtime. The emphasis on seamless hardware-software integration and SMS-based control makes this a robust example of industrial IoT for preventive maintenance

2.1.9. Yu-qiao Meng (2016) – "Design for GSM-based Motor Remote Monitoring Device"

Meng describes a compact, scalable GSM-based monitoring device capable of overseeing multiple motors simultaneously. The paper details the modular hardware design, including motor detectors, GSM interface, and microcontroller logic. The unit processes incoming SMS commands to start or stop motors and sends back operational status. It is designed with easy assembly, low-cost components, and flexible wiring, allowing users to expand the system with additional modules. The author highlights its suitability for diverse sectors—from agriculture to light industrial setups—where motor supervision is needed without physical presence. While the study lacks extensive field testing, its hardware-centric focus and modular architecture provide a practical foundation for developing customized GSM-control systems.

2.1.10. Muhammad Yousuf, Turki Alsuwian, Arslan Ahmed Amin, Sanwal Fareed, and Muhammad Hamza (2024) "IoT-based Health Monitoring and Fault Detection of Industrial AC Induction Motor for Efficient Predictive Maintenance"

This study presents a comprehensive IoT-driven system designed for real-time condition monitoring and fault detection in industrial AC induction motors. The system integrates sensors measuring temperature, vibration, current, voltage, and speed, feeding data into an Arduino-based control unit. Processed information is sent via GSM to a cloud-enabled platform (Blynk IoT), where analytics detect anomalies and trigger SMS alerts.

A notable feature is RPM control, allowing energy optimization while extending motor lifespan. Field trials and simulation using Proteus demonstrated the system's accuracy (~99%) in identifying anomalies such as vibration, thermal surges, voltage irregularities, and phase imbalances. The integration of GSM communication ensures prompt operator notification for timely intervention, reducing unscheduled downtime.

2.1.11. Palle Divya Vani and Kanchi Raghavendra Rao (2019), "Implementation of Smart Agriculture using CloudIoT and its Geotagging on Android Platform"

Vani and Rao developed a smart agriculture system combining CC3200 Wi-Fi microcontroller, SIM900A GSM, ThingSpeak cloud, and mobile Android UI to automate irrigation. The system reads soil moisture via FC-28 sensors and controls pumps accordingly, sending data to the cloud and smartphone. GSM ensures SMS-based notifications for farmers on soil status and pump activation. The inclusion of geotagging allows users to visualize moisture levels by location on their device. This hybrid platform enhances existing motor control by mixing real-time automation, cloud connectivity, and GSM-based alerts—even when Wi-Fi is absent. The proposal advances smart farming by providing an accessible, scalable solution that blends remote sensing, local actuation, and global monitoring.

2.1.12. Saravanan Ragavan and Ramesh Thangavel (2017), "GSM Based Low-Cost Smart Irrigation System with Wireless Valve Control"

This study presents a cost-effective irrigation system integrating GSM-based control of motor valves with sensor-driven environmental monitoring. The system uses a PIC16F877A microcontroller and SIM900 GSM module to receive SMS commands and transmit sensor data (soil moisture, humidity, temperature) from the field controller to the motor controller. The motor controller then activates pumps or valves based on received commands. Alerts are sent back to the farmer via SMS for remote operation and system feedback. Field tests demonstrated reliable performance, effective water usage, and low overall costs. This setup is adaptable to small and mid-size farms, especially in areas with poor internet connectivity. It extends typical GSM-motor control by adding valve automation and multi-sensor data feedback, making it a strong contender in smart-agriculture implementations that balance simplicity, functionality, and affordability.

2.1.13. Sweety Maiskar, Sonwill Sharma, Jagruti Korde, Prerna Bodele, Anisha Ukey, Arpita Thamke, Dr. Tarun Shrivastava (2022), "Controlling of Agriculture Motor with Water Level using GSM and Arduino Nano"

Maiskar et al. describe a GSM and Arduino Nano-based irrigation system that monitors water level, phase integrity, and pump status to manage 3-phase motors. The architecture sends SMS alerts upon detecting power anomalies (e.g., phase loss or dry running) and allows remote motor control. It includes over-current protection and status updates. This work builds on prior GSM motor control by adding essential safety monitoring and multi-phase diagnostics—addressing issues of unpredictable power supply common in developing regions. Their design bridges labor-saving automation with motor safety, enabling trustworthy operation and reducing equipment damage.

2.1.14. Dr. Neethu P S and B. Gowrishankari (2020), "Substation Control and Monitoring using GSM"

Neethu and Gowrishankari propose a GSM-based remote control and monitoring system for electrical substations. The paper details using microcontrollers to track and report on parameters like transformer load current and temperature. Upon detecting overload or faults, the system sends SMS alerts to operators via GSM. Their design enables remote breaker control and transformer cooling activation, improving reliability and reducing operator presence in substation environments. The integration of motor control with transformer monitoring demonstrates the versatility of GSM-based systems in broader electrical infrastructure. It showcases how traditional monitoring can evolve into remote, intelligent control—saving both manpower and operational risk.

2.2 PROBLEM STATEMENTS

- **Lack of Remote Accessibility in Motor Control Systems**

Most conventional industrial motor systems require physical presence for monitoring and control. This becomes a major limitation in industries where plants are located in remote or hazardous areas. In emergencies, reaching the motor panel can cause delays and risk human safety.

Our system solves this by enabling remote motor control and status retrieval using GSM-based SMS communication. Operators can turn the motor ON/OFF and monitor live sensor readings from anywhere with just a mobile phone.

- **Inability to Auto-Detect Electrical Faults**

Traditional systems often rely on human inspection or expensive industrial-grade PLC systems to detect abnormal voltage, overcurrent, or overheating. These setups are either too manual or too expensive for small and medium industries.

Our project introduces an automatic fault detection mechanism using ZMPT101B (voltage), ZMCT103C (current), and LM35 (temperature) sensors. It continuously monitors values and prevents the motor from starting or running under unsafe conditions.

- **High Risk of Motor Damage Due to Parameter Deviations**

Motors are vulnerable to burnout or mechanical failure if run under abnormal voltage, current, or temperature conditions for extended periods. In many systems, these faults are only detected after damage has occurred.

This system protects the motor in real-time. If any electrical parameter goes beyond the defined safe range (180–250V, 2–8A, 20–90°C), the motor is automatically turned OFF, and an SMS alert is sent with the fault reason.

- **Absence of Real-Time Feedback in Manual Control Systems**

Manual switches and relay-based control panels give no real-time insight into the motor's condition or the surrounding electrical environment. This leads to guesswork and potential risks when starting a motor blindly.

Our solution bridges this gap by displaying live voltage, current, and temperature readings on a 20x4 LCD. It also responds with detailed status reports when the user sends the "status" SMS command, ensuring full awareness.

- **Unreliable Power Supply in Remote Areas Leading to Motor Failures**

Many remote farms and small-scale industries suffer from unstable or fluctuating power supply, especially in developing regions. This leads to frequent over-voltage, under-voltage, or phase loss conditions. When three-phase motors are operated under such faulty conditions, it causesf overheating, coil damage, or complete motor burnout. These damages are costly to repair and result in operational delays.

Our system continuously monitors voltage across all three phases (R, Y, B) and shuts down the motor instantly if unsafe levels are detected. It then sends an SMS alert explaining the exact fault (e.g., “R Volt Err”), helping farmers or technicians take quick action without needing to physically inspect the motor site.

CHAPTER-3

METHEDOLOGY

3.1 BLOCK DIAGRAM:

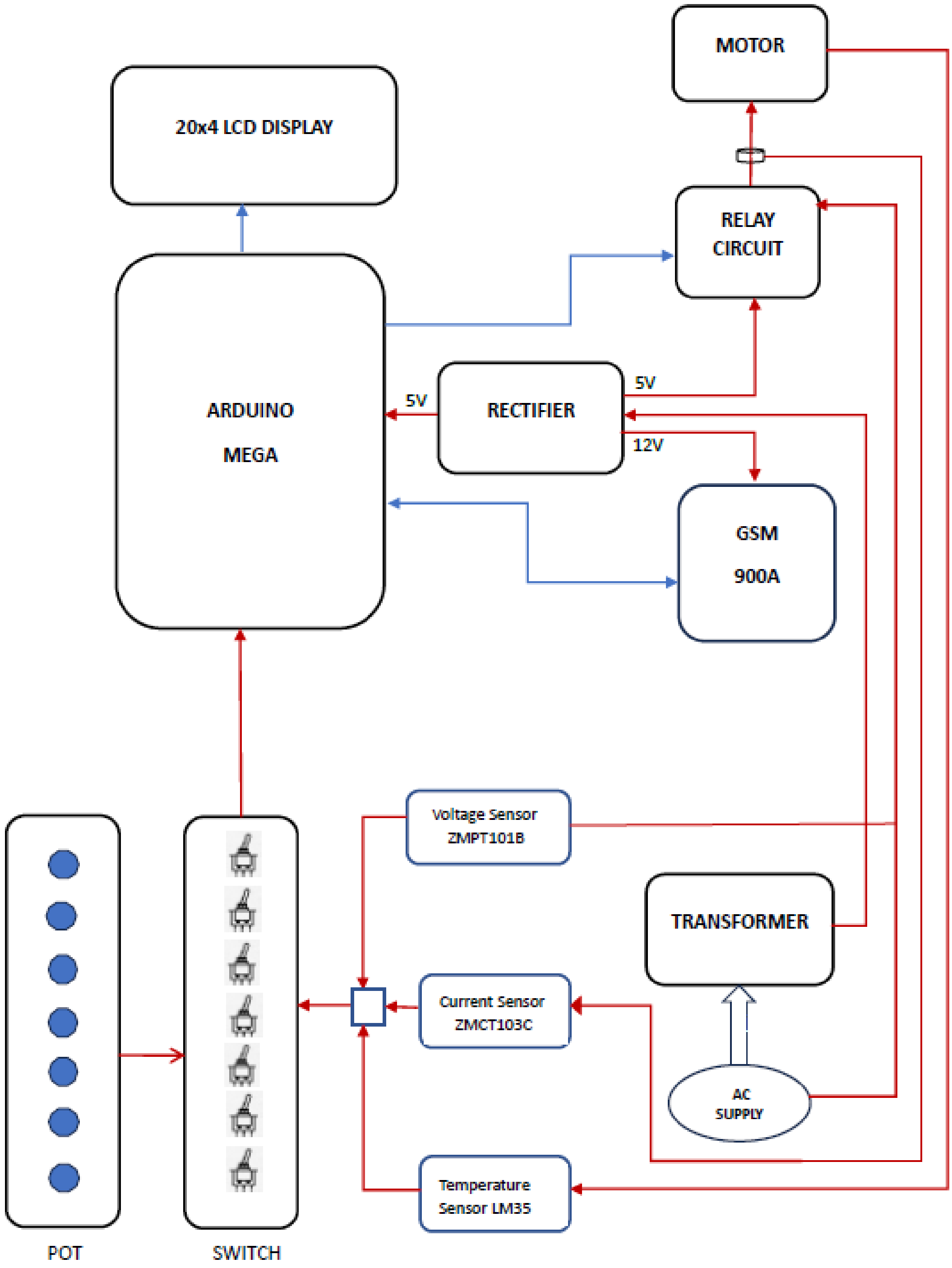

Figure 3.1.1 Block Diagram

3.2 COMPONENTS REQUIRED:

1. Motor
2. Potentiometers
3. Arduino Mega
4. LCD Display
5. GSM Module
6. Relay Circuit
7. Rectifier Circuit
8. Sensors
9. On-Off-On Toggle switch

1. MOTOR

The motor is the primary device being monitored in this system. It can be an AC or DC motor used in industrial applications, where its operating parameters such as voltage, current, speed (RPM), temperature, and phase balance need to be continuously monitored. If any abnormal condition is detected, the system takes necessary actions, such as shutting down the motor or sending an alert.

Figure 3.2.1 Water pumping motor

2. POTENTIOMETER

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment. It is also used in speed control of fans. Potentiometers operated by a mechanism can be used as position transducers, for example, in a joystick. In this project potentiometers are used to simulate the sensor values for temperature, voltage, current, RPM, and phase conditions that would normally be monitored by actual sensors.

Figure 3.2.2 Potentiometer

3. ARDUINO MEGA

The Arduino Mega 2560 is a powerful microcontroller board based on the ATmega2560, designed for complex and large-scale embedded applications. It features 54 digital I/O pins (15 of which support PWM), 16 analog inputs, 4 hardware serial ports (UARTs), and abundant memory resources with 256 KB of flash, 8 KB of SRAM, and 4 KB of EEPROM. Operating at 5V with a 16 MHz clock speed, it supports multiple communication protocols including UART, SPI, and I2C, making it ideal for interfacing with various sensors, actuators, and modules. Its extended I/O capabilities and high memory make it especially suitable for advanced robotics, automation systems, and IoT projects. Programmed using the Arduino IDE via a USB Type-B connector, the Mega 2560 is a robust platform for developers and hobbyists seeking to build feature-rich, high-performance electronic systems.

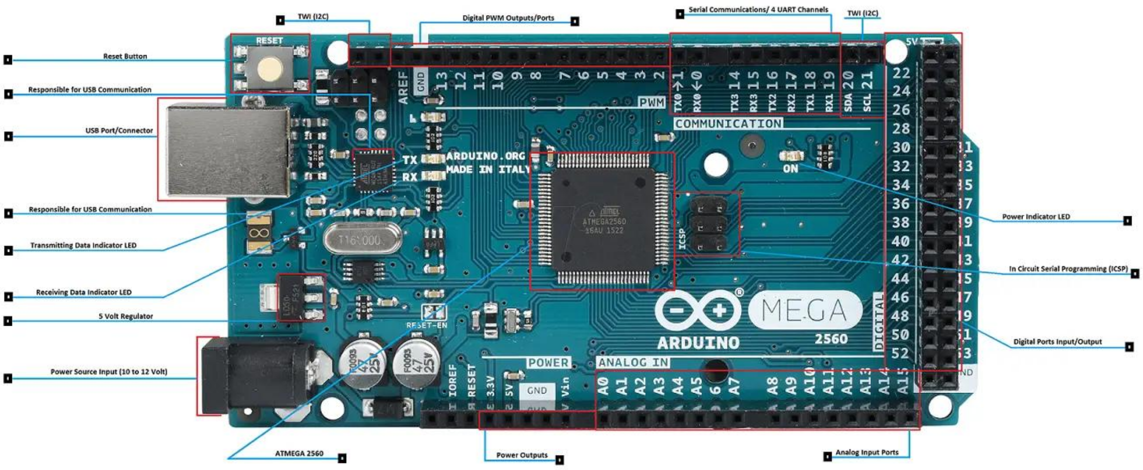

Figure 3.2.3 Arduino MEGA

Basic pin diagram of arduino mega:

Pin Number	Pin Name	Description
10, 31, 61, 80	V_{CC}	IC Supply pins
11, 32, 62, 81, 99	GND	IC ground reference pins
98	A_{REF}	Reference supply for ADC
100	A_{VCC}	Supply pin for analog peripherals
33, 34	XTAL	Crystal oscillator pins
30	$\overline{RESET}$	Reset pin, active low
2 - 9	PE0 – PE7	GPIO Port E pins
12 – 18, 27	PH0 – PH6, PH7	GPIO Port H pins
19 - 26	PB0 – PB7	GPIO Port B pins
28 – 29, 51 – 52, 70 ,1	PG3 – PG4, PG0 – PG1, PG2 ,PG5	GPIO Port G pins
35 - 42	PL0 – PL7	GPIO Port L pins
43 - 50	PD0 – PD7	GPIO Port D pins
53 - 60	PC0 – PC7	GPIO Port C pins
63 – 69, 79	PJ0 – PJ6, PJ7	GPIO Port J pins
71 - 78	PA7 – PA0	GPIO Port A pins
82 - 89	PK7 – PK0	GPIO Port K pins
90 - 97	PF7 – PF0	GPIO Port F pins

Figure 3.2.4 Pin Configuration of ATMEGA 2560

Technical specifications:

TABLE 3.1.1 Arduino MEGA specifications

Feature	Specification
Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7–12V
Input Voltage (limits)	6–20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB (8 KB used by bootloader)
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
USB Connector	Type-B
Power Jack	Barrel Jack (2.1mm center-positive)
ICSP Header	Yes
Reset Button	Yes
Dimensions	101.5 mm × 53.3 mm
Weight	~37 grams

Special pin functions:

The Arduino Mega 2560 features several special-purpose pins that enhance its versatility in complex applications. Among its most notable are the four hardware serial ports (Serial0 to Serial3), enabling simultaneous communication with multiple serial devices—essential for advanced IoT and robotics projects.

The board also provides 15 PWM-enabled digital pins (2–13, 44–46) for motor control, LED dimming, and analog signal simulation. For communication with peripherals, it includes dedicated SPI (pins 50–53) and I2C (SDA: 20, SCL: 21) interfaces. Six external interrupt-capable pins (2, 3, 18–21) allow for responsive real-time event handling. Additional features include a 3.3V output pin, a reset pin, an ICSP header for low-level programming, and the AREF pin, which supports external analog reference voltages for precise analog readings. Together, these special pins make the Mega 2560 exceptionally well-suited for large-scale embedded systems requiring high connectivity and control.

4. GSM MODULE

SIM900A GSM module delivers GSM/GPRS 900/1800MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. With a tiny configuration of 24mm x 24mm x 3 mm, SIM900A can fit almost all the space requirements in your applications, especially for the slim and compact demands of design

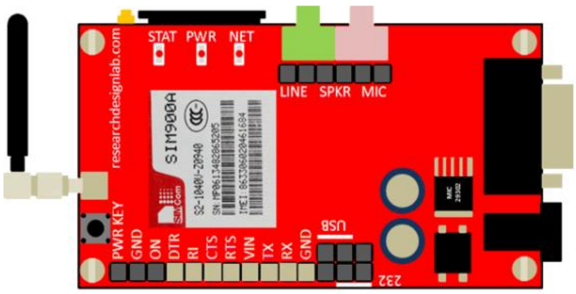

Figure 3.2.5 SIM Module 900A

The SIM900A is integrated with the TCP/IP protocol; extended TCP/IP AT commands are developed to use the TCP/IP protocol easily, which is very useful for data transfer applications. It can communicate with controllers via AT commands

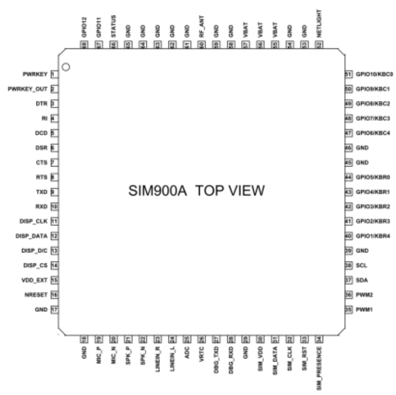

Figure 3.2.6 SIM 900A Module GSM Pinout

The GSM module (SIM800L or SIM900A) enables wireless communication between the motor system and the user. It performs two key functions:

Alert Notifications – If an issue such as overheating, phase failure, or overload is detected, the system sends an SMS alert to the user.

Remote Monitoring & Control – The user can request real-time motor status by sending an SMS command (e.g., "STATUS"), and the system responds with an SMS containing the live voltage, current, RPM, temperature, and phase readings. The user can also remotely turn the motor ON/OFF via SMS commands

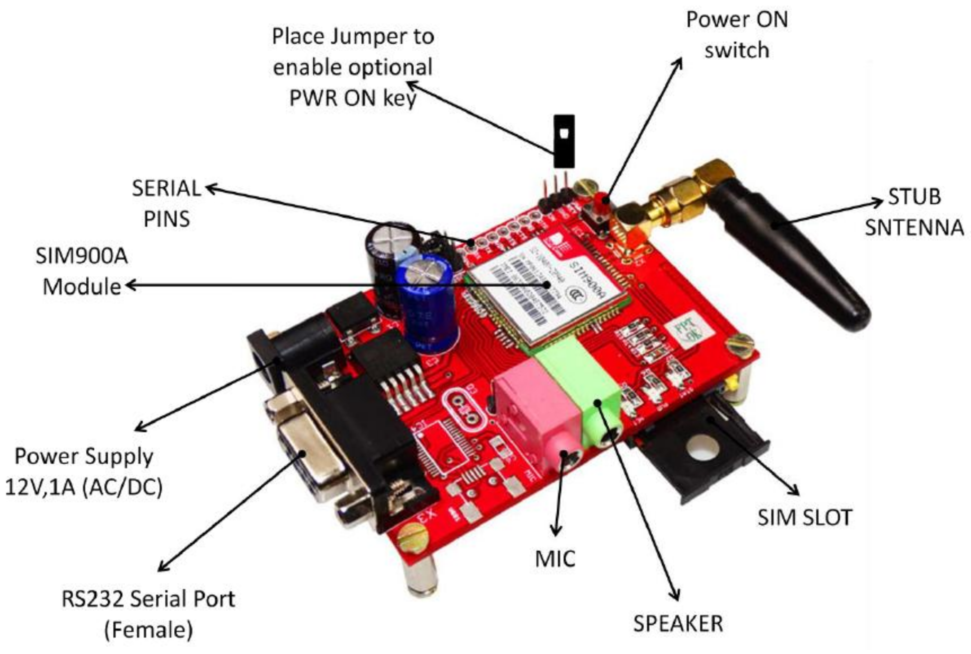

Figure 3.2.7 SIM 900A Peripheral Pins

SPECIFICATIONS:

- Single supply voltage: 3.4V – 4.5V
- Power saving mode: Typical power consumption in SLEEP mode is 1.5mA
- Frequency bands: SIM900A Dual-band: EGSM900, DCS1800. The SIM900A can search the two frequency bands automatically. The frequency bands also can be set by AT command.
- GSM class: Small MS
- GPRS connectivity:GPRS multi-slot class 10 (default) , GPRS multi-slot class 8 (option)
- Transmitting power: Class 4 (2W) at EGSM 900, Class 1 (1W) at DCS 1800
- Operating Temperature: -30ºC to +80ºC
- Storage Temperature: -5ºC to +90ºC
- DATA GPRS: download transfer max is 85.6KBps, Upload transfer max 42.8KBps
- Supports CSD, USSD, SMS, FAX

- Supports MIC and Audio Input

5. LCD DISPLAY

The 20x4 LCD (Liquid Crystal Display) module is a character-based display that can show 20 characters per line across 4 lines, making it ideal for applications that require more display area than smaller 16x2 LCDs. It uses the Hitachi HD44780 or compatible controller, and can be interfaced using 4-bit or 8-bit parallel communication or via I2C adapter for simpler wiring.

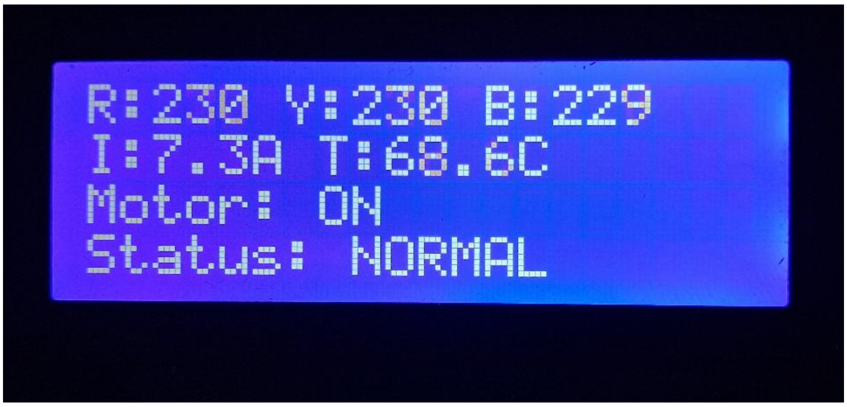

Figure 3.2.8 20x4 LCD Display

LCD pin configuration:

Table 3.1.2 LCD Pin Configuration

Pin No.	Symbol	Level	Description
1	VSS	0V	Ground
2	VDD	5.0V	Supply Voltage for logic
3	VO	(Variable)	Operating voltage for LCD
4	RS	H/L	H: DATA, L: Instruction code
5	R/W	H/L	H: Read L: Write
6	E	H,H→L	Chip enable signal
7	DB0	H/L	Data bus line
8	DB1	H/L	Data bus line
9	DB2	H/L	Data bus line
10	DB3	H/L	Data bus line
11	DB4	H/L	Data bus line
12	DB5	H/L	Data bus line
13	DB6	H/L	Data bus line
14	DB7	H/L	Data bus line
15	A	—	Power supply for B/L(+)
16	K	—	Power supply for B/L(-)

Features:

Table 3.1.3 LCD Features

Feature	Description
Display Type	Character LCD (20 characters × 4 rows)
Controller	HD44780 or equivalent
Operating Voltage	4.7V to 5.3V
Logic Voltage	5V TTL
Backlight	Usually LED (yellow-green or blue with white text)
Interface	Parallel (4-bit/8-bit) or I2C (with adapter)
Character Size	Approx. 5x8 dots
Module Size (Typical)	~98mm × 60mm × 14mm
Viewing Area	~76mm × 26mm
Current Consumption	~1.5–2 mA (without backlight), ~20 mA with backlight

6. RELAY CIRCUIT

The relay circuit is responsible for controlling the motor's ON/OFF operation. When an abnormal condition is detected, such as overheating, overcurrent, or voltage fluctuations, the Arduino activates the relay, cutting off power to the motor to prevent further damage. The relay can also be remotely controlled via SMS commands, allowing the user to restart the motor once the issue is resolved.

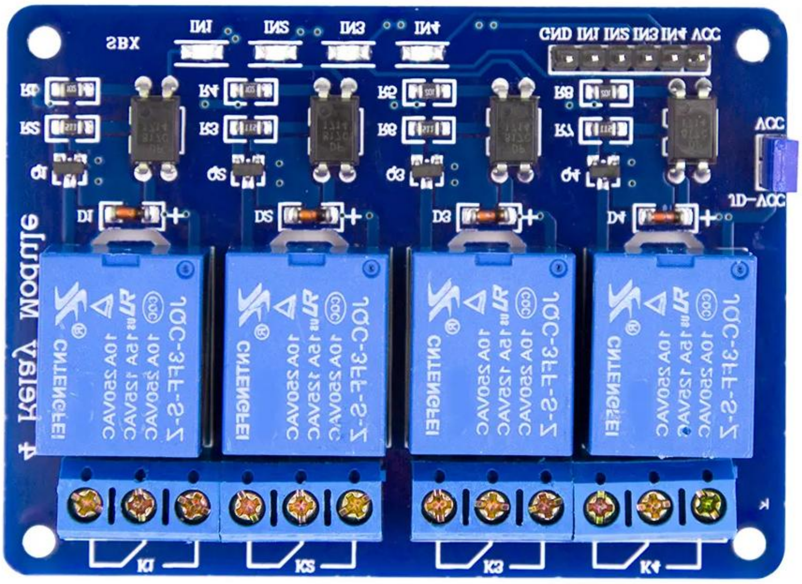

Figure 3.2.9 Relay Circuits

Four-Channel Relay Module Pinout

Table 3.1.4 Pinout table of 4 channel relay

Pin Number	Pin Name	Description
1	GND	Ground reference for the module
2	IN1	Input to activate relay 1
3	IN2	Input to activate relay 2
4	IN3	Input to activate relay 3
5	IN4	Input to activate relay 4
6	V_{CC}	Power supply for the relay module
7	V_{CC}	Power supply selection jumper
8	JD-V_{CC}	Alternate power pin for the relay module

7. RECTIFIER CIRCUIT

The rectifier circuit (Bridge Rectifier + Voltage Regulator) is essential for converting AC power from the mains supply into stable DC voltage, which is required for the Arduino, GSM module, and sensors. The rectifier circuit includes:

- Step-Down Transformer – Converts high-voltage AC into lower voltage AC.
- Bridge Rectifier (Diodes: 1N4007) – Converts AC into pulsating DC.
- Capacitor Filter – Smooths out the DC voltage to reduce fluctuations.
- Voltage Regulator (7805/LM317) – Ensures a stable 5V or 12V output to power the microcontroller and sensors.

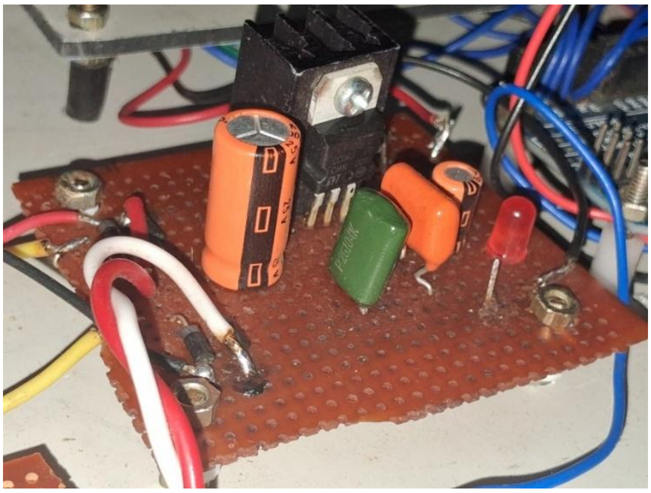

Figure 3.2.10 Rectifier Circuit

The L7805V is part of the L78xx series of three-terminal linear voltage regulators, delivering a fixed 5 V output at up to 1.5 A, with internal protections including thermal shutdown, current limiting, and safe-area control

8. SENSORS

A. Current sensor

The ZMCT103C is a precision current transformer (CT) designed for AC current measurement. It's widely used in energy meters, industrial control systems, and home automation projects. Unlike Hall-effect sensors, it works on the electromagnetic induction principle, providing high accuracy, excellent isolation, and very low power loss.

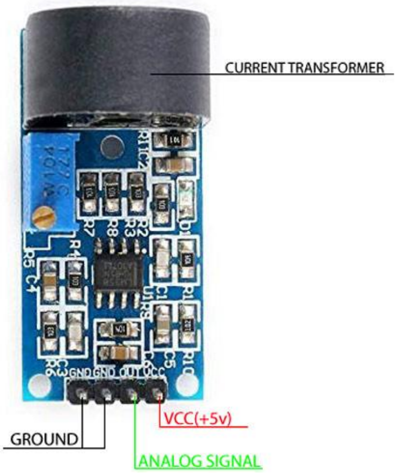

Figure 3.2.11 Current sensor

some features and specifications mentioned below:

1. Current Ratio: 5 A:5 mA
2. Rated Primary Current at 50/60 Hz: 5 A
3. Winding D.C. Resistance at 20 °C: 155 Ω
4. Maximum Primary Current at 50/60 Hz: 20 A
5. Transformer Turns Ratio: Np:Ns = 1000:1
6. Isolation Voltage: 4500V
7. Onboard sampling resistor, to drop the voltage to lower levels
8. Operating Temperature: -40 to 85 °C
9. Pin Length of the secondary coil (encapsulation) > 3mm
10. Epoxy Encapsulation

Pin Configuration for ZMCT103C Current Sensor Module

The ZMCT103C module has 4 pins, which are as follows:

1. Ground (G)
2. Ground(G)
3. Signal Out
4. VCC(+5V)

B. Voltage sensor

The ZMPT101B is a high-precision voltage transformer module designed for accurate measurement of AC voltages in single-phase systems. It's widely utilized in energy monitoring, home automation, and industrial control applications due to its compact size and reliable performance.

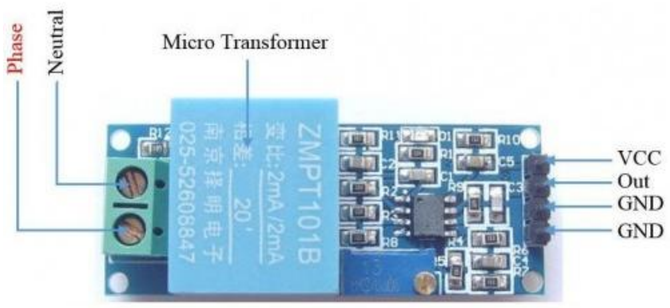

Figure 3.2.12 voltage sensor

Key Specifications

- Rated Input Current: 2 mA
- Rated Output Current: 2 mA
- Input Voltage Range: Up to 250V AC
- Output Signal: Analog voltage (0 to VCC), centered around VCC/2
- Operating Voltage: DC 5V to 30V
- Isolation Voltage: Up to 4000V
- Module Dimensions: Approximately 49.5 mm × 19.4 mm

C. TEMPERATURE SENSOR

This LM35D Analog Temperature Sensor Module is based on the semiconductor LM35 temperature sensor. The LM35 Linear Temperature Sensor module is useful in detecting ambient air temperature. Sensitivity is 10mV per degree Celsius. The output voltage is proportional to the temperature.

LM35 is a precision IC temperature sensor with its output proportional to the temperature (in °C). The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With LM35, the temperature can be measured more accurately than with a thermistor.

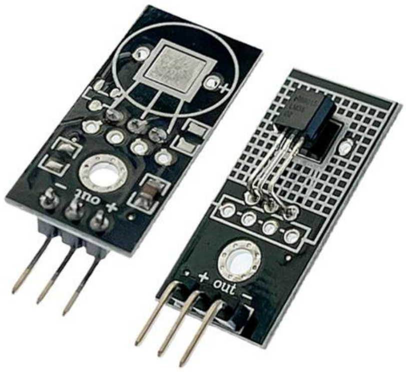

Figure 3.2.13 Temperature sensor

FEATURES :

1. Based on the semiconductor LM35 temperature sensor
2. Useful in detecting ambient air temperature
3. Calibrated directly in ° Celsius (Centigrade)
4. Linear + 10 mV/°C Scale Factor
5. 0.5°C Ensure accuracy (at +25°C)
6. Low power consumption, less than 60uA
7. Low output impedance, 1mA current through only 0.1Ω
8. With screw holes for easy installation and fixed. Aperture 2.6mm

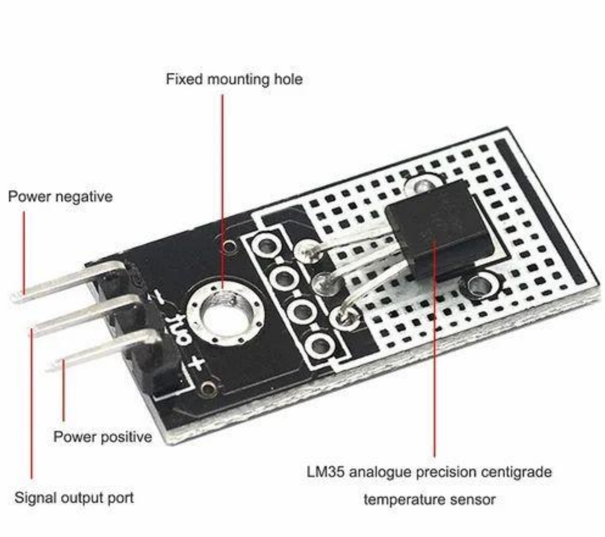

Figure 3.2.14 Pin configuration of LM35D

9. On-Off-On toggle switches

The On-Off-On SPDT (Single Pole Double Throw) toggle switch is a widely used electromechanical switch designed to control the flow of electricity between a common terminal and two selectable outputs. Its three-position configuration includes two active "ON" states and a central "OFF" position, providing flexibility in circuit routing. This makes it ideal for use in embedded systems, motor controllers, automation panels, and control systems where manual control and signal switching are necessary.

The toggle actuator is designed for durability, often rated for 40,000 or more cycles under normal operation. The toggle mechanism provides tactile feedback, allowing users to confirm the switch's position without needing a visual indicator. These switches typically feature panel-mount designs with a threaded bushing for secure installation, and either solder lug or PCB terminals, depending on the application.

Figure 3.2.15 On-Off-On toggle switch

Specifications:

Table 3.1.5 Specifications of switch

Feature	Specification
Switch Type	Toggle Switch (SPDT – Single Pole Double Throw)
Switching Action	On – Off – On (Maintained / Latching)
No. of Positions	3 positions (Center OFF)
Contact Configuration	SPDT (1 Common, 2 Throw terminals)
Electrical Rating	5 A @ 250 V AC, 5 A @ 30 V DC
Contact Material	Silver Alloy / Gold-plated Copper (varies by manufacturer)
Insulation Resistance	≥ 1000 MΩ @ 500 V DC
Dielectric Strength	1000 V AC for 1 minute
Contact Resistance	≤ 20 mΩ (typical)
Mechanical Life	≥ 40,000 cycles
Mounting Type	Panel Mount (with threaded bushing)
Terminal Type	Solder Lug / PCB Mount
Actuator Type	Lever-type toggle (flat or round tip)
Actuation Force	Typically 1.5–2.5 N
Toggle Angle	±15° to ±30° depending on switch size
Body Material	DAP (Diallyl Phthalate), Thermoplastic, or Metal
Sealing	Optional sealing boots available for dust/moisture protection
Operating Temperature	–30 °C to +85 °C
Storage Temperature	–40 °C to +100 °C
Standards Compliance	RoHS, CE (varies by supplier)

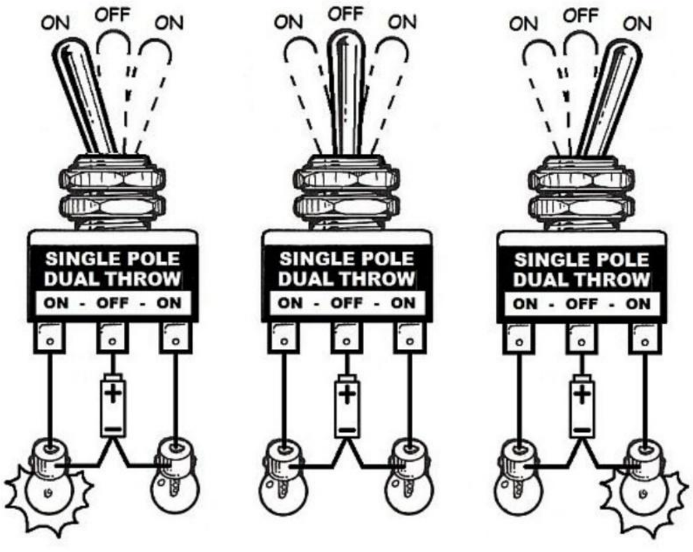

Figure 3.2.16 Pin configuration of SPDT switch

An SPDT On-Off-On switch has **three terminals**:

- **C (Common)** – The central terminal where the input signal or power is applied.
- **NO (Normally Open)** – Connected to C when the switch is in one ON position.
- **NC (Normally Closed)** – Connected to C when the switch is in the other ON position.

Working:

The On-Off-On SPDT (Single Pole Double Throw) switch operates by mechanically routing a common input terminal (C) to one of two output terminals, allowing manual control over two separate circuit paths. In the center OFF position, the switch is electrically isolated the common terminal is not connected to either of the two outputs (NO or NC), effectively breaking the circuit and preventing any current flow. When the switch is toggled to the first ON position, the internal contact bridges the common terminal (C) with the normally closed (NC) terminal, allowing current to flow through that specific output. Conversely, in the second ON position, the switch connects the common terminal (C) to the normally open (NO) terminal, enabling the alternative path for current. This configuration allows for selective control of two outputs using a single input and is widely used in applications such as load selection, motor direction control, or signal toggling.

3.3 WORKING:

The GSM-based Industrial Motor Control and Monitoring System is designed to remotely operate and monitor a three-phase motor using real-time sensor data and SMS communication. It ensures that the motor only functions under safe conditions, preventing damage due to voltage fluctuations, overcurrent, or overheating. The system combines automation with remote access, making it ideal for industrial environments where physical supervision may not always be possible.

When the system powers up, it displays an initialization message on the 20x4 LCD screen and immediately sends an SMS notification to the registered number. The message confirms that the system is active and that the motor is currently OFF. This provides instant awareness to the user that the controller is ready.

On powering up:

LCD shows “System ON” and initializes sensor reading.

An SMS is sent to all registered numbers:

System ON. Motor is OFF.

Send 'motoron' to start.

Operation Modes:

The system supports two input modes selected via a physical switch connected to digital pin 8:

Switch High for Pot Mode

Switch Low for Sensor Mode

POT Mode:

For testing and simulation purposes, three potentiometers are used to simulate the values of voltage (R, Y, B phases), current, and temperature. It is ideal for testing without real sensors or AC inputs.

SENSOR Mode:

In this mode, actual sensors are used:

- Voltage Measurement: ZMPT101B modules for R, Y, and B phases.
- Current Measurement: ZMCT103C modules for R, Y, and B currents.
- Temperature Monitoring: LM35 sensor.

A physical mode selection switch is provided to toggle between POT and SENSOR modes. The currently selected mode is also shown on the LCD in real time, allowing the user to verify which data source is active.

LCD Display (20x4):

The system's LCD provides continuous feedback to the user. The 20x4 display is updated every 500 milliseconds and shows:

- Line 0: R:230V Y:228V B:229V → Live phase voltages
- Line 1: IR:3.2A IY:3.4A IB:3.3A → Live phase currents
- Line 2: Temp:42.1C SENS → Temperature and Operation Mode(Pot or SENS)
- Line 3: MOTOR: ON FAULT → Motor status and fault (if any)

If a fault occurs, the LCD freezes and displays a warning message along with the fault cause (e.g., R Volt Err, Temp Err), helping the user diagnose the issue quickly.

After fault recovery, it resumes live updates.

Safety Conditions and Control Logic

The motor will only turn ON if all parameters are within the predefined safe range:

Voltage: 180V – 250V

Current: 2A – 8A

Temperature: 20°C – 90°C

If even one of these values is out of range, the system automatically blocks motor operation. If the motor is already ON and a fault is detected, the system shuts it OFF instantly for safety.

Manual Control Using Push Button:

The system includes a manual push-button to turn the motor ON or OFF directly. If the current readings are within safe limits, pressing the button will turn ON the motor and send an SMS:

"Manual Motor ON."

If the button is pressed again, the motor turns OFF, and the system replies:

"Manual Motor OFF."

If the button is pressed during a fault condition, the motor won't turn on, and a message is sent:

"Manual ON attempt failed. <reason>"

Remote Control via SMS:

The system supports SMS-based remote control. The registered user can send three types of commands:

- "motoron"

If conditions are safe, the system turns ON the motor and sends:

"Motor is turned ON."

If a fault is active, it replies:

"Cannot turn ON: Fault detected!"

- "motoroff"

Turns OFF the motor immediately and responds:

"Motor turned OFF."

"status"

Returns a full report with live sensor data:

R:228.4V

Y:229.2V

B:230.1V

IR:4.8A

IY:5.0A

IB:5.1A

T:33.6C

Motor: ON

This makes it possible to operate the system from a distance, without needing physical access.

Fault Detection and Alerts:

The system continuously monitors all sensors. If any reading crosses the safety limits, the motor is turned OFF immediately, and an SMS is sent to the user indicating the exact reason for shutdown. For example:

"Motor STOPPED due to: Temp Err"

along with the current values of all parameters.

Once the readings return to the safe zone, the system automatically sends a recovery message:

"All parameters normal. Motor ready to turn ON."

This ensures that the user is always aware of both the fault and the recovery status, without needing to physically inspect the system.

PARAMETRIC TABLE:

Table 3.3.1 Parametric Table

PARAMETER	LOWER THRESHOLD	UPPER THRESHOLD
VOLTAGE (3PHASE)	R: 180V	R: 240V
	Y: 180V	Y: 240V
	B: 180V	B: 240V
CURRENT (3 PHASE)	R: 2A	R: 8A
	Y: 2A	R: 8A
	B: 2A	R: 8A
TEMPERATURE	20	80

CHAPTER-4

RESULT AND DISCUSSION

1. System initialization

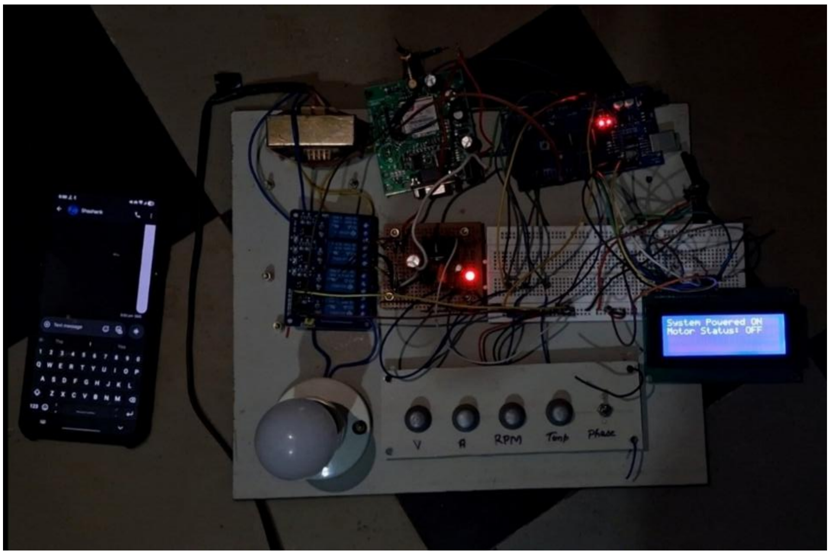

Figure 4.1 System initialization

The system displays "System Powered on, Motor Status: OFF" when the system is initialized. The 20*4 LCD screen displays the Motor parameters which includes 3 voltage phases, 3 current phases, temperature and Status of the motor, whether it is normal or fault is present. At this point the GSM transmits the message "System ON. Motor is OFF. Send 'motoron' to start". The motor will be off by default and it can either be turned on remotely or manually and the system is ready to receive the commands from registered mobile number and respond accordingly.

2. motoron command for turning the motor on

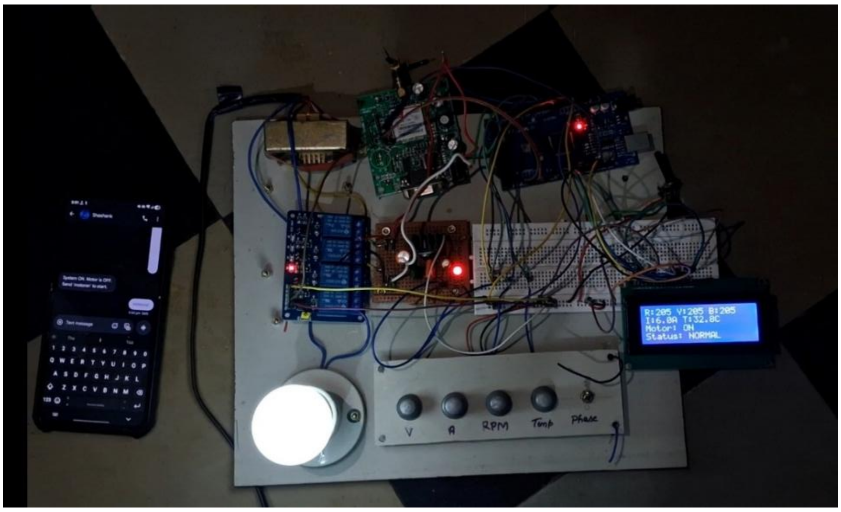

Figure 4.2 Initial parameter display with a message to transmit a command

The motoron command is sent to gsm through a registered mobile number to turn on the motor. When this message is transmitted, the system checks if a fault exists in the motor parameter. If there is no fault, then it proceeds to turn the motor ON. And if a fault is present, then a message is sent to the mobile number saying " Motor ON command received. Cannot turn ON: Fault detected". At this point the user can send the command "status" to get the status of motor and identify the fault.

3. Fault detected with the motor turning off

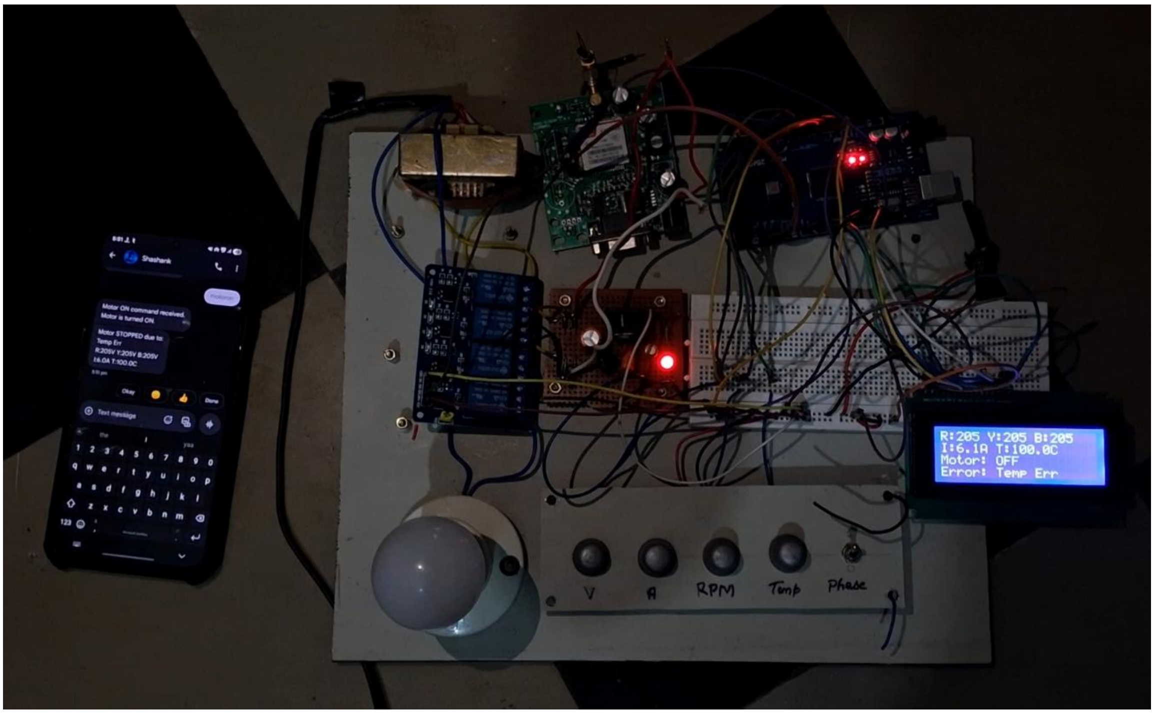

Figure 4.3 Fault detected with the motor turning off

As displayed in LCD we increased the temperature value using potentiometer to simulate sensor values and show case fault detection mechanism of our system. The system shuts down the motor as soon temperature value exceeded threshold value i.e, 80 degree Celsius. It works the same with other parameters, when values exceed threshold and decrease below threshold then the motor is shut down immediately, which prevents motor damage.

Simultaneously a message is sent to registered number, saying " Motor STOPPED due to: + fault Reason " with all the parameter Values at that time. Where fault reason can be either voltage, current or temperature. When the fault is cleared, the GSM sends a message saying " All parameters normal. Motor ready to turn ON ".

4. “STATUS” message to get the real time data

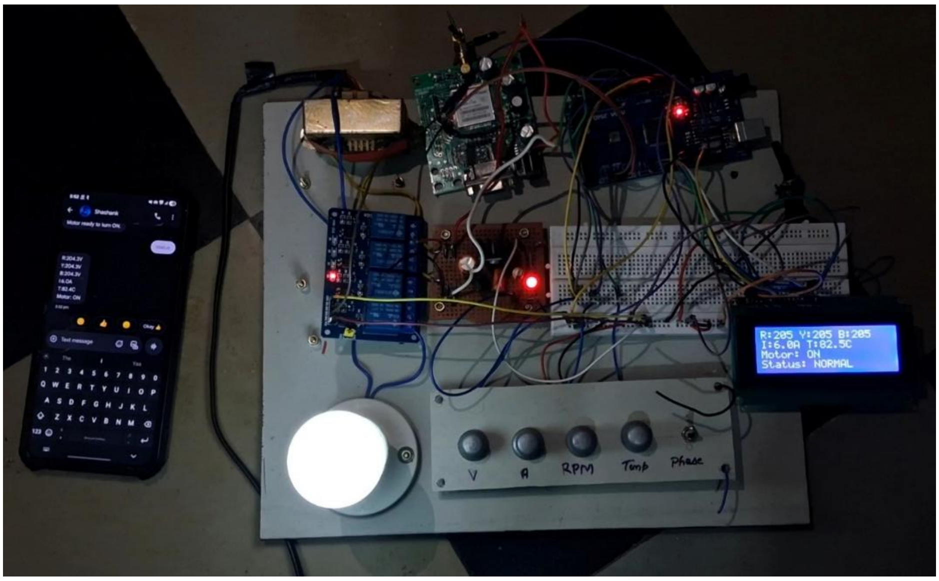

Figure 4.4 “STATUS” message to get the real time data

We have also introduced a command called status, which is sent through SMS. We can use it to fetch real time data of the motor. Upon receiving this command the arduino fetches the current parameters of the motor and the GSM transmits those parameters to the registered mobile number.

5. Motoroff message to turn off the motor

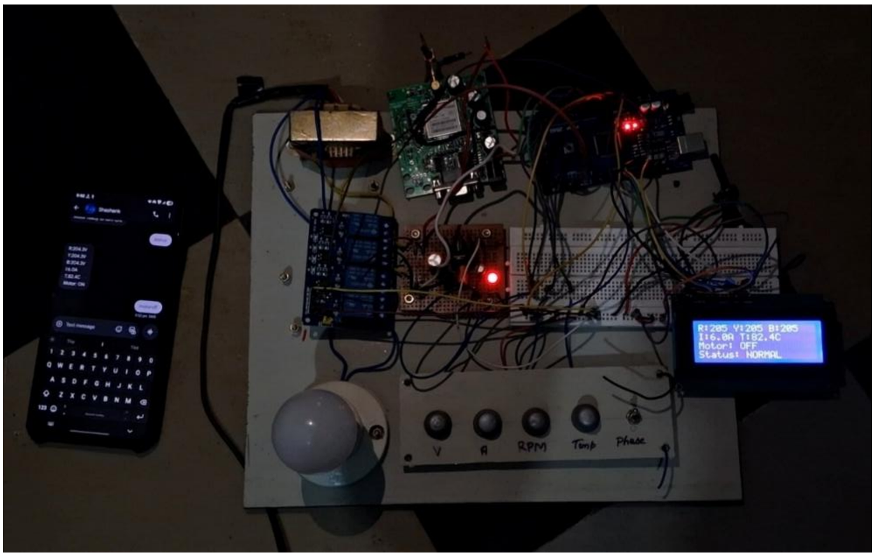

Figure 4.5 Motoroff message to turn off the motor

We can use the motoroff command to turn off the motor. This is quite simple, when motoroff command is received via GSM, the motor is turned off immediately irrespective of the motor condition.

6. Manual motor on when operating in sensor mode

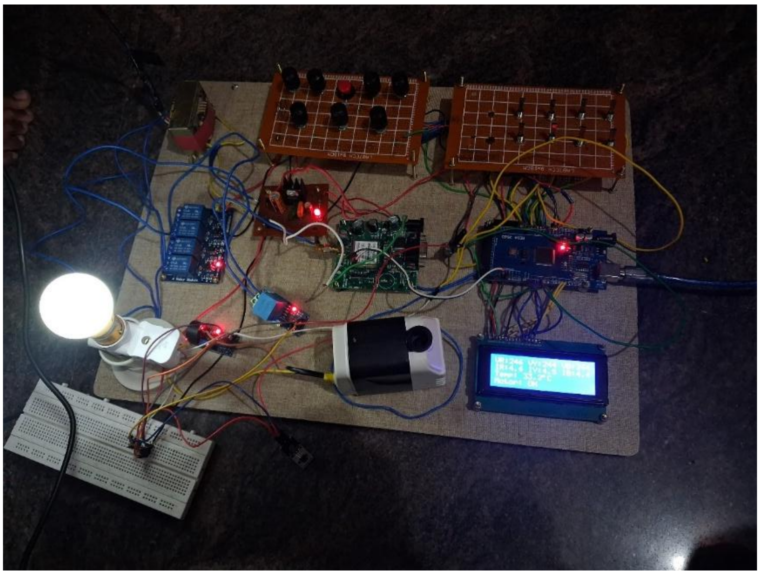

Figure 4.6 Motoron when the sensor values are normal

Our system works on 2 modes, one mode is pot mode and other is sensor mode. In above images 1 to 5 we used pot mode, since we cannot show faults in sensor mode and sensor values cannot change . So we use pot mode to simulate sensors and show faults and how our system behaves in those fault conditions. In this output we used manual on/off switch to turn ON the motor. It works same as the SMS , the system checks is the parameters are within range and if yes, then it turns on the motor.

7. Manual motoroff when operating in sensor mode

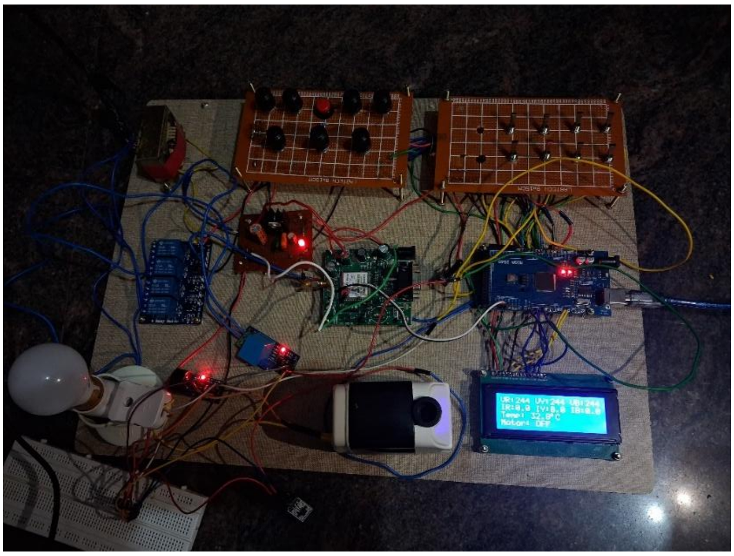

Figure 4.7 Motorff when the sensor values are not in range

Manual motor off command is used to turn off the motor. Same as in SMS motoroff, this also shuts down the motor immediately without checking any conditions. We tested this in sensor mode to show that manual turn on and off works perfectly when the system is working with real world data.

CHAPTER-5

ADVANTAGES, DISADVANTAGES AND APPLICATIONS

5.1 ADVANTAGES:

1. Remote Accessibility via GSM: Motor can be controlled from anywhere using a basic SMS, no need for internet or physical presence.

2. Real-time Monitoring: LCD shows live voltage, current, temperature, and motor status, aiding quick diagnostics.

3. Threshold-Based Safety: Motor only turns on when all conditions are within safe operating limits, preventing damage.

4. Cost-Effective: Uses affordable components like Arduino, GSM 900A, and common sensors; suitable for budget-sensitive applications.

5. User-Friendly Interface: Easy-to-understand LCD display and manual switch add redundancy and usability.

6. Scalability: Can be expanded to include more sensors, relay control for multiple motors, or even data logging via SD card.

7. Low Power Requirement: The system consumes very little power, ideal for solar-powered or backup-operated setups.

5.2 DISADVANTAGES:

1. No Internet or Cloud Features: Lacks advanced connectivity like Wi-Fi or IoT cloud integration for real-time analytics or dashboard viewing.

2. GSM Network Dependency: SMS-based communication relies entirely on mobile network availability and signal strength.

3. Security Limitations: SMS control is simple but lacks encryption or authentication unless specifically implemented.

4. Basic Display Capacity: Limited space on a 20x4 LCD restricts how much data can be shown at once, even with page rotation.

5. No Data Storage: System doesn't store historical data unless external memory modules (SD card) are added.

6. Limited Control Logic: Arduino handles basic logic; for more complex motor control (e.g., speed, direction, fault logging), a PLC or advanced MCU may be needed.

5.3 APPLICATIONS:

1. Industrial Manufacturing Plants

Factories using heavy motors for conveyor belts, compressors, CNC machines, etc. can benefit from remote monitoring and control to prevent overloading and overheating.

2. Agricultural Irrigation Systems

Used in farms and rural fields to control water pump motors. Farmers can turn the motor ON/OFF using SMS without physically traveling to the location.

3. Water Treatment Plants and Borewells

Municipal or private setups requiring continuous pumping of water can use this system for fault monitoring (like dry run, overheat, or overcurrent) and remote motor activation.

4. Cold Storage Warehouses

Motors used in refrigeration units can be monitored to ensure voltage and current stay within safe ranges and prevent breakdowns due to overheating.

5. Unmanned or Remote Installations

Ideal for remote oil fields, wind turbines, or telecom towers where personnel aren't always available but motor operation is critical.

6. Construction Sites

Temporary setups using generator-powered motors for lifting, cutting, and water pumping can use this system for safety and control without needing complex wiring.

7. Solar-Powered Pumping Systems

Ensures solar motors only run when voltage and current are stable and prevents running under low sun or overload conditions, especially important in off-grid areas.

8. Railway Stations and Signal Boxes

Motorized gates, fans, and water pumps can be managed and monitored remotely, reducing manual intervention and improving safety.

9. Fire Safety and HVAC Systems

Monitoring of exhaust fans or cooling motors in high-risk areas (like server rooms or power rooms) for early detection of anomalies.

CHAPTER-6

CONCLUSION AND FUTURE SCOPE

6.1. CONCLUSION:

This project provided valuable hands-on experience in integrating sensor inputs with a microcontroller and using GSM communication for remote monitoring and control of an industrial motor system. Through this work, I gained a clear understanding of how analog signals from voltage, current, and temperature sensors are read and processed by the Arduino Mega, including the importance of scaling these inputs properly for accurate measurements.

The use of threshold limits for voltage, current, and temperature ensures the motor operates safely within its designed parameters. Implementing real-time fault detection and automatic SMS alerts helped highlight the critical role of proactive monitoring in preventing equipment damage. Controlling the motor via SMS commands and displaying status updates on a 20x4 LCD also demonstrated effective user interaction with embedded systems.

Simulating sensor outputs using potentiometers was especially useful for testing and calibrating the system without the need for actual industrial sensors. This approach made it easier to explore different fault scenarios and verify that the safety logic worked correctly under varying conditions.

Looking ahead, the project can be extended by adding features such as automatic fault logging, integration with IoT platforms for cloud-based monitoring, and enhanced security measures for SMS command verification. Overall, this project laid a solid foundation for understanding industrial automation concepts and embedded system design, providing practical skills that are applicable to real-world industrial environments.

6.2. FUTURE SCOPE:

The current system offers robust control and monitoring for industrial motors using GSM and SMS-based communication. However, as industries shift toward Industry 4.0 and smart automation, there are several meaningful directions in which this project can evolve.

1. IoT Integration (Internet of Things)

Replacing GSM-based communication with IoT protocols (such as MQTT or HTTP over Wi-Fi or cellular modules like ESP32 or SIM7600) would enable real-time, continuous data streaming to cloud platforms like AWS, Azure, or Blynk. This would give plant operators a live dashboard on their smartphones or PCs, enabling them to monitor voltage, current, temperature, and motor status from anywhere in the world — not just via SMS.

2. Cloud-Based Data Logging and Visualization

By sending sensor data to a secure cloud database (Firebase, ThingsBoard, or InfluxDB), users can:

- Track long-term performance trends,
- Visualize fluctuations over time using graphs,
- Export logs for audits, maintenance, or compliance reports,
- Detect early signs of system degradation.

This upgrade would transform the system from reactive (responding to faults) to proactive and data-driven.

3. AI-Powered Predictive Maintenance

Integrating machine learning algorithms can help identify patterns in voltage or current fluctuations that indicate worn-out components, unbalanced loads, or environmental stress. An AI model trained on historical sensor data can predict:

- When a motor might fail,
- If the system is being overloaded frequently,
- Whether specific faults tend to occur under certain conditions (e.g., time of day, humidity, load levels).

This allows industries to prevent unplanned downtime, reduce repair costs, and schedule maintenance optimally.

4. Mobile App and Web Dashboard

Instead of SMS-based control, a dedicated Android/iOS app or web dashboard can be developed. This would offer:

- Graphical status display,
- Touch-based motor ON/OFF controls,
- Alerts via push notifications instead of SMS,
- User login with role-based access control (operator, admin, engineer, etc.).
- This kind of interface greatly improves user experience and accessibility.

5. Energy Efficiency and Power Factor Monitoring

- By integrating power meters or additional sensors, the system could:
- Measure real-time energy consumption
- Track power factor and suggest optimizations,
- Identify phases drawing unbalanced current (a sign of inefficiency or wiring faults),
- Report on carbon footprint or energy wastage — aligning with global green energy goals.

This makes the system suitable for sustainable industrial environments.

6. Multi-Motor and Industrial Expansion

The architecture can be expanded to monitor and control multiple motors simultaneously, each with their own sensor set. A centralized controller (e.g., Raspberry Pi or industrial PLC) can manage dozens of motor units across a plant, turning the current design into a complete industrial automation solution.

7. Security Enhancements

As control shifts to the cloud or app-based interfaces, security becomes crucial. Future versions can implement:

- Encrypted communication protocols (e.g., HTTPS, TLS),
- Two-factor authentication for remote commands,
- Tamper detection and alert systems for physical hardware.

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