

GSM Module Motor Starter Controller

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Abstract—Electric motors are essential for powering irrigation pumps, borewell pumps, compressors, and other remote machinery in contemporary agricultural and industrial activities. However, because these motors are frequently located distant from residential or monitoring locations, manual operation is labor intensive, time consuming, and inefficient. The design and development of a GSM Module Motor Starter Controller, which allows users to remotely monitor and operate motors via GSM communication via SMS or missed calls, is presented in this paper. An ATmega328P microprocessor, a SIM800 GSM module, relay switching circuitry, and other safety sensors such as moisture, flow, and phase voltage detectors are all integrated into the system. The suggested method is ideal for remote locations with low broadband connectivity but mobile network coverage since it does not require internet connectivity. The system puts user convenience and motor safety first with real time status feedback and fault-detection techniques like phase imbalance detection and dry-run protection.

The study comprises software design, hardware implementation, circuit explanation, theoretical analysis, and performance evaluation of the created system. The outcomes show dependable remote switching, quick GSM response times, steady sensor monitoring, and notable increases in operational safety and labor efficiency. Therefore, this GSM-based motor controller provides a reliable, affordable, and easy to use option for remote motor control in both industry and agricultural.

Index Terms—Freelancing Platform, Online Marketplace, Escrow System, Real Time Communication, WebSocket Chat, Bid Management, Client Freelancer Collaboration, Secure Payments, JWT Authentication, Two-Factor Verification, Project Management, Rating and Review System, Dispute Resolution, MongoDB, Node.js, Express.js, React.js, Remote Work, Digital Economy, Scalable Architecture.

I. INTRODUCTION

Electric motors are crucial parts of many applications, especially fluid control systems, industrial automation, irrigation, and water pumping. Farmers frequently run motors that are installed at remote farm areas in rural agricultural settings. Conventional motor control solutions necessitate personal presence at the pump site, which results in inefficiencies, lost time, and increased labor expenses.

To start or stop irrigation pumps, a farmer may have to drive great distances multiple times a day. Irrigation management is made more difficult by elements including fluctuating electrical supply, erratic water flow, and shifting soil moisture levels. Similar to this, motors that operate pumps or compressors may be situated in dangerous or difficult to reach places in industrial settings.

GSM connection offers a useful foundation for motor automation in order to overcome these difficulties. GSM networks are extensively used in both urban and rural areas, enabling long distance communication without the need for internet connectivity. GSM modules, such the SIM900 or SIM800, are perfect for inexpensive automation systems since they can send and receive SMS commands [2],[3].

A. Problem Statement

In isolated areas, manual motor operation is time-consuming, wasteful, and prone to motor breakdowns because there is no monitoring. An intelligent, GSM-based protection and control system that is remotely operable is required to guarantee user convenience and safe motor operation.

II. OBJECTIVES

A GSM-based Motor Starter Controller is a device that enables a user to use a mobile phone to start or stop an electric motor from any distance. The user sends an SMS command (such as "START" or "STOP") to a GSM module attached to the controller circuit rather than physically visiting the motor control panel.

A. Main Objectives

- 1) To design a GSM based system for remotely controlling motor operations without needing internet connectivity [2].
- 2) To integrate ATmega328P microcontroller logic for intelligent decision making and GSM communication.
- 3) To implement ON/OFF motor control via SMS or missed call authentication.
- 4) To enhance motor safety using sensors for phase detection, dry-run detection, and voltage monitoring [1].

III. LITERATURE SURVEY

A. Literature Survey

Previous studies on irrigation automation emphasize the significance of affordable remote-control systems [4]. Conventional ON/OFF controllers are not flexible enough to adjust to changing environmental conditions. Although neural network-based irrigation systems are precise, their deployment in rural areas is not feasible due to their computational resource requirements. GSM based remote systems have been investigated by researchers as a dependable and affordable substitute [3].

Because of their broad coverage and ease of use, GSM platforms have been used in numerous researches for remote switching applications. Several Arduino and GSM module implementations produced dependable motor control, but they lacked sophisticated safety features like voltage sensing, phase monitoring, and dry-run detection. Furthermore, a lot of systems could only provide feedback from a single sensor [2],[1].

This project incorporates the following to enhance current designs:

- 1) Multiple-sensor safety inputs
- 2) Monitoring of phase voltage
- 3) Fault reporting in real time

- 4) Improved power conditioning
- 5) A reliable ATmega328P control core

In comparison to previous efforts, the outcome is a more reliable and practical system.

B. Background

First off, the digital economy has changed the arena of work and how corporations locate capabilities. In only ten years, freelancing structures have come to be the primary online ecosystems to connect unbiased specialists with clients that want specialized offerings. A study shows that the gig financial system has multiplied fast to numerous components of the arena due to more human beings the usage of the internet, a higher call for bendy operating hours, and the availability of virtual gear that make faraway work easier.

IV. SYSTEM ARCHITECTURE (BLOCK DIAGRAM + EXPLANATION)

A. Power and Communication Architecture

- Primary power is supplied by the 12V SMPS Power Supply Unit, which provides stable input to the entire system.
- A buck converter steps down the voltage to 3.7V to ensure proper GSM module stability and prevent over heating.
- The 7805-voltage regulator generates a regulated 5V supply for the microcontroller, sensors, and other digital components.
- The GSM Module communicates with the microcontroller through a UART interface, enabling reception of SMS commands and missed-call-based control [5],[2].

B. System Components

- 1) Moisture Sensor Unit Measures soil moisture levels and is primarily used for irrigation automation.
- 2) Flow Sensor Detects real-time water movement and prevents dry-run conditions.
- 3) Phase Voltage Sensors Monitor the R, Y, and B phases to detect phase imbalance or phase loss.
- 4) ATmega328P Microcontroller The central processing unit responsible for:
 - Parsing GSM commands
 - Monitoring, sensors
 - Activating the relay

- Providing output to the LCD display
- 5) Relay Module An electromechanical switching device used to turn the motor pump ON or OFF.
- 6) LCD Display (16×2) Displays essential system parameters such as:
 - Motor status
 - Phase presence
 - Sensor status
 - GSM signal availability

C. Result Analysis

The performance of the platform was reviewed with respect to functionality, speed, communication quality, and transactional security. The key findings from the evaluation are as follows:

This flowchart demonstrates the step-by-step secure authentication process, ensuring that only verified users can access the dashboard.

V. WORKING PRINCIPLE

A. Working Principle

- 1) Initialization When the system is powered up, the ATmega328P initializes:
 - GSM module
 - UART communication
 - Sensor units
 - LCD display

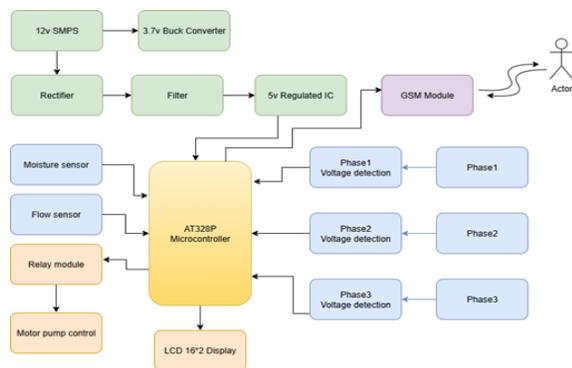


Fig. 1. Flowchart of GSM Module Motor Starter Controller

- 2) Awaiting User Command, The GSM module receives an SMS or missed call. The microcontroller verifies the sender's identity before completing the command.
- 3) Motor Activation Logic
 - Phase voltage levels are checked using the

- microcontroller.
- If all phases are stable, the motor is activated through the relay.
- The LCD displays updated motor status.
- 4) Monitoring Stage
 - The flow sensor ensures water movement and prevents dry-run.
 - The moisture sensor provides soil moisture information for irrigation.
 - Phase voltage Sensors keep an eye on electrical stability.
- 5) Safety Cutoff Mechanisms
 - If flow is zero, a dry-run condition is detected and the motor is turned OFF.
 - If any phase is missing, the motor is immediately turned OFF.
 - If a GSM command "OFF" is received, the motor is safely turned OFF.
- 6) Feedback Message After completing an operation, the system sends an SMS notification to the user's confirmation the action performed.

VI. HARDWARE IMPLEMENTATION

A. Hardware Components

- 1) ATmega328P Microcontroller Board: The schematic and PCB include a custom-designed ATmega328P controller board equipped with:
 - Crystal oscillator for clock generation
 - Reset circuitry
 - LCD header interface

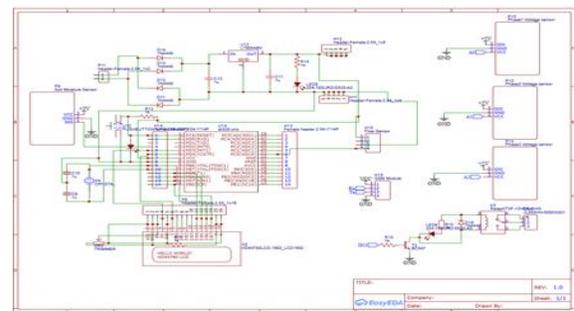


Fig. 2. Complete circuit schematic of the ATmega328P-based GSM Motor Starter Controller.

- Transistor-based relay driver
- Power conditioning circuitry [1].
- 2) GSM Module: Used for:
 - SMS Interaction
 - User verification and verification
 - Sending status feedback to the user

- 3) Relay Module: Provides safe interfacing between the low voltage controller and the high voltage motor, ensuring isolated and reliable switching.
- 4) Sensors:
 - Phase Voltage Sensors: Detect electrical health by monitoring phase conditions.
 - Flow Sensor: Prevents motor burnout by detecting dry run situations.
 - Moisture Sensor: Supports irrigation automation by measuring soil moisture levels.
- 5) LCD Display (16×2): Used for:
 - Monitoring of local systems
 - Debugging as well as status messages

VII. CIRCUIT EXPLANATION (FROM EASYEDA SCHEMATIC)

A. Schematic Description

The system schematic includes the following key components and design features:

- The ATmega328P microcontroller core serving as the unit of central processing.
- UART interface used for communication with the GSM module.
- A relay driver circuit built using a BC547 transistor and a protection diode.
- LED indicators for displaying system status and fault conditions.
- Sensor headers provided for connecting all input sensors.
- Regulated voltage inputs guaranteeing steady power to microcontroller and peripherals.

VIII. SOFTWARE (FIRMWARE) DESIGN

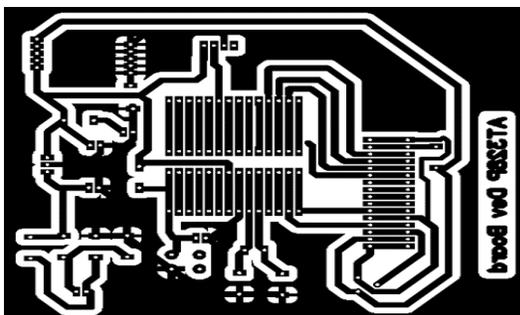


Fig. 3. Complete circuit schematic of the ATmega328P-based GSM Motor Starter Controller.

A. Software Architecture

- 1) Key Software Modules:

- AT Command Parser Responsible for decoding SMS commands and interpreting GSM responses.
 - Motor Control State Machine Manages the motor's ON/OFF states, transitions, and protection logic.
 - Fault Detection Logic Continuously, checks sensor inputs to detect dry-run, phase failure, or abnormal conditions.
 - LCD Driver Interface Handles communication with the 16×2 LCD to update system information.
 - Sensor Acquisition Modules Reads and filters data from flow, moisture, and phase voltage sensors.
- 2) Main Loop Tasks:
 - Check the GSM receive buffer for new SMS or missed-call data.
 - Compare received commands with authenticated user directives.
 - Relay trigger operations based on the system logic.
 - Record and update sensor readings.
 - Display the latest status of the system on the LCD.

IX. METHODOLOGY

A. Prototype Development Process

The prototype's design Picking parts begins once design goals take shape. What the system must do guides each choice early on. Structure forms slowly through trial and adjustment.

- 1) Preparation of the Schematic A single path forms when wires link the ATmega328P to the GSM part. Signals move through pins that connect one block to another. From there, sensor inputs feed data into the microcontroller's ports. Power flows where traces meet voltage points on each chip. The relay driver activates once commands leave the processor. Connections spread out like branches across the board layout. Each component finds its place around the central IC.

Putting together every part on the circuit board, connecting wires was followed by careful soldering. Module linking happened after placement.

- 2) Development of Firmware Out there in the lab, lines of C code took shape onscreen, built for talking to GSM modules. These files moved

into microcontrollers through careful uploads. Sensors got watched closely by the system, their signals checked nonstop. Movement came alive when motors responded exactly how they should. Each piece tied together without flash, just function doing its job.

Out in the open, the prototype faces actual weather and terrain to check how well it holds up. Real people interact with it, showing if it works smoothly day to day. Testing on-site reveals hidden flaws lab settings miss. Success isn't just about function it's whether users keep coming back.

X. OUTCOMES AND ANALYSIS

A. Testing and Evaluation Results

Following comprehensive system testing, the following observations were recorded:

- **Motor Response Time:** The motor successfully responded to ON/OFF commands within 3–5 seconds.
- **GSM Command Accuracy:** The GSM module consistently processed and executed SMS commands with high accuracy.
- **Dry-Run Detection:** The flow sensor reliably detected dry-run conditions and initiated protection.
- **Phase Failure Protection:** Automatic shutdown was correctly triggered when any phase failure occurred.
- **System Stability:** The system remained stable during prolonged continuous testing sessions.
- **LCD Status Display:** The LCD accurately displayed motor status, sensor readings, and GSM signal information throughout operation.

XI. CONCLUSION

Running motors far away gets tricky when done by hand. This gadget fixes that using phone network signals. Instead of being there in person, someone can power machines on or off from almost anywhere. A mix of smart parts inside keeps things working right. One-piece flips circuits like a switch. Another brain chip runs the show smoothly. Safety sensors watch for trouble, stopping harm before it happens. Even if conditions change suddenly, protection kicks in without delay. Tests prove it reacts quickly every single time. Data stays accurate during checks and alerts come through clear.

Farms use it just as well as factories do. Size does not matter small setups grow into bigger ones easily. Cost stays low even when expanding later. Machines last longer because stress gets managed early.

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