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IoT-Based DOL Starter for 3-Phase Water Pump in Agriculture

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Abstract- In agriculture, 3-phase motors are used to run water pumps for irrigation. Farmers usually have to go to the field every time to turn the pump ON or OFF, but electricity in rural areas is not available all the time, especially at night. This causes time loss, fuel wastage, and inconvenience. Also, if the motor runs during problems like single-phasing, low voltage, high voltage, dry running, or overheating, it can get damaged. This project provides a smart solution by allowing farmers to control the pump using their mobile phone from anywhere. The ESP32 microcontroller and BLYNK app are used to switch the pump ON/OFF remotely. A phase identification circuit checks if all three phases are available before starting the motor to prevent damage. The system sends real-time notifications to the user and protects the motor from electrical faults. This makes irrigation easier, safer, and more efficient while saving time and effort for farmers.

Keywords: *Step Down Transformer, ESP32 Microcontroller, Cloud Server, Relay, DOL Starter.*

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I. INTRODUCTION

In day-to-day life, electric motors play an important role in both domestic and industrial applications. In agriculture, 3-phase induction motors are widely used for operating water pumps to support irrigation. Traditionally, these motors are started and stopped manually using DOL starters, which requires the farmer or operator to be physically present at the location of the pump. However, manual motor control is not always reliable, especially in rural areas where 3-phase power availability is unpredictable and often occurs late at night.

With the advancement of technology, automation and IoT-based control systems have become more efficient and affordable. These developments have created opportunities to replace manual control with remote monitoring systems. In agricultural applications, the ability to remotely start and stop the water pump can save time, fuel, and manpower while ensuring timely irrigation. High-rating motors, however, require safe and protected operation because faults like voltage fluctuations, dry running, single-phasing, and overheating can cause serious damage to the motor, leading to costly repairs and crop loss.

The objective of this project is to design an IoT-based DOL starter that provides both remote control and safety features for a 3-phase agricultural water pump. The system uses an ESP32 microcontroller and Wi-Fi connectivity to allow the farmer to operate the starter from a remote location through a mobile application. A phase identification circuit ensures that the pump is switched ON only when all three phases are available, preventing unsafe operation. The system also provides real-time status feedback, enabling the farmer to monitor motor conditions continuously.

This project offers a dynamic, low-cost, wireless, and user-friendly solution for agricultural motor control. By combining automation, protection, and IoT connectivity, the system improves irrigation efficiency, increases motor safety, and reduces the physical effort involved in managing agricultural pumps.

II. LITERATURE SURVEY

- Y. Kim, R. Evans and W. Iversen (2008):- In the paper titled “Remote Sensing and Control of an Irrigation System Using a Distributed Wireless Sensor Network” by Y. Kim, R. Evans, and W. Iversen (IEEE Transactions on Instrumentation and Measurement, 2008), the authors developed an advanced irrigation system that uses a wireless sensor network to monitor and control water usage efficiently. Their system deploys multiple distributed sensors across the field to collect

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real-time data on soil moisture, temperature, and other environmental factors. This data is wirelessly transmitted to a central controller, which analyzes the information and automatically adjusts irrigation schedules to optimize water use. The approach aims to improve water conservation, reduce labor, and enhance crop yield by ensuring irrigation is applied only when and where it is needed. The system demonstrates the practical benefits of integrating wireless sensor networks into agriculture for precise and automated irrigation management.

- Poornima Mahesh, Pramod Raut (2017):- The literature survey in this paper reviews existing technologies and methods related to automated irrigation systems, focusing on the integration of IoT and GSM modules for remote monitoring and control of water pumps to improve agricultural efficiency. It discusses systems using microcontrollers like the ATMEGA16 to automate pump operation by monitoring soil moisture and water levels. The survey also highlights the use of solar power to address electricity shortages in rural areas and emphasizes the importance of security measures to prevent unauthorized access. Real-world examples such as the Nano Ganesh system demonstrate the practical benefits of these technologies. The proposed system combines these elements by using a microcontroller that interfaces with sensors and a GSM module to control the pump based on soil moisture readings or SMS commands. Solar power supplies ensure continuous operation even without reliable electricity, making the system ideal for remote farming areas. This approach helps automate irrigation, conserve water, reduce labor, and provide farmers with convenient remote control over their water pumps.

- Muthineni, K., Yalagonda, (2020) :- The authors developed a low-cost, automated motor starter unit that allows farmers to control their irrigation water pumps remotely using a GSM module. The system was designed to address key issues in Indian agriculture, such as unreliable electricity supply, difficulty in accessing far-off agricultural fields, and manual labor dependency. The motor control unit uses a microcontroller (like Arduino or PIC) to interface with the GSM module and relay circuits to switch the pump ON or OFF. Farmers can send an SMS to the system to activate or deactivate the motor, and the system also responds with status updates. The project emphasizes automation, ease of use, and cost-effectiveness, making it suitable for small and marginal farmers. Overall, this system enhances water management, conserves electricity, and reduces physical effort, aligning with the goals of smart farming in India.

- Nigar Sultana, S k Khairul Alom (2023) :-The paper by Nigar Sultana and S k Khairul Alom focuses on the design and implementation of an Arduino-based control system for a three-phase induction motor. The system incorporates star-delta starting to reduce the high starting current and mechanical stress on the motor by initially connecting the motor windings in a star configuration and then switching to a delta configuration after the motor starts running. Additionally, the system enables easy forward and reverse direction control of the motor through Arduino programming, allowing the motor to change its rotation direction as needed. To enhance safety and reliability, the design also includes fault protection features that detect motor faults such as overloads or short circuits and take necessary actions to prevent damage. This integrated approach simplifies motor control and improves efficiency, making it suitable for industrial applications where automated and safe motor operation is essential.

III. BLOCK DIAGRAM AND IT'S EXPLANATION

➢ *Working:*

The ESP32 gets 5V DC from the regulated power supply and uses it to operate the controller section of the circuit. The 230V AC input supply is stepped down by the SMPS to provide 12V DC, which is used to power the magnetic relay / relay driver module. The relay driver controls the 3-phase contactor coil that switches the 3-phase supply to the water pump motor.

The auxiliary contact (230V AC) of the contactor is fed back to the ESP32 so that the controller can accurately monitor the motor's ON/OFF status.

Since 3-phase power is not always available in agricultural locations, a Phase Identification

Circuit is included to detect the presence of the R, Y, and B phases. When 3-phase supply becomes available at the pump point, the ESP32 senses it and immediately sends a notification to the user through the BLYNK app, allowing the farmer to avoid unnecessary travel to the field.

When the user presses the ON command in the BLYNK app, the ESP32 receives the command over Wi-Fi and triggers the 12V magnetic relay, which completes the 230V AC path to the contactor coil. This energizes the contactor and allows the 3-phase supply to reach the pump motor, causing the pump to start. When the OFF command is sent, the ESP32 de-energizes the relay, cutting the supply to the contactor coil, and the contactor switches OFF, stopping the motor immediately.

Throughout the operation, the ESP32 continuously monitors phase availability, motor status, and electrical parameters (if sensors are provided) and updates all information in real time to the BLYNK app, ensuring safe and reliable remote control of the 3-phase agricultural water pump.

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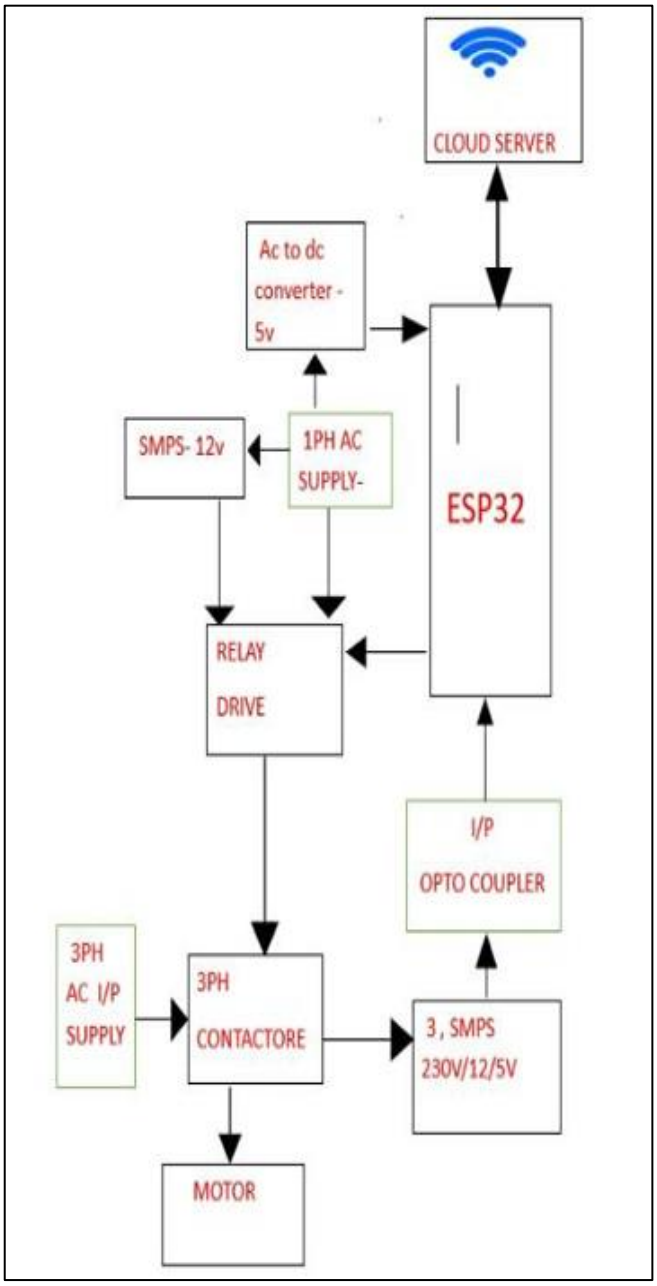

Fig 1 IoT Based Dol Starter for 3 Phase Water Pump in Agriculture

A. Advantages

➢ *Remote Control of Pump*

- The farmer can switch the water pump ON or OFF from anywhere using the BLYNK mobile app.
- This removes the need to visit the field every time, saving time and effort.

➢ *Automation and Smart Monitoring*

- The pump system operates automatically based on commands and real-time feedback from sensors.
- The farmer receives continuous updates on pump status and power availability on the mobile phone.

➢ *Motor and Equipment Protection*

- The system protects the pump from faults such as single-phasing, dry running, overheating, and voltage fluctuations.
- Automatic shutdown during unsafe conditions prevents equipment damage and reduces repair cost.

➢ *Suitable for Rural Areas*

- The system works using Wi-Fi and mobile networks available in o -most villages.
- It is designed to overcome problems like long-distance farms and irregular power supply.

➢ *Energy and Water Saving*

- The pump runs only when required and turns OFF immediately during faults, preventing wastage.
- This increases irrigation efficiency and reduces electricity bills and water consumption.

➢ *Phase Identification*

- The OPTO coupler-based sensing circuit checks the presence of all three phases before starting the motor.
- This avoids single-phasing and ensures safe operation of the 3-phase agricultural water pump.

B. Applications

➢ *Smart Irrigation for Agriculture:*

This system allows farmers to remotely turn ON/OFF the water pump using a mobile phone via BLYNK IoT, even from far away. It solves the problem of manual pump operation in remote fields, especially where 24x7 electricity is not available.

➢ *Fault Protection in Motor Operation:*

By using voltage, current, and temperature sensors, the system provides automatic protection against:

- Over-voltage or under-voltage conditions
- Dry running (when the pump runs without water)
- Motor overheating

➢ *Power-Efficient Water Management:*

Using real-time sensor data, the system ensures that the motor only runs when needed, saving electricity and water. It prevents unnecessary pumping and improves energy efficiency.

➢ *Reduction of Manpower and Field Visits*

Eliminates frequent physical visits to pump locations, saving time, fuel, and labor.

➢ *Rural and Village Water Supply Systems*

Can be used to operate community water pumps from a remote location, improving water distribution management.

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IV. CONCLUSION

The IoT-Based DOL Starter for a 3-Phase Water Pump in Agriculture successfully enables farmers to remotely control and monitor their irrigation pump using a mobile application. The ESP32 controller, along with the BLYNK platform, provides real-time communication and status updates, eliminating the need for physical visits to the farmland. The inclusion of a phase identification circuit ensures that the pump is operated only when all three phases are available, preventing damage to the motor and improving safety. By automating pump control and providing remote accessibility, the system saves time, fuel, and labor while increasing efficiency and convenience in agricultural irrigation. Overall, this project offers a smart, reliable, and cost-effective solution for modern farming and rural water management.

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