Smart Three Phase Induction Motor Panel for Agricultural Pump Set

Neha B. Dharmik
Department of ElectricalEngineering
JSPM Rajarshi Shahu College of Engineering Pune, India nehadharmik1234@gmail.com
Manjusha A. Kanawade Department of ElectricalEngineering JSPM Rajarshi Shahu College of Engineering Pune, India makanawade_elec@jspmrscoe.edu.in

Tejashree G. Rajguru
Department of ElectricalEngineering JSPM Rajarshi Shahu College of Engineering Pune, India tejashreerajguru09@gmail.com
Sanjay A. Chaudhari
Electronics Study Center Nashik, India escelectronics@gmail.com

Harshada N. Chavan
Department of ElectricalEngineering JSPM Rajarshi Shahu College of Engineering Pune, India harshdachavan58@gmail.com

***Abstract*—Globally, technology has advanced as systems have transitioned from manual to automated. This essay discusses thesmart control panel that operates the appliances. The LM35 temperature sensor, auto switch, MCB, star delta starter, and soil moisture sensor are all integrated into the design of a smart three-phase induction motor panel. Energy consumption is optimized by the auto switch, which facilitates a smooth transition between power sources. By facilitating a smooth motor start-up, star delta starters lessen mechanical stress. Circuit protection against overloads is provided. The LM35 and soil moisture sensor work together to monitor environmental factors, enabling temperature and irrigation control that is automated.**

Keywords—auto switch, controlling, malfunctioning, 3 phase induction motor panel, soil moisture detection, temperature sensor.

I. INTRODUCTION

In emerging nations, agriculture serves as the foundation of the economy and plays a major part in it. Typically, this system uses sensors to collect data on variables including crop requirements, weather, and soil moisture levels. By using this information, the intelligent irrigation system may self-adjust the quantity of water that crops receive, reducing wasteful water use and increasing agricultural yields [1]. An intelligent irrigation system makes use of automation and sensors to maximize water use in farming. It maximizes crop productivity by accurately delivering water when and where it is needed, minimizing waste, by keeping an eye on variables including soil moisture, weather, and plant requirements. Intelligent irrigation systems improve productivity, preserve water, and support environmentally friendly agricultural methods. They constitute a significant development in contemporary agriculture, reducing environmental impact and guaranteeing food security for an expanding population, with scalable solutions appropriate for a range of agricultural situations [2]. The book gives the complete construction and building up panel for three phase induction motor this includes complete specification of each component as per requirements. [3]. The article "Arduino-Based Dry Run Protection for Water Pumps" describes how to identify and stop dry run situations in water pump systems using Arduino microcontrollers. When the pump is operating without water, the system can detect it and prevent harm by using sensors to track water levels or pump performance.

Real- time monitoring and automated shutdown procedures are used to guarantee effective pump performance and prolong equipment life. This creative approach lowers maintenance costs and improves dependability, making it a useful tool for home, commercial, and agricultural water management applications [4]. Water pumps with dry running protection avoid harm by identifying when the pump is not operating with water. It uses sensors to keep an eye on pump performance or water levels, and when it senses overheating or wear,it automatically shuts off. This function guarantees dependable operation in home, commercial, and agricultural water systems whileextending the pump's lifespan and lowering maintenance expenses [5]. Analog sensors provide data as a continuous voltage or current signal by continuously measuring fluctuations in physical parameters such as temperature or pressure. Conversely, digital sensors

provide accurate measurements and are immune to signal noise since they transform physical inputs into discrete digital values. Digital sensors offer accuracy, dependability, and compatibility with digital systems, while analog sensors are more straightforward and economical [6]. For programming Arduino microcontrollers, the official software is called the Arduino IDE (Integrated Development Environment). This tool provides an easy-to-use interface for creating, gathering, and uploading code to Arduino devices. The Arduino IDE is the recommended tool for Arduino projects because of its capabilities, which make development easier for both novice and expert users. These features include syntax highlighting, code completion, and an integrated serial monitor [7]. To increase agricultural productivity, the study suggests a secure multi-crop irrigation system for smart farming that is based on the Internet of Things. Effective water management for a variety of crop kinds and real- time monitoring are ensured by integrating IoT technologies. [8] Strong security measures are put in place by the system to protect against possible cyber threats and guarantee data integrity and confidentiality. This novel strategy has potential for optimizing and sustainable farming methods [9]. IoT technologyis used in the suggested automated plant watering system to maximize plant care. It allows for automated watering depending on plant requirements and remote monitoring of soil moisture levels using sensor data and connectivity. [10]. This creative method ensures ideal levels of hydration while cutting down on water waste, improving ease and efficiencyin plant care.

II. PROBLEM STATEMENT

Farmers deal with issues with motor dry run, automatic motor operation, efficient power use, and simple motor operation. The motor may become damaged when it is forced to operate solely on dry run when the well's water level drops. Additionally, when crops receive enough water, a motor that is still in operation can cause an excessive amount of water tobe applied to the crops, endangering their health. The health of crops is also affected when ambient temperature rises. This intelligent three-phase induction motor panel, which includes protective and automated elements including an auto switch, a star delta starter, a soil sensor, and an LM 35 temperature sensor, solves all of these issues.

III. PROPOSED SENSORS & EQUPMENTS

The components of the Smart three-phase induction motor panel are displayed in Figures 1–10.

Fig 1. RYB Indicators

Fig 2. Miniature Circuit

Fig 3. Arduino UNO

Fig 4. Dual Channel Relay

Fig 5. LM 35 Sensor

Fig 6. Voltage Frequency Current meter

Fig 7. Auto Switch

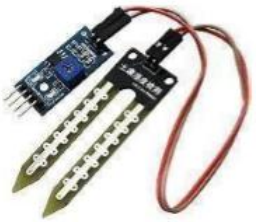

Fig 8. Soil Moisture Sensor

Fig 9. 4 pole contactor

Fig 10. Star Delta Starter

Table. I Components Specification Table

Components	Specification
1)Miniature Circuit Breaker (MCB)	4 pole 63 amp
2)Star Delta Starter	15 hp 415 volt
3) Auto switch	440v
4)Arduino UNO	ATmega328P 5v
5)Dual Channel Relay	Input 5v Output upto 230 v
6)Contactor	3 phase 4 pole
7)Soil moisture sensor	3.3 To 5v
8)LM35 temperature sensor	−40°C to 110°C

IV. METHODOLOGY

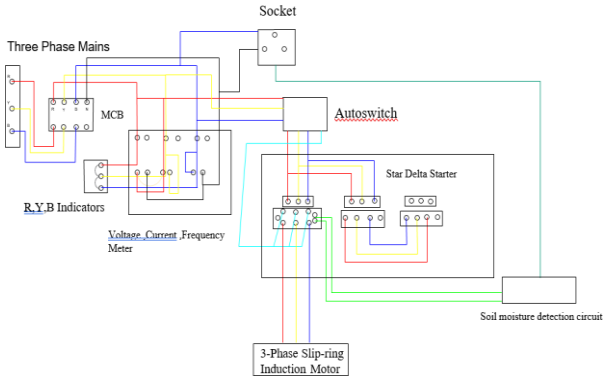

Fig 11. Wiring diagram of Smart three phase induction motor

Three phase mains supply is connected to RYB indicators, as the block diagram illustrates. The voltage frequency current meter (VFC) is connected to the RYB indication supply first, followed by a 4 pole, 64 amp MCB. The auto switch is linked to the supply next, and the Star Delta Starter is attached last. Starter and three- phase slip ring induction motor are linked. In order to control the motor's on/off state based on sensor input, the smart circuit's auto switch output is connected to one of the phases.

All three indicators should light up when the supply is turned on and all three phases are arriving. Next, the voltage frequency and current readings of the incoming three-phase supply are displayed by the VFC meter. An electrical instrument used to measure voltage (in volts), frequency (in hertz), and current (in amperes) is called a voltage, frequency, and current meter. It is necessary to ensure correct operation, avoid equipment damage, and monitor and troubleshoot electrical systems.

MCBs improve system reliability and guard against electrical fires and equipment damage since theyare small, DIN-rail mountable, and have fast response times. International standards such as IEC/EN 60898 are met by them. The automatic Miniature Circuit Breaker is connected

First followed by the auto switch. An automated control device used to regulate the functioning of three-phase electric pumps is called a three-phase auto switch for pumps. It guarantees the pump operates effectively and guards against malfunctions.

.

The automatic Miniature Circuit Breaker is connected first, followed by the auto switch. An automated control device used to regulate the functioning of three-phase electric pumps is called a three-phase auto switch for pumps. It guarantees the pump operates effectively and guards against malfunctions. Protection against phase loss, overload, and voltage imbalances, as well as automatic start and stop based on demand, are important characteristics. The switch is essential in industrial and agricultural contexts because it can manage variable power loads, usually up to several kilowatts. By eliminating manual intervention and preventing dryrunning, it improves operational safety and pump longevity. Adherence to norms such as IEC 60947 guarantees dependability and security in challenging circumstances.

The star delta starter is connected to the auto switch. An electrical device called a star-delta starter is used to lower the starting current of three-phase induction motors. In order to reduce voltage and current, it first links the motor windings in a star (Y) configuration. For normal operation, it then shifts to a delta (Δ) configuration. Both mechanical wear and electrical stress are reduced by this transition. Star-delta starters are widely used in industrial settings and are appropriate for motors ranging in power from several hundred kW to around 5 kW. They meet IEC standards and extend the life of motors while maximizing their energy efficiency.

A three-phase slip ring induction motor is connected to a star- delta starter, which lowers starting current and torque by first setting the motor windings in a star (Y) configuration. It transitions to a delta (Δ) state for full voltage operation after a predetermined amount of time. Three contactors are used in this configuration: one for the delta connection, one for the star connection, and one for the main contactor. For high- power motor applications, it minimizes mechanical and electrical stress during motor initiation and guarantees a smooth operation shown in Figure-11.

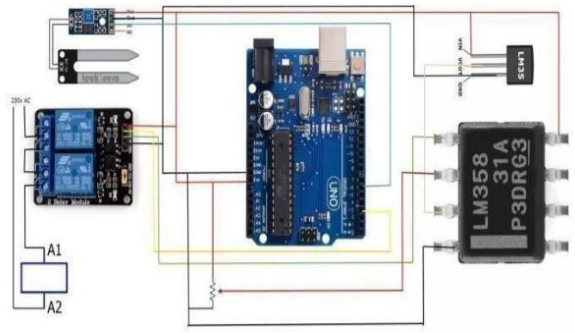

Fig 12. Smart Circuit

Figure-12 shows the smart circuit between the starter and the auto switch in Figure B is connected to one phase. The dual channel relay and Arduino are coupled to sensors such as the temperature sensor and the soil moisture sensor in this smart circuit. Sensor functions are managed by Arduino, which also signals a dual channel relay. The four-pole contactor that regulates the contactor's on/off action is connected to a relay To check the soil's moisture content, soil moisture is first added. To assist with irrigation management, a soil moisture sensor gauges the amount of water in the soil. Usually, two probes are placed into the soil for this purpose. The electrical resistance or capacitance between these probes is measured, and it.

changes with soil moisture content. Increased moisture causes a similar signal by decreasing resistance (or increasing capacitance). A microcontroller processes this signal to produce real-time moisture readings. In order to maximize water consumption and ensure that plants receive enough hydration while preserving water resources, soil moisture sensors are used in gardening, agriculture, and environmental monitoring. It provides dual channel relay with a signal. There are two sets of output connections and two input channels on a dual channel relay. Low- power control signals, usually from a microcontroller or switch, are received by the input channels. A distinct relay coil is activated by each input. The high-power circuit linked to the outputs is completed or broken when the coil's magnetic field is engaged. This is accomplished by closing or opening the relevant output contacts. Two devices can be independently controlled in this configuration, which offers separation and permits automation or remote control of lights, motors, and other equipment.

Additionally, a dual channel relay receives an output from the LM 35 environment temperature sensor, which measures temperature. With a linear output proportional to the Celsius temperature, the LM35 is a precision temperature sensor. Operating temperature range: -55°C to 150°C; sensitivity: 10mV/°C. The sensor offers a linear output, low output impedance, accurate readings (usually ±0.5°C at room temperature), and requires a 4 to 30V power source. Its low self- heating factor ensures that the temperature rises very little. Reliable temperature measurement in industrial applications, HVAC systems, and environmental monitoring are all made possible with the LM35.

The relay's output regulates the contactor's on/off action. An electromechanical switch called a 4-pole contactor is utilized in commercial and industrial settings to regulate power circuits. There are four contact sets in total: one for the neutral line or an auxiliary function, and three for the three-phase power lines (L1, L2, and L3). An electrical control signal energizes the contactor coil, creating a magnetic field that draws in the armature, closing the contacts and permitting current to pass through the circuit. Springs restore the contacts to their open position when the coil is de-energized, stopping the current. This makes it possible to operate high-power equipment safely and dependably. To manage the motor's operation appropriately, this contactor must be linked to a three-phase slip ring induction motor.

Whole this operation is get controlled by Arduino UNO ATmega328P. The Arduino UNO, equipped with the ATmega328P microcontroller, interfaces with a soil moisture sensor and environment temperature sensor. The soil moisture sensor measures soil water content by analyzing electrical conductivity, while the temperature sensor detects ambient temperature variations. The Arduino reads analog signals from these sensors, processes the data using its programming, and displays information or triggers actions, like activating a water pump based on soil moisture or adjusting a cooling system according to temperature. The versatility of the Arduino platform, coupled with the ATmega328P's processing power, enables efficient and customizable environmental monitoring and control applications. When the soil receives sufficient moisture from water, the motor turns off; when the soil becomes dry, it turns on.

V. RESULTS


Fig 12 RYB Indicators & VFC meter

Fig 13 Auto switch power on mode

Fig 14 Auto switch dry run mode

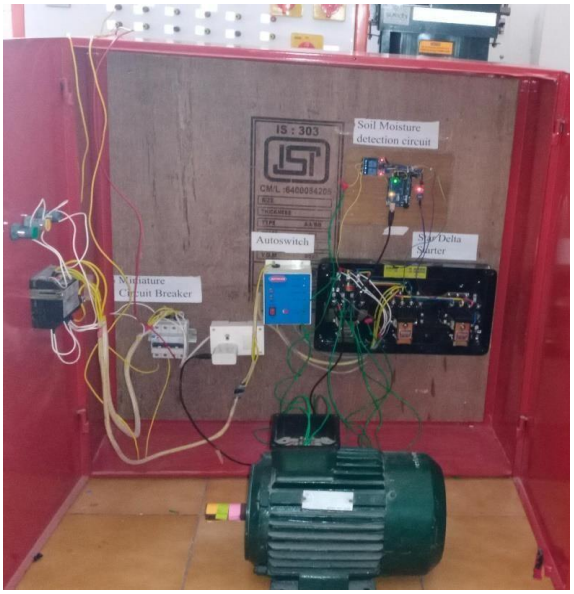

Fig 15 Overall design of panel

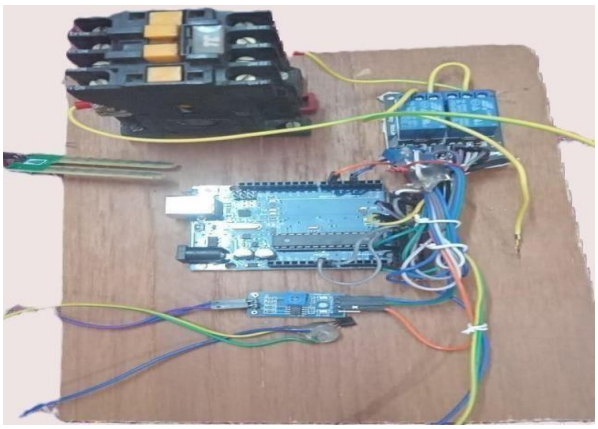
Fig 16 Overall design of smart circuit

When the supply is first turned on, the RYB indicators light up, and the Voltage Frequency Current (VFC) meter displays the voltage, frequency, and current of the incoming supply, in that order as shown in figure-12. When the incoming supply is fault- free, the manual mode of the auto switch is engaged, and the line fault led illuminates figure-13. The motor will start when the previouslyconfigured dry run and unit's led light up to 60 seconds as shown in figure-14.

The motor will be automatically turned off by this auto switch when the water level in the well drops. To facilitate this operation, the autoswitch should be programmed to turn off the motor earlier. Conversely, a soil moisture sensor detects the moisture content of the soil and uses that information to switch off the contactor, which in turn switches off the motor via a dual channel relay.

In a similar vein, when the earth becomes dry, the temperature sensor will detect the surrounding air temperature and activate the engine. The farmer will thus benefit from an automated system that makes it very easy to turn on and off the motor using sensors, ensuring that the crop receives enough water when it needs it and improving the crop's health in the process. Whole hardware panel for motor control operation is shown in figure-
15. Smart sensors with Arduino is shown in figure-16.

VI. CONCLUSION

An important step forward in industrial automation and agricultural efficiency is the installation of a smart three- phase induction motor panel that includes an auto switch, star delta starter, MCB, soil moisture sensor, and LM35 temperature sensor. The diverse strategy taken by this project tackles a number of issues that are present in both industries and provides answers that improve output, resource management, and equipment longevity.

First of all, by smoothly switching between various power sources, the auto switch feature guarantees a constant power supply. This feature lowers downtime while optimizing energy use, which lowers costs and boosts operational effectiveness. By facilitating a smooth motor start-up, the integration of a star delta starter adds even more to the project's success.Mechanical stress during start-up is reduced by first connectingthe motor windings in a star configuration and then switching to a delta configuration, extending the motor's lifespan and lowering maintenance needs.

Additionally, by offering circuit protection against overloads and short circuits, the addition of an MCB improves safety. This lowers the possibility of damage and possible accidents in industrial settings by guaranteeing the safety of both people and equipment.

The integration of an LM35 temperature sensor and a soil moisture sensor revolutionizes environmental control and irrigation in the agricultural industry. The ability to precisely and efficiently monitor soil moisture levels in real- time maximizes water efficiency and fosters the growth of healthy plants. Concurrently, the temperature sensor facilitates proactive temperature control, guaranteeing ideal growth circumstances for agricultural produce. Through the implementation of these crucial elements of industrial and agricultural operations, this project provides a comprehensive solution that enables enterprises and farmers to adopt sustainable practices, increase productivity, and streamline processes. In addition to improving operational efficiency, smart technologies and advanced automation also support environmental stewardship and resource conservation.

Conclusively, the intelligent three-phase induction motor panel, equipped with its diverse characteristics and sensors, signifies a noteworthy advancement in the modernization of industrial and agricultural methodologies. Its influence goes beyond simple automation; it helps to build a future that is more robust and sustainable for both industries.

REFERENCES

[1]. N Sudharshan, AVS Kasturi Karthik, JS Sandeep Kiran, S. Geetha, Renewable Energy Based Smart Irrigation System, Procedia Computer Science,Volume165,2019,Pages 615-623,ISSN 1877-0509, https://doi.org/10.1016/j.procs.2020.01.055.(https://www.sciencedirect.com/science/article/pii/S187705092030 0636)

[2]. El Mezouari, Asmae & Fazziki, Aziz & Sadgal, Mohammed. (2022). Smart Irrigation System. IFAC-PapersOnLine. 55. 3298-3303. 10.1016/j.ifacol.2022.10.125.

[3]. S. S. A. Choudari, Me and my pump booklet.

[4]. K S, Fahad. (2020). Arduino Based Dry run protection for Water Pumps. 10.13140/RG.2.2.34820.55685/1.

[5]. Cai, Guanxing., Cao, Liangzhi, Yang, Hongliang. (2012). Novel dry running protection water pump.

[6]. Chakraborty, J. (2020) Analog Sensors Vs. DigitalSensors.Available at: https://iot4beginners.com/analog- sensors-vsdigital- sensors/.

[7]. Fezari, M. and Dahoud, A. Al (2018) 'Integrated Development Environment " IDE " For Arduino', ResearchGate, (October).

[8]. Moorberg, C. J. and Crouse, D. A. (2021) 'Soil and Water Relationships', Soils Laboratory Manual. New Prairie Press

[9]. Samawi, V. W. (2021) 'Smcsis: An iot based secure multicrop irrigation system for smart farming', International Journal of Innovative Computing, Information and Control.

[10]. Shah, K., Pawar, S., Prajapati, G., Upadhyay, S. and Hegde,G. (2019) 'Proposed Automated Plant Watering System Using IoT', SSRN Electronic Journal.