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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

OPTION OF ELECTRICAL TECHNOLOGY

Final Year Project

DESIGN AND IMPLEMENTATION OF SMART WATER PUMPING SYSTEM FOR COMMERCIAL BUILDING

Final Year Project Submitted in Partial Fulfillment of the Requirement for Award of Advanced Diploma in Electrical Technology

Submitted by:

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Kigali, October 2024

DECLARATION - A

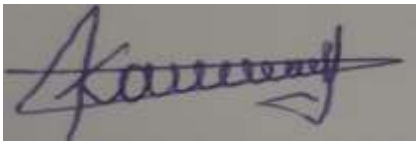
I **KWIZERA GIFT** Declare that This research study is my original work and has not been presented for a degree or any other academic award in any University or Institution of Learning". No part of this research should be reproduced without the authors' consent or that of Ulk Polytechnic Institute.

Sign: _____ Date: _____

DECLARATION-B

I confirm that the work reported in this research project was carried out by the candidate under my supervision and it has been with my approval as the UPI supervisor.

Supervisor name: Mr. KARANGUZA FRANCOIS

Signature:  Date:21/10/2024

DEDICATION

I dedicate and thank my Almighty God for his guidance, grace and mercy throughout life time. This project is dedicated to my parents who have supported us all the way since the beginning of my studies. Also, this project is dedicated to all my lectures who have been a great source of knowledge, motivation and inspiration. Finally, this report is dedicated to all my friends and those had faith in me for the completion of this project, and also, for our fellow juniors who are fresh minds in this college.

ACKNOWLEDGEMENT

I am excited to thank God Almighty for unconditional love and overwhelming protection for me from beginning of my studies till now. We are thankful **ULK POLYTECHNIC INSTITUTE** for the skills and knowledge that they have provided to me for better future. We would like to express our deepest appreciation to my **KARANGUZA Francois** who has given a piece of advice and for his great ideas and support that take a huge contribution in my project. Without his supervision and constant help this project would not have been possible. Special thanks to my family and relatives who have contributed on my studies financially and in prayers so that we can achieve my goals. I appreciate your support God bless you abundantly.

ABSTRACT

Wastage of water and electricity as results of overflow of water from water storage tank during pumping of water using electric water pump is a serious challenge in the conservation and storage of water for domestic, industrial and commercial future use. To solve this problem, this paper presents a design and implementation of an automatic electric water pump controller using float switch which is used to detect the level of liquid within a tank and will energize the contactors. The circuit is supplied by a three-phase voltage, lamps will light to indicate that there is power, red lamp will indicate that there is power, green lamp shows that the pump is pumping and yellow lamp shows that the tank is full.

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CHAPTER 1 : GENERAL INTRODUCTION

1.1 Background of the Study

The project “smart water pumping system” is design to monitor the level of liquid in the tank. The system has an automatic pumping system attached to it so as to refill the tank once the liquid gets to the lower threshold, while offing the pump once the liquid gets to the higher threshold. Sustainability of available water resource in many reasons of the word is now a dominant issue. This problem is quietly related to poor water allocation, inefficient use, and lack of adequate and integrated water management. Water is commonly used for agriculture, industry, and domestic consumption. Therefore, efficient use and water monitoring are potential constraint for home or office water management system. Moreover, the common method of level control for home appliance is simply to start the feed pump at a low level and allow it to run until a higher water level is reached in the water tank. This water level control, controls monitor and maintain the water level in the overhead tank and ensures the continuous flow of water round the clock without the stress of going to switch the pump ON or OFF. [1]

1.2 Statement of the Problem

The efficient and sustainable management of water resources is a pressing global challenge. Commercial buildings, with their high consumption rates and often complex operational requirements, play a significant role in this issue. Traditional water pumping systems often suffer from inefficiencies, leading to increased operational costs, water wastage, and environmental impacts [2]. To address these challenges, the design and implementation of a smart water pumping system tailored to commercial buildings is essential. The design and implementation of a smart water pumping system for commercial buildings is a critical step towards addressing the challenges of water resource management and promoting sustainability. By optimizing energy efficiency, conserving water, improving operational efficiency, and reducing costs, these systems can provide significant benefits for both building owners and the environment.[3]

1.3 Research Objectives

1.3.1 General Objective

The general objective of the study is to Desing and implementation of smart water pumping system for commercial building

1.3.2 Specific Objectives

The specific objectives are:

i. Design the system that can detect the water level in the tank
ii. Implement system that can alert when water level in a tank is low
iii. to design an automatic water monitoring system

1.4 Research Questions

- What are the most efficient and cost-effective pump technologies for commercial buildings (e.g., centrifugal, variable frequency drives)?
- How can pump selection be optimized based on building size, water demand patterns, and energy efficiency requirements?

- What is the most suitable system architecture for a smart water pumping system (e.g., centralized, decentralized, hybrid)?

1.5 Education Significance of the Project

The implementation of this project helps us, as electrical engineering students to apply electrical and electronics engineering skills to develop our system which help us to improve skills and knowledge including skills of integrating electronic and electrical components to design a sustainable and innovative system that can solve a certain problem in the society like this Project of **Design and implementation of smart water pumping system for commercial building**.

1.6 Scope and Limitations

The project was design to automatically control the pump which ensures constant reserve of water in the reservoir.

The scope of the design was kept concise and simple to in other not to introduce unnecessary complexities and render it generally uncomfortable. The system does not have attached complex peripheral device which though impossible for the detail printable information has been excluded for reasons of affordability material of low range and less accurate performances as opposed to a well-built automatic water pump was use d to achieve this aim, the automatic water level controller detects and control the water in the tank.

1.7 Significance of Study

Smart water pumping systems offer numerous benefits for commercial buildings, including:

- Energy efficiency**:** Optimized pump operation reduces energy consumption and costs.
- Water conservation**:** Leak detection and demand management prevent water wastage.
- Cost reduction**:** Lower operational expenses and reduced maintenance costs.
- Improved building management**:** Valuable data and insights for informed decision-making.

By adopting smart water pumping systems, commercial buildings can become more sustainable, efficient, and resilient.

1.8 Organization of the Study

This project is subdivided into five chapters:

The one chapter is introduction: It discusses about motivation for the work that is being reported. **The two chapter is literature review**: which provides detail about what other authors have done and hence set a benchmark for the current project as well as to justify the use of specific solution techniques. **The three chapter is research methodology**: It help us to get more information. **The chapter four** is design specification (result and discussion): deals designing and implementation of the final circuit and it clarifies the methods and steps used in smart water pumping system. It shows in details each part and its role in the complete circuit. **The five chapter** is conclusion and recommendation: It gives the summary of the main findings, also the problems and limitation is declared.

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

This chapter has mainly focused on other author's works, their opinions and idea that present some similarities with the one, which is said in this book. It explains basic concept, related study and information that had been used during development of this project and contains the basic component used and their functions.

2.2 Related Works

The development of smart water pumping systems for commercial buildings has been a burgeoning area of research and application in recent years. Numerous studies and projects have explored the design, implementation, and benefits of these systems. This essay will delve into some key related works, highlighting the advancements made in this field.

One significant area of focus has been the invert technology into water pumping systems. Researchers have developed solutions that enable real-time monitoring of water levels, pump operation, and energy consumption.[4] For example, proposed a system that uses sensors to measure water levels in storage tanks and automatically control pump operations to maintain optimal levels. This approach helps to prevent water wastage and reduce energy costs.

2.3 Main Gap in the Existing Literatures

While significant advancements have been made in the design and implementation of smart water pumping systems for commercial buildings, several key gaps remain in the existing literature. These gaps present opportunities for further research and development to enhance the effectiveness and sustainability of these systems.

One of the primary gaps lies in the area of scalability and interoperability. Many existing studies focus on small-scale implementations or specific use cases. However, the successful adoption of smart water pumping systems in large-scale commercial buildings requires solutions that can be easily scaled and integrated with existing infrastructure. There is a need for more research on scalable architectures, standardized protocols, and interoperability standards to facilitate the widespread deployment of these systems.

Another area where further research is needed is long-term performance and reliability. While short-term studies have demonstrated the benefits of smart water pumping systems, there is a lack of data on their long-term performance and reliability. Understanding how these systems perform over time under various operating conditions is crucial for assessing their overall value and ensuring their sustainability.

2.4 Components to Be Used In My Project

2.4.1 Protective Devices

Protective devices are those devices used to isolate automatically electrical circuits from the supply to protect them against damages to be occurred due to short circuit or over current, etc. Protective devices mainly used in electrical installation are fuses, circuit breakers, protection relay and thermal resistors.

Protective devices are these devices used to isolate...

In domestic installations mainly fuses and circuit breakers are used. Protective devices are connected in series with the equipment to protect...

2.4.2 Circuit Breaker

Circuit breakers are essential components in electrical systems, designed to protect circuits from damage caused by excessive current.

They act as automatic switches that interrupt the flow of electricity when they detect an overload or short circuit.

2.4.2.1 Symbol

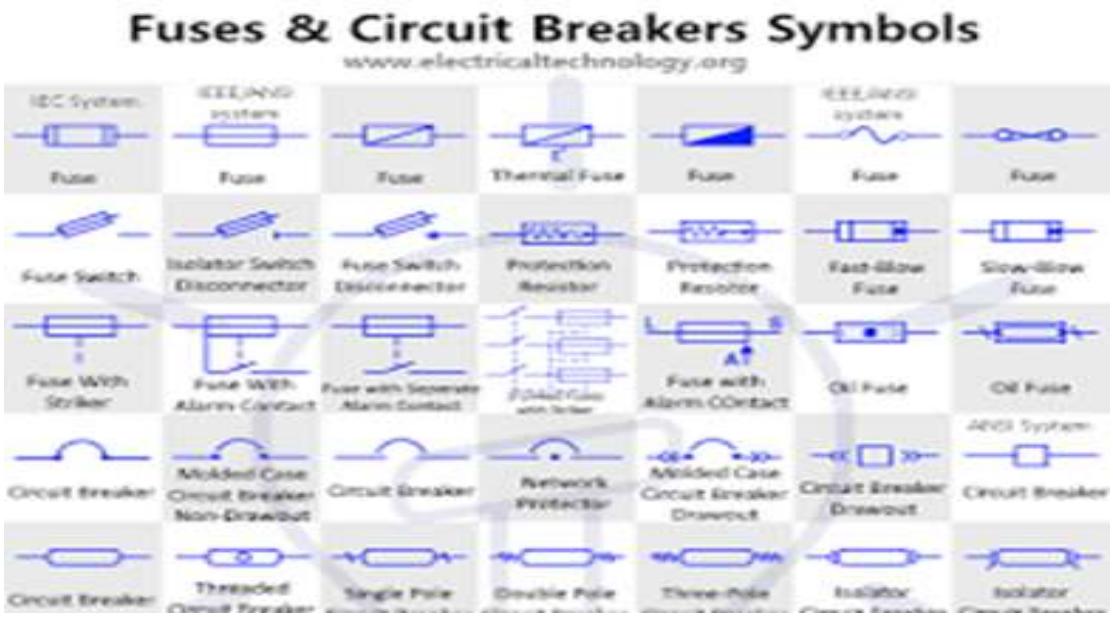

Figure 2-1: Fuse

2.4.2.2 Working principle of Circuit Breakers

1. Overload Protection: When a circuit draws more current than it can safely handle, the breaker's thermal element heats up. If the temperature exceeds a predetermined threshold, the breaker trips, cutting off the power.
2. Short Circuit Protection**:** If there's a direct connection between a live wire and a neutral wire (short circuit), a large current flows. This triggers the breaker's magnetic element, causing it to trip and interrupt the current.

2.4.2.3 Types of Circuit Breakers

- Miniature Circuit Breakers (MCBs): Commonly used in residential and commercial settings, MCBs are small, easy to install, and have a resettable mechanism.
- Molded Case Circuit Breakers (MCCBs): Used in industrial and commercial applications, MCCBs are larger and more robust, capable of handling higher currents and voltages.

- Air Circuit Breakers (ACBs): Primarily used in high-voltage power distribution systems, ACBs are designed to interrupt large currents and can be operated manually or automatically.

2.4.2.4 Why Are Circuit Breakers Important?

- Safety**:** Prevent electrical fires and injuries by limiting the amount of current flowing through a circuit.
- Protection**:** Protect expensive electrical equipment from damage caused by overloads or short circuits.
- Convenience**:** Allow for quick and easy restoration of power by resetting the breaker after a fault is resolved.

2.4.3 Timer Relay

A time relay is an electrical device that introduces a delay between the activation of a circuit and the response of a connected device.

It essentially acts as a timer, allowing for the control of timing sequences in various applications.

Figure 2-2: Timer Relay

Working principles of Timer Relay

The basic principle behind a time relay is the use of a timing mechanism that can be either mechanical, pneumatic, or electronic. Once activated, this mechanism starts a countdown timer. When the specified time has elapsed, the relay either opens or closes a set of contacts, triggering a desired action.

2.4.3.1 Types of Timer Relays

There are several types of time relays, each with its own characteristics and applications:

- On-delay relays**:** These relays delay the closing of their contacts after being energized. They are commonly used for applications like starting motors gradually or preventing surge currents.
- Off-delay relays**:** These relays delay the opening of their contacts after being de-energized. They are often used for maintaining a function for a specific duration after the initiating signal is removed.
- Instantaneous relays**:** These relays have no delay time and close their contacts immediately upon being energized.
- Multifunction relays**:** These relays can perform multiple timing functions, such as on-delay, off-delay, and pulse timing.

2.4.3.2 Applications of Time Relays

Time relays are used in a wide range of applications, including:

- Industrial automation**:** Controlling production processes, conveyor systems, and machinery.
- Heating, ventilation, and air conditioning (HVAC): Regulating temperature and humidity levels.
- Security systems**:** Controlling alarms, access control, and lighting.
- Traffic signals**:** Coordinating traffic flow.
- Household appliances**:** Controlling functions like washing machine cycles or dryer timers.

2.5 Control Devices

2.5.1 Contactor

2.5.1.1 Definition

A contactor is an electromagnetically driven electrical switch used for switching a power circuit of high current (load circuit) using a coil switch used which has much lower power than the switched circuit.

Figure 2-3: Contactor

2.5.1.2 Symbol of Contactor

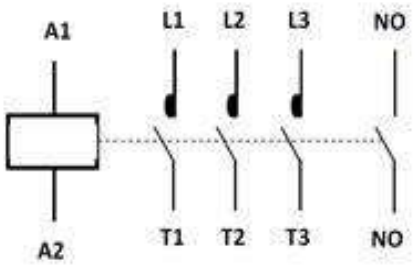

Figure 2-4: Symbol of Contactor

2.5.1.3 Working principle of contractor

A contactor, a crucial component in industrial electrical systems, functions as a heavy-duty relay designed to control high-current circuits. Its operation is rooted in the principles of electromagnetism.

At the heart of a contactor lies an electromagnetic coil. When this coil is energized, it generates a magnetic field. This magnetic field, in turn, attracts a moving core within the contactor's structure. As the core moves, it mechanically operates a set of contacts. These contacts are typically arranged in a normally open (NO) or normally closed (NC) configuration.

When the coil is de-energized, the magnetic field dissipates, causing the core to return to its original position. This action results in the contacts reverting to their normal state. For instance, in a normally open contactor, the contacts will be open when the coil is de-energized, preventing current flow. Conversely, a normally closed contactor will have its contacts closed when the coil is de-energized, allowing current to pass.

The key to a contactor's operation lies in the relationship between the electromagnetic coil and the moving core. The strength of the magnetic field generated by the coil determines the force exerted on the core. This force, in turn, controls the movement of the contacts, effectively switching the electrical circuit on or off.

Key Features and Benefits:

- High Current Capacity**:** Can handle much larger currents than standard relays.
- Reliability**:** Designed for frequent and heavy-duty use.
- Safety**:** Provides isolation between the control circuit and the main power circuit.
- Remote Control**:** Allows for convenient and safe control of high-power equipment.
- Versatility**:** Available in various sizes and configurations to suit different applications.

Common Applications:

- Motor Control**:** Starting, stopping, and reversing electric motors.
- Lighting Control**:** Switching large lighting fixtures or systems.
- Heating Control**:** Controlling heating elements or systems.
- Industrial Automation**:** Used in various automation systems and processes.

2.5.2 Three Phase Induction Motor

2.5.2.1 Introduction

Figure 2-5: Three Phase Induction Motor

As a general rule in motors, the conversion of electrical power into mechanical power takes place in the rotating part. In DC motors, the electrical power is conducted directly to the armature through brushes and a commutator, hence a DC motor can be called a conduction motor. In an AC motor, the rotor receives electrical power by induction in exactly the same way as the secondary of a transformer receives its power from the primary. That is why such motors are known as induction motors.

In fact, an induction motor can be treated as a rotating transformer in which the primary winding is stationary but the secondary is free to rotate.

2.5.2.2 Working principle of Three-Phase Induction Motor

Three-phase induction motors, ubiquitous in industrial and commercial settings, operate on the principle of electromagnetic induction. This principle, discovered by Michael Faraday, states that a changing magnetic field can induce an electric current in a nearby conductor.

The fundamental components of a three-phase induction motor are the stator and the rotor. The stator is the stationary part, housing three windings arranged 120 degrees apart. When a three-phase electrical supply is applied to these windings, a rotating magnetic field is created. This rotating magnetic field is a key characteristic of three-phase power systems.

The rotor, on the other hand, is the rotating part of the motor. It can be either a squirrel-cage type or a wound rotor type. The squirrel-cage rotor is the most common type, consisting of a series of conductive bars embedded in a laminated core. The wound rotor type, on the other hand, has windings connected to slip rings, allowing for external resistance to be added to control the motor's speed.

As the rotating magnetic field from the stator cuts across the rotor conductors, it induces a current in them. This induced current, interacting with the stator's magnetic field, produces a torque that causes the rotor to rotate. The direction of the rotor's rotation is determined by the sequence of the three-phase supply.

The speed at which the rotor rotates is known as the synchronous speed. It is determined by the frequency of the power supply and the number of poles in the stator windings. However, the rotor typically rotates at a slightly lower speed than the synchronous speed, due to the phenomenon known as slip. Slip is the difference between the synchronous speed and the actual rotor speed.

Three-phase induction motors are highly efficient and reliable, making them ideal for a wide range of industrial applications. Their simplicity of construction and minimal maintenance requirements further contribute to their popularity.

Key features and advantages:

- Simplicity: Induction motors have a simple construction and require minimal maintenance.
- Reliability**:** They are known for their ruggedness and long service life.
- Efficiency**:** Induction motors generally have high efficiency ratings.
- Versatility**:** They can be used in a wide range of applications, from pumps and fans to conveyors and machine tools.
- Constant speed**:** Induction motors typically operate at a constant speed, which is often desirable in industrial applications.

2.5.2.3 Types of induction motors

- Squirrel-cage induction motors**:** The most common type, characterized by their simple rotor construction.

- Wound rotor induction motors**:** Have a wound rotor with slip rings, allowing for variable speed control.

2.5.2.4 Applications of induction motors

- Industrial machinery**:** Pumps, fans, compressors, conveyors, machine tools
- Commercial applications**:** HVAC systems, escalators, elevators
- Household appliances**:** Washing machines, refrigerators

Three-phase induction motors are essential components in modern industrial and commercial settings. Their reliability, efficiency, and versatility make them the preferred choice for a wide range of applications.

2.5.3 Water Pump

A pump used for raising or circulating water, the pumping of water is a basic and practical technique, far more practical than scooping it up with one's hands or lifting it in a hand-held bucket. xviii This is true whether the water is drawn from fresh source, moved to a needed location, purified, or used for irrigation, washing, and sewage treatment or for evacuating water from an undesirable location. Regardless of the outcome, the energy required to pump water is an extremely demanding component of water consumption. All other processes depend or benefit either from water descending from a higher elevation or some pressurized plumbing system.

Figure 2-6: Water Pump

Water pump A water pump composed by two main parts build in it such as dc motor and pomp. Those part help a water pump in it function of pumping water (circulating or raising water). It has two terminals such as vcc as voltage supply of 5V and ground of 0V Dc Motor: is an electrical device that convert electrical energy into mechanical energy. Those mechanical energy pull a water from one contain to another one. As working principle of water pump. Pomp: it a plastic material that draw a way of water from contain. The operator has to supply the two terminals on it. As supplying a dc motor that produce a mechanical energy that pull a water from contain through a pump

2.6 Control Devices

2.6.1 Push Button

2.6.1.1 Definition of Push button

A push button is a simple device with one stable state: either ON or OFF. It's activated by physical pressure.

2.6.1.2 Symbol of bush button

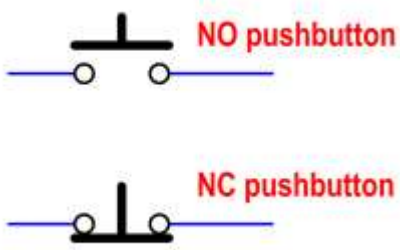

Figure 2-7: Push Button

2.6.1.3 Application of Push button

Push buttons are used in various applications, including:

- Industrial and commercial devices**:** For controlling machinery and processes
- Home appliances**:** For controlling household devices
- Telephones: For dialing numbers

Interlocking**:** Push buttons can be interconnected to prevent accidental activation.

Color Coding**:** To avoid confusion, push buttons are often color-coded. Red is typically used for stopping, and green for starting.

2.6.2 Float Switches

2.6.2.1 Definition

A float switch is a device used to detect the level of a liquid within a tank.

Figure 2-8:Float Switches

2.6.2.2 Symbol

float switch symbol

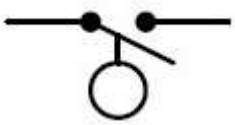

Figure 2-9: Symbol of Float Switch

2.6.2.3 Principle

Float switches range from simple, cast-iron designs to more complex mechanisms. They can be as basic as a mercury switch inside a hinged float or incorporate sophisticated differential or conductance sensors within a sealed casing. These sensors produce discrete binary outputs as the liquid reaches different levels within the tank, perhaps triggering an alarm or activating a pump.

A simpler type of float switch consists of a float raising a rod that actuates a mechanism, such as a valve or switch. Float switches are often adjustable and can include substantial hysteresis. This means the "turn on" point may be higher than the "turn off" point, minimizing the frequent switching and associated pump wear.

Some float switches feature a two-stage design. When the liquid rises to the lower set point of the first stage, the associated pump is activated. If the liquid continues to rise, the second stage is triggered. This stage may switch off the source of the liquid being pumped, activate an alarm, or both.

2.6.2.4 Application of float switch

A very common application of float switches is in sump pumps and condensate pumps. The switch detects the rising level in the sump or tank and energizes an electrical pump to pump the liquid out until the level is substantially reduced, at which point the pump is switched off again.

CHAPTER 3 RESEARCH METHODOLOGY

3.1 Introduction

In this chapter, we discuss the research methodology employed in investigating smart water pumping system for commercial building. This includes the overall research design, the population of interest, the sample size, and the methods used to gather and analyze data. It will be crucial in ensuring the reliability and validity of the research findings.

3.2 Research Design

In the research design, the necessary understanding and useful information needed in this project comes from various resources. Here resources like books, some websites on the internet, as well as reports done by other researchers have been consulted, we have also used site survey by asking questions related to our research.

3.3 Data Collection Methods

Data collection is the process of gathering and measuring information on variables of interest, in an established systematic fashion that enables one to answer stated research questions, test hypotheses, and evaluate outcomes [5]. While methods vary by discipline, the emphasis on ensuring accurate and honest collection remains the same. The goal for all data collection is to capture quality evidence that then translates to rich data analysis and allows the building of a convincing and credible answer to questions that have been posed. Methods adopted for collecting data are chosen due to area civilization and are suitable to all categories of people working in that area (skilled, semi-skilled and unskilled one) to obtain more detailed information.

3.3.1 qualitative data collection methods

Qualitative data collection is concerned with the nature, explanation and understanding of phenomena. Unlike quantitative data, qualitative data is not measured in terms of frequency or quantity but rather are examined for in-depth meanings and processes. Here are the top qualitative data collection methods we used in this study: interviews and observations.[6]

3.3.1.1 . Interview

This is method of collecting data in which interviewer is asking face to face question with his/her respondent. Interviews are widely used as data collection tool in qualitative research. They are typically used as a research strategy to gather information about participants' experiences, views and beliefs concerning a specific research question or phenomenon of interest. This helps us to get accurate information even those we had not observed there during field visit because of short time.

3.3.1.2 Observations

Observation is a fundamental way of finding out about the world around us. As human beings, we are very well equipped to pick up detailed information about our environment through our senses. However, as a method of data collection for research purposes, observation is more than just looking or listening. Research, simply defined, is 'systematic enquiry made public'. Mostly observation done to know whether the information taken from interview questions are correct by going to the field of study. These methods of observation are more accurate than others during our observation we make a visit to different commercial buildings.

3.4 Sample Size

Determining the sample size is essential for the reliability of the study's findings. The sample size must be large enough to represent the target population accurately but manageable within the scope of the study. For this research, the sample includes:

1. commercial building owners.

2.A Plumber who do water maintenance in commercial building.

3.4.1 Sampling Procedures

In this section for data collection the probability sampling type is used as sampling procedure. This is where the researcher has a significant measure of control over who is selected and on the selection methods for choosing them. Sampling methods allow for representative cross-sections, or particular groups to be identified or targeted. researchers

prefer to use that because who are selected must be specified and they are presenting the whole population.

3.5 Research Instrument

3.5.1 Choice of The Research Instrument

The researcher uses survey and interview method for gathering data, interview method Commonly used in behavioral sciences, researcher made direct observations of relevant people, actions and situations without asking from the respondent, it was used in association with other research approaches and as the primary way of gathering data. The interview was a good way of getting below the surface of any situation and to help reveal or unravel complex causal of the processes. this schedule as the data collection method, researchers use a face-to-face conversation with the respondent for obtaining information 10 of targeted respondents are interviewed, the questions researcher design are relevant to that said in research question and there is no other special tools or instrument for collecting data.[7]

3.5.2 Validity And Reliability of The Instrument

According to the previous instrument used in data collection, researcher have established update information in fact the respondents are assumed to have full information and they provide accurate information refer to their understanding researcher have already used different documentation in order to make sure that the information that researchers have are truly updated, the information gotten are recorded for making them secure and for keeping their accuracy.

3.6 Data Analysis and Interpretation

Several methods are available to analyze qualitative data.[8] The most commonly used data analysis method is narrative analysis. It focuses on using the stories and experiences shared by people to answer the research questions. [9] Variety documents that used to examine our project are books of electrical and electronics and other documents from different websites. In order to get all the relevant data information to this project, some methods of data collection procedures or techniques have been used for the collection data, interviewers, documentation were carried out and even observation were used all those ideas collected help us to develop project concepts, programming and implementing our project.

3.7 Tools Used To Implement the Project

The tools used in this project are not different from those which are related to the field of electrical and electronics which Is in our subject area.

- Combination A plier
- Striping plier
- a hammer
- A screwdriver
- Digital multimeter

3.8 Challenges/Limitations Faced During Research

During this research, we met some limitations and obstacles in different ways. The problem of designing and implementing new system, we have never used in our day per day lessons, and this take time to the researchers for collecting data and lacking some information about this system. To design and implement this project (system) electronic and electrical materials were used. where getting these materials required some amount of money so it was difficult journey. However, we find out how to handle these problems. But all of them they did not stop us to make more research and we got the required information. which helped to design and implement this smart water pumping system.

CHAPTER 4 : DESIGN, ANALYSIS AND IMPLEMENTATION

4.1 Introduction

In this chapter, we delve into the detailed design, analysis, and implementation of the Design and implementation of smart water pumping system for commercial building. The design process involves a careful selection of components, including switch, contractor. This chapter presents the technical drawings of the system, key calculations for system performance, detailed specifications, and an estimation of costs. Finally, the implementation process is documented, highlighting the steps taken to bring the system from concept to reality

4.2 Calculations

4.2.1 Power consumption:

Based on the components we used, we have the possibility of summing up all powers consumed by every component to get the total power:

From the formula of Power= Current*Voltage, these are the powers consumed:

1.CONTRACTOR

The coil power consumption of contractor:

Closing: 1480VA\ 1480W

Holding: 22.6 VA\ 6.8W

2.FLOAT SWITCH

Voltage: 250V

Maximum current: 16A

Power: 250*16=4kw

3.LED BULB

Power: 7W

Total Power:

Closing: 1480(3) W + 4000 W + 7W = 8447W

- Holding: 6.8 (3)W + 4000W+7W =4027.4 W

4.3 Specifications

Component	Specifications
Power Supply	Input voltage: AC, Range: 220V-230V
Single phase Circuit Breaker	Primary current: 3.3 A - 108 A, VAC: 250 V Rating: 0.5 A - 20 A
Delay timer	AC 220v, T = 1.1 * R * C
Contractor (3)	25 Amp 220VAC
Single Phase Electric Motor Water Pump	1 HP Single Phase Water Pump Motor,220-240 Speed:<2000RPM Voltage:220-240V Capacity:40LPM Frequency. 50 Hz
Float Switch	Rated voltage ranges from 220-240V. The maximum current is 10Amps. The protection grade is IP-68
AC bulb colored green/led/yellow	7W(AC)

Table.4. 1.specification

Specifications of Design and implementation of smart water pumping system for commercial building

4.4 Circuit Diagram

4.4.1 Control Circuit

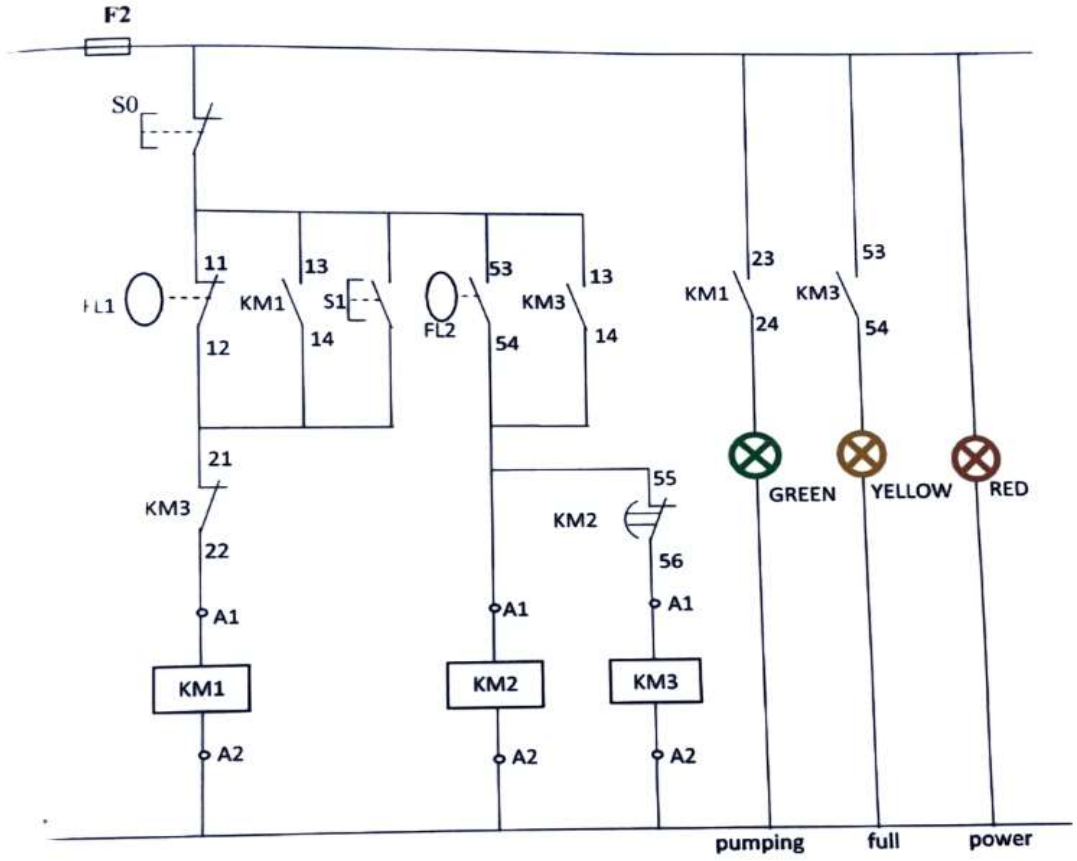

Figure 4-1: Control Circuit

4.5 Power Circuit

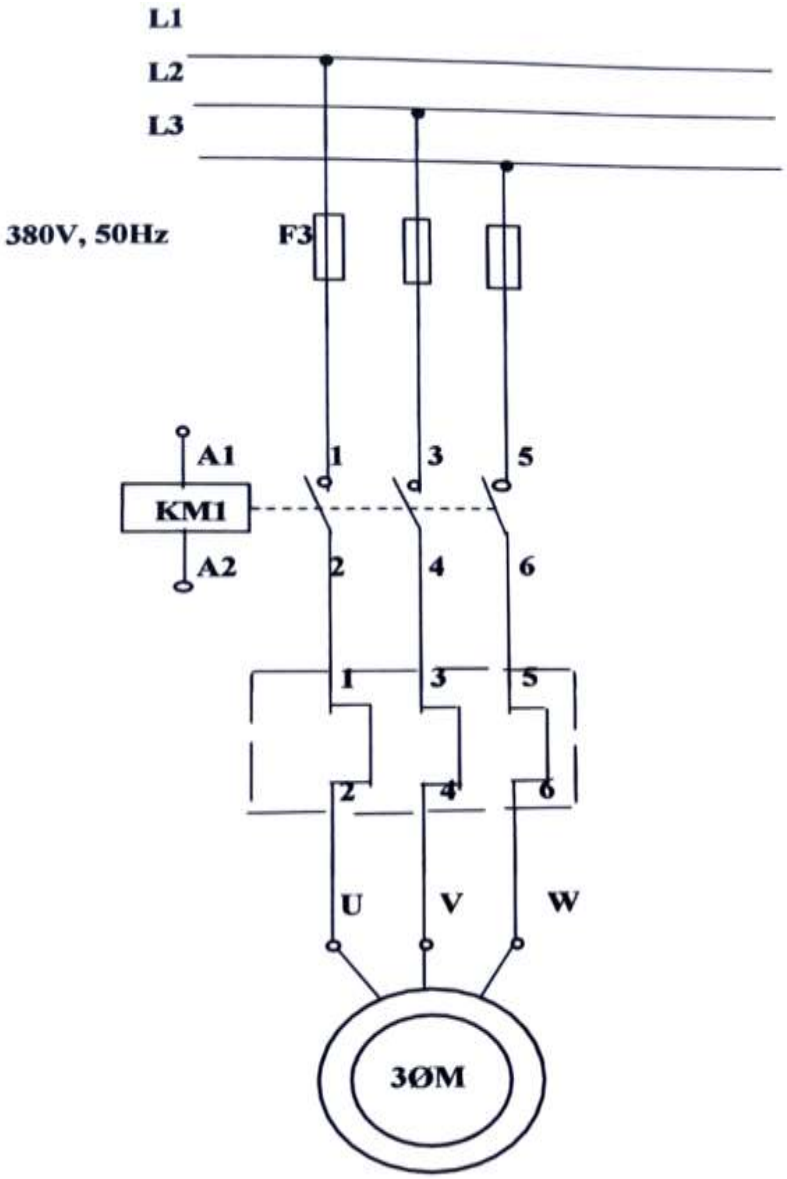

Figure 4-2: Power Circuit

4.6 Working Principle of the Circuit

Power Supply:

- When the circuit is supplied with a three-phase voltage, a red lamp lights up to indicate that power is available.

Pump Activation:

- The contactor KM1 is closed by either the normally closed float switch FL1 or by manually pressing the push button 51.
- This closes the normally open contact (KM1 23-24), lighting the green lamp to show that the pump is running.

High Level Control:

- When the water level reaches a predetermined high point, the normally open high-level float switch FL2 closes.
- This energizes both KM2 and KM3.
- KM3 opens its normally closed contact (KM3 21-22), stopping the pump.
- KM3 also closes its normally open contact (KM3 53-54), switching on the yellow lamp to indicate that the tank is full.

Delay and Yellow Lamp Turn-Off:

- After two minutes, the contactor KM2's delayed contact (KM2 55-56) closes.
- This turns off the yellow lamp.

Low Level Control:

- As water is consumed, the level drops.
- When the water level reaches a low point, the low-level float switch closes.
- This closes the contactor KM1, restarting the pump.

4.7 COST ESTIMATION

component	Quantity	Unit price (Rwf)	Total cost (Rwf)
Contractor	3	25000	75000
Float switch	1	35000	35000
Push Putton	1	8000	8000
Fuse	1	4000	4000
LED Bulb	3	2500	7500
Cable	10m	500	5000
Total			134,500

Table.4. 2.cost estimation

Implementation

This section outlines the practical steps taken to bring the smart water pumping system for commercial building from design to reality. This includes assembling the components, testing the system. Here's how to structure and detail this section:

Wiring Connection

- We connected the fuse to push button.
- We connected push button to contractor.
- We connected contractor to float switch, water pump, led bulb.
- At the end, we ensured that all components share a common ground

Figure 4-3implementation

CHAPTER 5 : CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In developed countries, pumping stations play a crucial role in various activities such as irrigation and supplying water to local communities. They are also essential in industrial areas. This project was conducted to assist readers of this pumping system book in understanding the system without experiencing delays or lost time. Water is a vital source of life, and we must manage it effectively in our daily lives.

5.2 Future Scope

Enhanced Energy Efficiency**:**

- Variable Frequency Drives (VFDs): Implement VFDs to control pump speed based on demand, reducing energy consumption.
- Solar Power Integration: Explore integrating solar power systems to provide renewable energy for pumping, especially in areas with abundant sunlight.
- Energy Recovery Systems**:** Consider using regenerative braking or energy recovery systems to capture and reuse wasted energy.

Improved Water Quality Monitoring**:**

- Real-Time Sensors**:** Install real-time sensors to monitor water quality parameters like pH, turbidity, and temperature.
- Remote Alerts**:** Implement systems that send alerts to building managers or authorities if water quality deteriorates.
- Water Treatment Integration**:** Integrate the system with water treatment technologies to ensure safe and potable water supply.

Enhanced Reliability and Resilience**:**

- Redundancy**:** Introduce redundant pumps and components to minimize downtime in case of failures.
- Predictive Maintenance**:** Use data analytics to predict equipment failures and schedule preventive maintenance.

- Disaster Preparedness**:** Design systems that can withstand natural disasters like heavy rains, droughts, or earthquakes.

Smart Grid Integration**:**

- Demand Response**:** Enable the system to participate in demand response programs, reducing energy consumption during peak hours.
- Grid Stability**:** Contribute to grid stability by adjusting pump operations based on grid conditions.

Integration with Building Automation Systems (BAS)**:**

- Centralized Control**:** Integrate the pumping system with the building's BAS for centralized control and optimization.
- Energy Efficiency**:** Coordinate pump operations with other building systems to maximize energy efficiency.

Water Conservation and Leakage Detection**:**

- Leak Detection Sensors**:** Install leak detection sensors to identify and address water leaks promptly.
- Smart Metering**:** Implement smart water meters to track water consumption and detect anomalies.

By focusing on these areas, we can develop smart water pumping systems that are more efficient, reliable, sustainable, and contribute to the overall well-being of Rwandan commercial buildings and their occupants.

5.3 Recommendation

Along the course of study completion, I encountered various problems and obstacles. Not everything that I had planned went smoothly during the project development span. I had to start from the research at the beginning and needed to gain knowledge on all devices and components that I had intended to use for my project.

As part of my recommendation, I would like to recommend to the commercial building owners to use **Design and implementation of smart water pumping system for commercial building** in order to prevents water wastage and it reduce human labor, saves time and also keeps the user updated regarding the water content.

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