Design and Implementation of Smart Water Level Indicator and Valve Controller

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***Abstract*— Accurate and reliable water level monitoring and control are crucial for efficient water management. This research paper presents the design and implementation of a smart water level indicator that utilizes the BC547 transistor-based inductive level measurement technique for discrete level measurement. The system includes an ATmega328p microcontroller that processes the data and controls the different inputs and output lines, such as LEDs and an online interface for remote monitoring and control of water levels. The system uses the inductive properties of water to detect water levels at four different levels. The online interface displays real-time water levels and allows the user to control the solenoid valve to manage water levels. The smart water level indicator provides an efficient and user-friendly solution to water level management, helping to minimize water wastage and promote sustainable water usage. The results of testing demonstrate the accuracy and reliability of the system in monitoring and controlling water levels.**

Keywords—Water level sensor, ATmega328p, ESP8266, Solenoid Valve.

I. INTRODUCTION

In a broad range of situations, including industrial and domestic applications, such as fuel storage, flood warning, and water level control in homes, accurate, moderately priced, and dependable equipment for detecting liquid levels is crucial. Conventional liquid level sensors use electromechanical methods, which raise safety issues in areas where explosives are present. Point level measurement sensors and continuous level sensors are the two primary types of level measurement control sensors utilised in industries.[1]–[3] Continuous level sensors monitor fluid level across a wide range as opposed to at a single spot, unlike point level measurement sensors. Different level measurement devices have been developed, including mechanical, capacitive, inductive, ultrasonic, acoustic, or optical methods. While mechanical and ultrasonic[4] methods are primarily used for measuring the level of solid materials in the form of dust, capacitive and optical methods are better suited for detecting fluid levels.[5]–[8]

The main focus on designing and implementing a smart water level indicator using the discrete water level indication technique with an NPN bipolar transistor-based sensor, specifically the BC547 transistor. This technology works on the conductive properties of water, making it an affordable and reliable option for liquid level measurement. Our system includes an ATmega328p microcontroller connected to the BC547 transistor for processing data, with different inputs and output lines such as an LCD display and a buzzer for providing real-time information to the user.[9], [10] We also incorporate an ESP8266 Wi-Fi module that provides a connection to a website interface, allowing the user to interact with the system remotely. [11]The website interface displays real-time water levels and allows the user to control the solenoid valve to manage water levels.

The significance of the smart water level indicator in industrial processes cannot be overstated. It is a crucial component that plays a vital role. Water scarcity is a significant problem that affects many areas worldwide, and improper management and control of water resources often contribute to the lack of access to clean water. Our project aims to provide an efficient and user-friendly solution to water level management, which helps to minimize water wastage and promote sustainable water usage.

II. SPECIALTY OF TRANSISTOR:

Transistors are electronic devices that have a wide range of applications in modern electronics. They are used for amplification or switching of electrical signals, making them an essential component in many circuits. One type of transistor is the NPN bipolar junction transistor (BJT) BC547, which has three terminals: emitter, base, and collector. In this project,

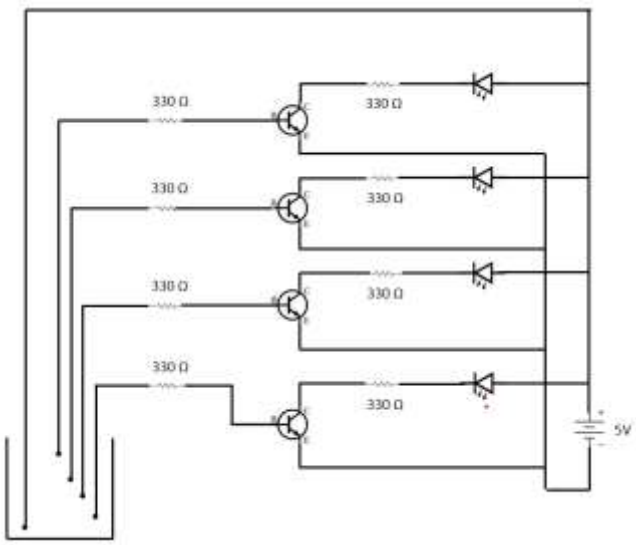
we'll make a water level sensor using transistors' switching ability. A BJT transistor's emitter and collector are connected to a negative potential, and the base is applied a positive potential, according to the ability of transistors to switch, which specifies that current will begin to flow from the collector to the emitter via the base. The stream stops flowing if we take away the base's positive potential. In other words, the transistor functions as a closed switch when a signal is applied at the base, and as an open switch when a signal is not applied.

To construct the water level indicator circuit, we connect all the emitters of the transistors to the negative terminal of the battery and all the collectors to an LED via a 330Ω resistor. The base of all the transistors is dipped into the water via a 330Ω resistor. The fourth transistor is used to power the buzzer when the water level rises to its sensor.

The circuit is in an off state when powered by a 9V or 5V battery, and no current flows through the transistors or the remaining circuit. But, when the positive terminal of the battery is placed to the water tank and the base terminals of each transistor are submerged one at a time, a current in micro amperes begins to flow via the base terminal. The transistors are switched to the ON state as a result.

The additional base terminals link to the battery via water when the water level in the container or tank rises, and as a result, other LEDs and the buzzer soon start to glow. This is so that the transistor can function, which requires a small amount of current (about less than 2% of total current) to pass through the base. Water has some conductivity because of the dissolved minerals and impurities in it, which enables a very little current (measured in microamperes) to pass through it.

In conclusion, transistors are versatile electronic devices that can be used for various applications, such as amplification and switching of electrical signals. Here the ability of transistors to switch have been used to create the water level indicator circuit, which can be helpful in many industries and households.



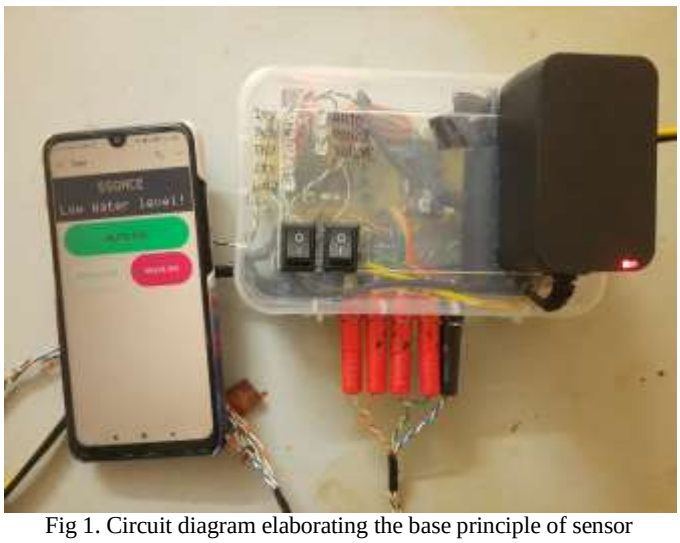


Fig 1. Circuit diagram elaborating the base principle of sensor

Fig. 2 Water Level Indicator and valve control system with IoT interface images

III. DISCUSSION OF WATER LEVEL INDICATORS

The importance of water level indicators cannot be overstated, especially in situations where the level of water needs to be monitored and controlled, such as in industrial processes, flood warning, and water level control in homes. There are various types of water level indicators available, each with its own advantages and disadvantages different types of water level indicators used to monitor and control the level of water in various applications such as industrial processes, flood warning, and water level control in homes. Four types of water level indicators have been described: float type, capacitance-based, conductivity type, and ultrasonic type.[11]–[14]

Float type water level indicators are simple devices consisting of a float, lever arm, and switch that can turn on or off the water pump based on the water level. Capacitance-based water level indicators use the principle of capacitance to measure the level of water in a container. Conductivity type water level indicators measure the level of liquid in a container using the principle of electrical conductivity, and ultrasonic type water level indicators use high-frequency sound waves to measure the distance between the sensor and the surface of the liquid in a container. [14]

Each type of water level indicator has its own advantages and disadvantages. Float type water level indicators are easy to install and maintain, but may not be suitable for applications with rapid water level fluctuations. Capacitance-based water level indicators are not affected by factors such as temperature, pressure, or impurities in the water, making them suitable for industrial and agricultural applications. Conductivity type water level indicators are highly accurate but may not be suitable for liquids with low conductivity or high levels of impurities. Ultrasonic type water level indicators are highly

accurate and reliable and can be used with a variety of liquids in tanks or containers of different sizes and shapes.

Conductivity type water level indicator:

A conductivity type water level indicator is an electronic device that measures the level of liquid in a container using the principle of electrical conductivity. This type of water level indicator consists of two or more electrodes made of conductive materials such as stainless steel, copper or brass, which are inserted into the liquid at different levels.

When an electrical current is passed through the electrodes, the conductivity of the liquid between the electrodes varies with the level of the liquid. The conductivity of the liquid is higher when the liquid level is higher between the electrodes, and lower when the liquid level is lower between the electrodes. The change in conductivity is detected by the electronic circuitry of the device, and the resulting voltage or current signal is used to determine the liquid level. The device may have a visual display to indicate the liquid level, or it may be connected to a control system to trigger alarms, pumps, or other devices based on the liquid level.

Conductivity-based water level indicators are commonly used in applications where a high degree of accuracy is required, such as in chemical processing, water treatment plants, and fuel storage facilities. However, they may not be suitable for liquids with low conductivity or high levels of impurities, which can interfere with the accuracy of the measurement.

COMPARISON OF THE ADVANTAGES AND DISADVANTAGES OF SOME COMMON TYPES OF WATER LEVEL INDICATORS:

1) Float type water level indicator:
Advantages:
- Simple and reliable design
- Inexpensive
- Easy to install and maintain

Disadvantages:
- Limited accuracy
- Can be affected by waves or turbulence
- May not be suitable for corrosive or hazardous liquids

2) Conductivity type water level indicator:
Advantages:
- High accuracy
- Suitable for a wide range of liquids
- Can measure levels in large containers

Disadvantages:
- Can be affected by impurities or changes in conductivity
- Requires calibration for different liquids
- More expensive than float type indicators

3) Ultrasonic type water level indicator:
Advantages:
- High accuracy
- Suitable for a wide range of liquids
- Can measure levels in large containers

Disadvantages:
- Can be affected by obstacles or interference
- Requires regular maintenance to ensure accuracy
- More expensive than float type or conductivity type indicators

4) Capacitance type water level indicator:
Advantages:
- High accuracy
- Can measure levels in non-metallic containers
- Less affected by changes in temperature or pressure

Disadvantages:
- Can be affected by impurities or changes in conductivity
- Requires calibration for different liquids
- More expensive than float type indicators

5) Pressure type water level indicator:
Advantages:
- Suitable for a wide range of liquids
- Can measure levels in hazardous or corrosive liquids
- Less affected by changes in temperature or pressure

Disadvantages:
- Requires accurate calibration for different liquids
- May be affected by changes in atmospheric pressure
- More expensive than float type indicators

The choice of water level indicator will depend on various factors such as the accuracy required, the type of liquid being measured, the size and shape of the container, and the environmental conditions.

EXPLANATION OF THE DESIGN AND IMPLEMENTATION PROCESS OF THE SMART WATER LEVEL INDICATOR

The conductive sensor implemented in this project uses BC547 transistors to detect changes in conductivity as the water level changes. The transistor acts as a switch, allowing current to flow through the circuit when a positive potential is applied to the base. The conductive property of water allows for a small amount of current to flow through it, which is detected by the transistor.

All of the transistors' emitter terminals are connected to the battery's negative terminal to implement the water level sensor circuit, and all of the transistors' collector endpoints are connected to an LED using a 330Ω resistor. Via the use of a 330Ω resistor, the base of each transistor is submerged in water. The circuit is in an off state and does not have any current flowing through the transistors or the remaining components when it is powered.

As the water level in the container rises, the base terminals of the transistors are also submerged in the water, allowing a small amount of current to flow through the water and activate the transistor switches. This causes the LEDs to light up and the buzzer to sound, indicating the water level.

The conductive sensor implemented in this project is a simple and effective way to detect water levels using transistor switches. It can be used in various applications, such

as in industries and households, to monitor and control water levels.

FLOW CONTROL

The flow control of the code written in a microcontroller is the sequence of instructions that dictate how the program will execute. In the case of a smart water level indicator, the flow control code is responsible for receiving data from the sensor, processing the data, and then displaying the results on the LCD screen or transmitting the data to the website interface.

The code starts with initializing the microcontroller and setting up the sensor input pin. Next, the program enters a loop where it continuously reads the water level sensor data and performs calculations to convert the sensor output into meaningful water level measurements.[12] Once the calculations are complete, the program updates the LCD display with the current water level reading.

In addition to displaying the water level on the LCD screen, the program also checks if the water level is above or below a certain threshold. If the water level is too low or too high, the program will activate the solenoid valve to turn off or on respectively to maintain the desired water level.

The program also communicates with the ESP8266 Wi-Fi module to transmit the data to the website interface. The website interface allows the user to remotely monitor the water level and control the solenoid valve.

In summary, the flow control of the code in a microcontroller is critical to the operation of a smart water level indicator. It determines how the program will execute and control the various components of the system to ensure accurate and reliable water level measurement and control.

OVERVIEW OF IOT AND SMART SENSORS

The Internet of Things (IoT) is a system of physical devices, vehicles, buildings, and other objects that are equipped with sensors, software, and network connectivity, allowing them to gather and exchange data. This technology is built upon the idea of linking ordinary objects to the internet, allowing them to communicate and exchange information with each other and with humans with proper interface.

Smart sensors are an essential component of IoT. They are advanced sensors that are embedded with microprocessors, enabling them to process data and communicate with other devices over a network[9], [12]. Smart sensors can collect various types of data such as temperature, humidity, pressure, motion, and sound, and transmit this data to other devices or the cloud for processing and analysis.

Smart sensors can be used in a wide range of applications, such as environmental monitoring, industrial automation, smart homes, and healthcare. They can offer real-time information on the condition of the surroundings or of the machinery, allowing predictive maintenance and eliminating downtime.

IoT and smart sensors have the potential to transform industries by providing real-time data on various parameters, enabling more efficient and sustainable operations, reducing costs, and improving safety. For example, in the transportation industry, IoT sensors can provide real-time data on traffic, weather, and road conditions, enabling more efficient and safe driving.

The Internet of Things (IoT) and smart sensors are technologies that have the potential to revolutionize the way we interact with our environment. These technologies can be used to collect and transmit real-time data from physical devices, vehicles, buildings, and other objects embedded with sensors, software, and network connectivity. This data can then be analyzed to provide valuable insights into the state of the environment or equipment, enabling more efficient and sustainable operations, reducing costs, and improving safety.

In the context of the project, the use of IoT and smart sensors is particularly relevant for the design and implementation of a smart water level indicator. This technology can be used to monitor and control water levels remotely, enabling more efficient water management and reducing the risk of water damage or shortages. [9]–[11]

The conductive sensor implemented using BC547 transistors is a key component of the smart water level indicator. This sensor uses the transistor to detect changes in conductivity as the water level changes, and then transmits this data to the online interface. The online interface is a web-based platform that allows users to access the data from the water level indicator remotely, and to control the water level indicator as needed.

Overall, the project aims to demonstrate the potential of IoT and smart sensor technologies for water management, and to provide a practical solution for monitoring and controlling water levels. The use of these technologies has the potential to reduce water waste, increase efficiency, and promote sustainability, which are all important goals for modern society.

FUTURE SCOPE

A smart water level indicator that works on the principle of conductivity of water and has an online interface to show water level and valve control system has significant potential for future applications. Here are some potential areas of development and expansion for this technology:

1. Home Automation: With the advancement of smart homes, this technology can be integrated into the smart home ecosystem, and users can control the water flow of their homes through their smartphones.
2. Agriculture: This technology can be used in agriculture to monitor the water levels of crops and enable farmers to manage irrigation efficiently. The online interface can also provide farmers with real-time data about their crops' water requirements.
3. Industry: Many industries require large amounts of water for their operations. This technology can be used to monitor water levels in industries such as food and beverage, pharmaceutical, and chemical manufacturing.
4. Water conservation: By monitoring water levels in real-time, water conservation measures can be implemented

effectively, and the loss of water due to overflowing or leakage can be avoided.

5. Smart city: Smart water level indicator technology can be integrated into smart city initiatives, and data from the online interface can be used to manage water distribution systems more efficiently.
6. Disaster management: This technology can be used in disaster management to monitor water levels in rivers and lakes, and provide early warnings to residents in areas prone to flooding.
7. Water quality monitoring: By monitoring water conductivity, this technology can be used to detect changes in water quality, and ensure that the water supply is safe for consumption.

In conclusion, the potential for the future scope of a smart water level indicator that works on the principle of conductivity of water and has an online interface to show water level and valve control system is vast. It can be used in various fields, and its benefits can have a positive impact on society.

CONCLUSION

In conclusion, project aims to provide a cost-effective and reliable solution for water level measurement with a user-friendly interface. With the use of conductivity-based technology and an NPN bipolar transistor-based sensor, our system offers accurate and real-time water level measurements. The incorporation of an ESP8266 Wi-Fi module allows for remote access and control through a website interface. This smart water level indicator is a critical tool in promoting sustainable water usage and minimizing water wastage.

REFERENCES

[1] P. Imperatore, G. Persichetti, G. Testa, and R. Bernini, "Continuous Liquid Level Sensor Based on Coupled Light Diffusing Fibers," *IEEE Journal of Selected Topics in Quantum Electronics*, vol. 26, no. 4, Jul. 2020, doi: 10.1109/JSTQE.2020.2988603.

[2] D. S. Montero and C. Vázquez, "Polymer Optical Fiber Intensity-Based Sensor for Liquid-Level Measurements in Volumetric Flasks for Industrial Application," *ISRN Sensor Networks*, vol. 2012, pp. 1–7, Oct. 2012, doi: 10.5402/2012/618136.

[3] K. R. Sandra, B. George, and V. J. Kumar, "A Nonintrusive Magnetically Coupled Sensor for Measuring Liquid Level," *IEEE Trans Instrum Meas*, vol. 69, no. 10, pp. 7716–7724, Oct. 2020, doi: 10.1109/TIM.2020.2982842.

[4] S.A. Engineering College and Institute of Electrical and Electronics Engineers, *2017 International Conference on Information Communication and Embedded Systems (ICICES) : February 23rd and 24th 2017*.

[5] M. Bottacini, N. Burani, M. Foroni, F. Poli, and S. Selleri, "All-plastic optical-fiber level sensor," *Microw Opt Technol Lett*, vol. 46, no. 6, pp. 520–522, Sep. 2005, doi: 10.1002/mop.21034.

[6] Daniel Paczesny, Grzegorz Tarapata, Marzecki Michal, Ryszard Jachowicz, "The Capacitance Sensor for Liquid Level Measurement made with Ink-Jet Printing Technology", Proc. Eurosensors, UK, 2015

[7] S. M. Chandani, "Optical fiber-based liquid level sensor," *Optical Engineering*, vol. 46, no. 11, p. 114401, Nov. 2007, doi: 10.1117/1.2801506.

[8] J. E. Antonio-Lopez, J. J. Sanchez-Mondragon, P. Likamwa, and D. A. May-Arrioja, "Fiber-optic sensor for liquid level measurement," 2011.

[9] A. OO, "Design, simulation and implementation of an Arduino microcontroller based automatic water level controller with I2C LCD display," *International Journal of Advances in Applied Sciences*, vol. 9, no. 2, p. 77, Jun. 2020, doi: 10.11591/ijaas.v9.i2.pp77-84.

[10] Mr. G. M. Barbade, Mr. S. N. Chandurkar, Mr. V. S. Shounak, Mr. V. R. Nimkar, and Mr. U. B. Patil, "Automatic Water Tank Filling System with Water Level Indicator," *Indian Journal of Microprocessors and Microcontroller*, vol. 1, no. 2, pp. 1–7, Sep. 2021, doi: 10.54105/ijmm.B1711.091221.

[11] D. Mounika, "Design and Implementation of Microcontroller Based Automated Water Level Indicator," 2016. [Online]. Available: http://www.ijitr.com

[12] S. Ismail, D. W. Dawoud, N. Ismail, R. Marsh, and A. S. Alshami, "IoT-Based Water Management Systems: Survey and Future Research Direction," *IEEE Access*, vol. 10, pp. 35942–35952, 2022, doi: 10.1109/ACCESS.2022.3163742.

[13] Y. Ran, L. Xia, D. Niu, Y. Wen, C. Yu, and D. Liu, "Design and demonstration of a liquid level fiber sensor based on self-imaging effect," *Sens Actuators A Phys*, vol. 237, pp. 41–46, Jan. 2016, doi: 10.1016/j.sna.2015.11.018.

[14] A. Susheel and S. Selvendran, "Investigation on Water Level Regulation Using Floating Sensor and Arduino Uno," in *IOP Conference Series: Materials Science and Engineering*, Nov. 2019, vol. 561, no. 1. doi: 10.1088/1757-899X/561/1/012009.