The Precision Beverage Drink Level Detection System

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ABSTRACT- The Precision Beverage Drink Level Detection System monitors liquid levels in containers like boilers and flasks, ideal for tea and coffee vending machines.

It uses non-invasive level detection and PWM pulses for efficient control of devices can measure the accurate level in the liquid like Hot or Cold.

DC voltage injection prevents rust, salt formation, and corrosion, enhancing system durability.

AC supply protection ensures safety for both users and components.

A temperature sensor monitors the beverage, classifying it as hot or cold.This system offers precision, reliability, hygiene, and energy efficiency for smart beverage systems.

Key words: STM32 Micro-controller, Temperature sensor, Level sensor, Display, Capacitors, Resistor, Zener Diode, and LED, Buck Convertor..

IINTRODUCTION

In today's automated beverage dispensing systems, maintaining hygiene, efficiency,

and precision is essential. The Precision Beverage Drink Level Detection System is specifically designed to address these needs in applications like tea and coffee vending machines. This system employs non-invasive conductive rod sensors to accurately detect liquid levels in storage tanks and flasks, avoiding direct contact with the beverage. PWM (Pulse Width Modulation) pulses are used to efficiently control heating and pumping devices, optimizing power consumption. To enhance system durability, DC voltage pulses are injected through conductive elements to prevent corrosion, rust, and salt formation. Additionally, protection against AC supply interference ensures the safety of both users and sensitive electronics. The system integrates a temperature sensor to monitor the liquid's thermal state, classifying it as hot or cold and providing intelligent control. Built using core components like the STM32 micro controller, buck converter, transistors, operational amplifiers, and zener diodes, this system provides a hygienic, reliable, and energy-efficient solution for modern beverage and smart kitchen applications.

II) PROPOSED METHOD

The proposed system utilizes non-invasive conductive sensors to detect the presence and level of liquid in beverage containers without making direct contact, ensuring hygienic operation. An STM32 microcontroller processes the sensor inputs and uses PWM pulses to efficiently control devices such as heaters and pumps, enhancing energy efficiency. To increase the longevity of the components and maintain system cleanliness, the method includes DC voltage pulse injection through the conductive rods, which helps in preventing corrosion, rust, and salt deposits.

The system is also designed with AC supply protection, using DC isolation techniques to safeguard sensitive electronic components and ensure user safety. A

temperature sensor is integrated to continuously monitor the temperature of the liquid, classifying it as hot or cold. Based on both level and temperature data, the controller activates the appropriate devices, offering optimized system performance and real-time control. This approach ensures reliable, safe, and hygienic beverage dispensing in modern automated systems such as tea and coffee vending machines.

III) COMPONENTS USED

BUCK CONVERTOR

In the Precision Beverage Drink Level Detection System, the buck converter plays a crucial role in managing the system's power efficiency and voltage regulation. A buck converter is a type of DC-DC step-down converter that reduces a higher input voltage (e.g., 12V) to a lower, stable voltage 3.3V suitable for powering sensitive components like the STM32 micro controller, temperature sensor, and signal processing circuits.

This power regulation ensures that all low-voltage components receive a consistent and safe power supply without overheating or malfunctioning. Additionally, using a buck converter improves energy efficiency, reduces heat dissipation, and extends the overall lifespan of the system by preventing voltage fluctuations. Its compact size and high conversion efficiency make it ideal for embedded applications such as smart beverage machines where space and power conservation are critical.

STM32

The STM32 micro controller serves as the central control unit of the Precision Beverage Drink Level Detection System, coordinating all sensor inputs and output control signals. Renowned for its high processing speed, low power consumption, and rich peripheral support, the STM32 efficiently handles data from non-invasive conductive level sensors and the temperature sensor. It interprets these inputs to determine the current liquid level and temperature status of the beverage.

Based on real-time sensor data, the STM32 generates PWM (Pulse Width Modulation) signals to control heaters and pumps for precise and energy-efficient operation. It also manages DC voltage pulse injection through GPIO or timer peripherals to prevent corrosion and rust on conductive components. Furthermore, it provides AC protection logic, monitors voltage conditions, and controls display outputs, ensuring both safety and user feedback.

With its robust architecture and multiple communication interfaces (SPI, I2C, UART), the STM32 is ideal for smart kitchen appliances and embedded control systems requiring high reliability, making it the backbone of this intelligent beverage detection solution.

Level Sensing Electrode (Low and High):

In the Precision Beverage Drink Level Detection System, conductive rods are used as a non-invasive, reliable, and cost-effective method for detecting liquid levels—specifically for identifying low and high level conditions inside the container or tank. These rods are placed at different heights corresponding to the low and high liquid level thresholds.

When the liquid in the container comes into contact with the rod, it completes an electrical path through the liquid, which acts as a conductor. This signal is then passed through signal conditioning circuits (using transistors, resistors, and op-amps) to the STM32 micro controller, which detects the presence or absence of liquid at those specific levels.

The system uses three rods: one for common ground, one for detecting low level, and one for detecting high level. This arrangement allows the controller to monitor when the liquid drops below or rises above specific limits. Based on this input, the STM32 can activate or deactivate pumps or heaters, ensuring automated and precise liquid management in beverage systems. This method maintains hygiene, as the rods do not require moving parts or complex maintenance.

TEMPERATURE SENSOR

The temperature sensor in the Precision Beverage Drink Level Detection System plays a key role in monitoring the thermal condition of the beverage, determining whether the liquid is hot or cold. This information is crucial for applications like tea and coffee vending machines, where maintaining the appropriate beverage temperature directly impacts quality and user satisfaction.

The sensor provides analog temperature readings to the STM32 micro controller, which processes the data and classifies the beverage accordingly. This classification helps the system control associated devices such as heaters or indicators, ensuring the liquid is heated when required and giving real-time feedback through displays.

By integrating this temperature monitoring feature, the system ensures precise thermal regulation, energy efficiency, and safe dispensing, making it more intelligent and suitable for smart beverage machines. It also adds an extra layer of user convenience and system responsiveness.

BC547 TRANSISTOR

The BC547 NPN transistor is used in the Precision Beverage Drink Level Detection System as a signal amplification and switching component. It plays a critical role in the level detection circuit, particularly in processing signals from the conductive rods used for sensing low and high liquid levels.

When the conductive rod detects the presence of liquid, a small current flows through the base of the BC547 transistor. This turns the transistor ON, allowing a larger current to flow from the collector to the emitter. This amplified signal is then fed to the STM32 micro controller or other logic circuits for further processing. This allows the system to reliably sense even small conductivity changes in the liquid.

CAPACITORS & RESISTOR

In the Precision Beverage Drink Level Detection System, resistors and capacitors are fundamental passive components used throughout the circuit for biasing, filtering, timing, and signal conditioning.

Resistors are primarily used to:

Set biasing currents for components like transistors (e.g., BC547).Limit current flow to sensitive components like LEDs and sensors. Create voltage dividers for analog signal scaling and interfacing with the STM32 micro controller.Pull-up GPIO pins to ensure stable logic levels.

Capacitors is used to Filtering noise from power supply lines to protect micro-controllers and analog circuits. Smoothing voltage in the buck converter output for stable DC supply. Assisting in timing circuits where precise delays or pulse shaping is needed (especially when used with resistors). Providing decoupling at IC power pins to prevent voltage fluctuations.

Together, resistors and capacitors ensure the system operates reliably, accurately, and safely, making them essential for the control, sensing, and protection functions of the smart beverage system.

DISPLAY

In the Precision Beverage Drink Level Detection System, the display acts as the primary user interface, providing real-time visual feedback about the system's status. It shows vital information such as the current liquid level (Low/High), the temperature of the beverage (Hot/Cold), and any system alerts or actions like pump or heater activation.

The display is controlled by the STM32 micro controller, which sends relevant data after processing input from the level sensor and temperature sensor. Depending on the type used TFT or LCD, the display may also show icons or images, such as flask visuals indicating water levels.

ZENER DIODE & OP-AMP

Zener diodes can be used for voltage regulation and over voltage protection, ensuring stable operation of the STM32 and other components. Op-amps can condition sensor signals (e.g., temperature and liquid level sensors) for accurate readings. Op-amps can also function as compactor to detect liquid levels, sending high or low signals based on sensor input. For temperature control, op-amps compare sensor outputs to reference voltages, triggering actions like heating. These components enhance system stability, safety, and responsiveness in the beverage level detection system.

IV) BLOCK DIAGRAM

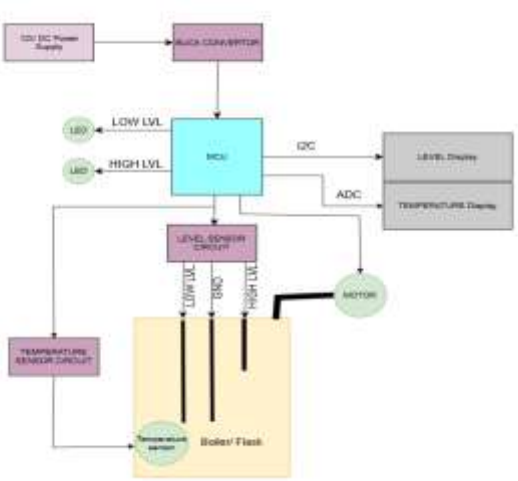

Fig.4.1 Block Diagram

CIRCUIT DIAGRAM

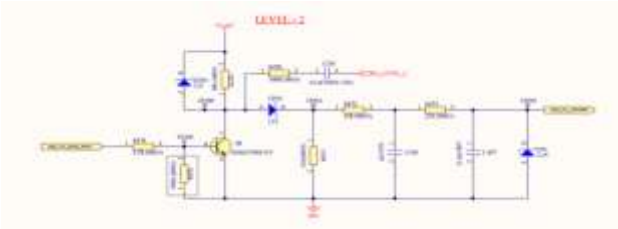

Fig.5.1 Circuit Diagram

HARDWARE RESULT

Fig.5.2 Hardware Image

RESULT

The Precision Beverage Drink Level Detection System successfully achieved accurate and real-time detection of liquid levels and temperature inside beverage containers using non-invasive conductive rod sensors and temperature sensors. The STM32 micro controller efficiently processed sensor inputs, controlling pumps and heaters through PWM for optimal energy usage. The integration of DC pulse injection prevented corrosion on conductive parts, and DC isolation provided robust protection against AC fluctuations. The system displayed live status updates on a user interface, including liquid level (Low/High), temperature (Hot/Cold), and system alerts. Overall, the project resulted in a safe, efficient, and hygienic automation solution ideal for modern tea and coffee vending machines.

CONCLUSION

The Precision Beverage Drink Level Detection System offers an efficient, reliable, and hygienic solution for automated beverage applications. By utilizing non-invasive conductive rod sensors, PWM control, and temperature monitoring, the system ensures precise liquid level detection and optimal heater/pump operation. The inclusion of DC voltage pulses for corrosion prevention and DC isolation for safety further enhances system longevity and protection. With real-time feedback, the system provides accurate dispensing and maintains hygiene, making it ideal for use in automated tea and coffee vending machines, while also ensuring safety and energy efficiency.

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