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AUTOMATIC DISPENSER USING DISTANCE SENSOR

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Abstract :Arduino Uno-based automatic water dispenser is an automation system designed to improve hygiene and efficiency in daily water consumption. This system uses an Arduino Uno as the main controller and an HC-SR04 ultrasonic sensor to detect the presence of a glass within a specified distance. Data from the sensor is processed to control a DC pump via a relay module. The methods used include hardware design, programming, and system testing. Test results show that the system functions well, detecting objects accurately between 2 cm and 8 cm. Through code optimization, the response time for turning off the pump was significantly improved from 5.2 seconds to 0.02 seconds.

Keywords: arduino uno; automatic dispenser; HC-SR04; microcontroler; touchless.

Abstract : Dispenser otomatis berbasis Arduino Uno adalah sistem otomatisasi yang dirancang untuk meningkatkan kebersihan dan efisiensi dalam konsumsi air sehari-hari. Sistem ini menggunakan Arduino Uno sebagai pengontrol utama dan sensor ultrasonik HC-SR04 untuk mendeteksi keberadaan gelas pada jarak tertentu. Data dari sensor diproses untuk mengontrol pompa DC melalui modul relai. Metode yang digunakan meliputi desain perangkat keras, pemrograman, dan pengujian sistem. Hasil pengujian menunjukkan bahwa sistem berfungsi dengan baik, mampu mendeteksi objek secara akurat dalam rentang 2 cm hingga 8 cm. Melalui optimasi pengkodean, waktu respons mati pompa telah meningkat secara signifikan dari 5,2 detik menjadi 0,02 detik.

Keywords: arduino uno; dispenser otomatis; HC-SR04; microcontroller; tanpa kontak.

INTRODUCTION

In today's era of technological disruption, the implementation of automation systems has touched various aspects of daily life, including the provision of drinking water facilities. Conventional dispensers commonly used in campus and office environments still rely on manual tap mechanisms that require physical contact between the user's hand and the device. This poses the risk of cross-contamination of bacteria and viruses, especially in public areas with high usage intensity.

In addition to hygiene issues, user negligence in properly closing the tap often leads to wasted water resources. Based on these problems, we designed an innovative contactless dispenser *based* on a microcontroller. This project aims to create a water filling system that works automatically by detecting the presence of objects without contact. By integrating an ultrasonic sensor as a distance detector and an Arduino Uno as the control brain, this device is expected to minimize physical contact and increase water use efficiency through more precise and responsive flow control.

In today's era of technological disruption, the implementation of automation systems has touched various aspects of daily life, including the provision of drinking water facilities. Conventional water dispenser facilities commonly used in campus and office environments still rely heavily on manual tap mechanisms. The use of these manual taps requires direct physical contact between the user's hand and the device, which significantly increases the risk of cross-contamination of bacteria and viruses, especially in public areas with high usage intensity.

In addition to hygiene issues, user negligence in closing the tap completely is often a major cause of water resource waste. Several previous studies have attempted to automate water dispensers using various types of microcontrollers and sensors. However, there is a research gap that is often found in similar automation systems, namely the problem of latency or delay in response time when turning off the pump. In standard systems, there is often a significant time lag between when the glass is lifted and the water flow stops, resulting in water overflow and inefficiency. The novelty of this research lies in the optimization of coding parameters, specifically in setting the delay value and adjusting the timeout in the pulseIn function to minimize system latency.

Through this approach, the system is not only able to detect objects without contact, but also managed to drastically reduce the pump off response time from 5.2 seconds to 0.02 seconds. Based on these problems, the purpose of this research is to design and implement an automatic dispenser system based on Arduino Uno and a more responsive HC-SR04 ultrasonic sensor. This research is expected to produce a hygienic water filling system by minimizing physical contact, while increasing the efficiency of water use through precise and real-time flow control.

METHOD

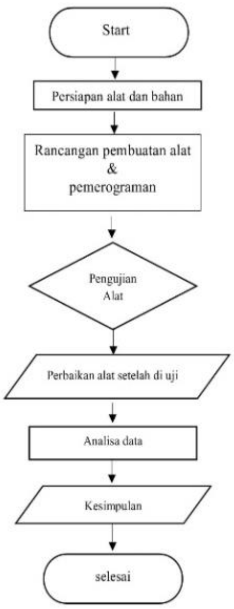

Image 1. Research flow

The method stages described, the hardware implementation process is carried out in accordance with the system design. The results of the tool realization are shown in the following Image.

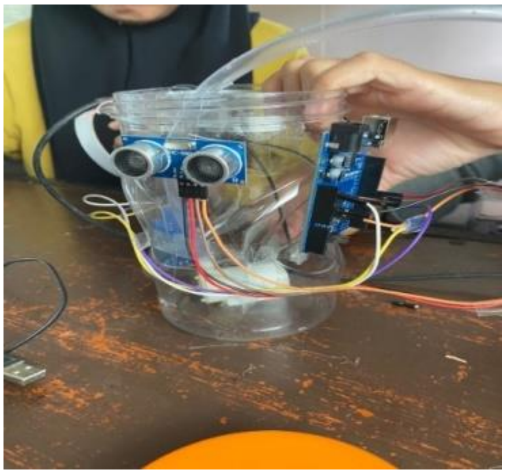

Image 2 Realization of automatic dispenser

Testing was conducted to validate system performance under various distance and response time conditions. Data was collected through direct observation of the hardware and monitoring of values via *the Serial Monitor* in the Arduino IDE.

Table 1 Distance Testing (Sensor Accuracy)

test	Measured Distance (cm)	Relay Response	Pump Response	Information
1	1 cm	OFF (Dead)	Dead	Too close (Blind Spot)
2	2 cm	ON (On)	Life	Water Filling Begins
3	3-5 cm	ON (On)	Life	Ideal Charging Conditions
4	8 cm	ON (On)	Life	Safe Charging Limit
5	10 cm	OFF (Dead)	Dead	The glass is moved away (Stop)

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Table 2 Response Time (Latency) Testing

Parameter Test	Before Optimization (delay 5000)	After (delay 20)	Conclusion
Life Time	0.1 Seconds	0.1 Seconds	Stay Responsive
Dead Time	5.2 Seconds	0.02 Seconds	Improvement Significant

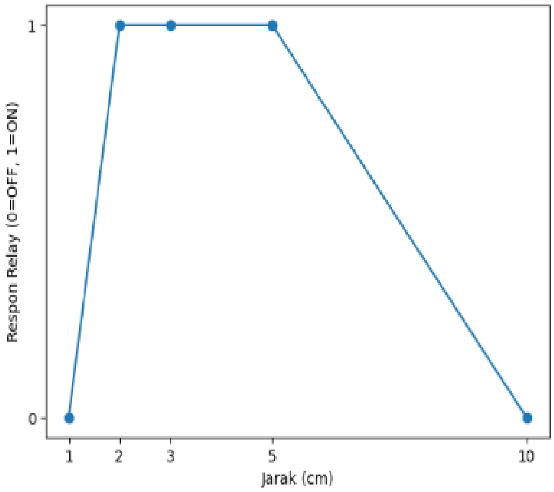

Image 3 distance test graph (sensor accuracy)

Blind Spot Area (Distance < 2 cm):

The graph shows that at a distance of 0 to 1 cm, the system is in the "OFF" or inactive state. This indicates a blind spot in the ultrasonic sensor, where the sound waves return too quickly for the microcontroller to accurately process.

Optimal Operational Range (2 cm – 8 cm):

The graph shows a constant line (Logic 1/ON) over a distance range of 2 cm to 8 cm. This is the system's Active Zone. In this area, the sensor has the highest level of accuracy in detecting the glass, which triggers the relay to consistently turn on the pump. This range was chosen to ensure the glass is close enough to the water fountain to avoid splashing.

Threshold and Safety Point (> 8 cm):

Just after the 8 cm point, the graph shows a sharp drop back to 0 (Logic 0/OFF). This demonstrates that the system has a very tight threshold. When the glass is moved more than 8 cm or lifted, the sensor instantly detects the change in distance and cuts off the water flow.

Linearity and Stability:

The stability of the line in the 3 cm to 5 cm range indicates the most ideal area for the user to place the glass. A clean graph with no fluctuations in this range indicates that code optimization and the use of threshold filters have successfully minimized environmental noise.

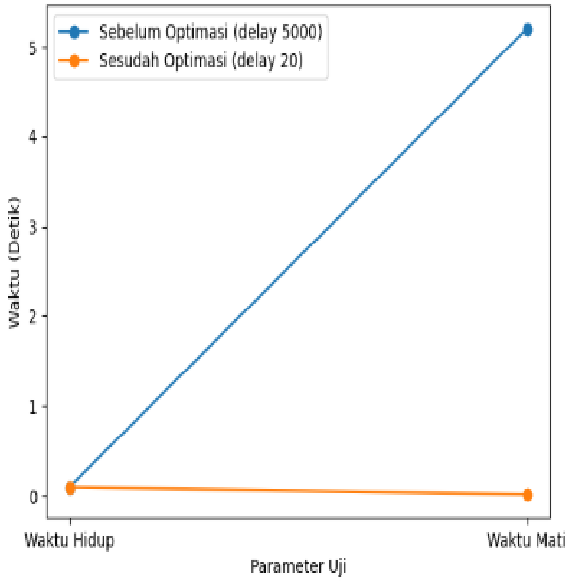

Image 4 Response Time (Latency) Test Graph

This research was conducted through an experimental approach divided into several systematic stages. The research flow starts from literature study, hardware component preparation, system design, to validation testing.

Hardware Design This system uses Arduino Uno as a central processing unit that integrates several main components: HC-SR04 Sensor: Used to detect the presence of a glass with the principle of ultrasonic wave reflection. Relay Module: Acts as an electronic switch to disconnect and connect the current to the pump. DC Pump: Functions to flow water from the source to the container (glass).

Software Design The system logic is developed using the C++ programming language on the Arduino IDE. The main algorithm focuses on reading the duration of the signal reflection through the $pulseIn$

function which is converted into distance units in centimeters (cm). Optimization is done by applying a timeout value to the $pulseIn$ function and reducing the delay to increase system responsiveness.

RESULTS AND DISCUSSION

The Arduino Uno-based automatic dispenser system can function according to the design that has been made. The HC-SR04 ultrasonic sensor shows stable accuracy in detecting the presence of objects (glasses), where based on distance parameters, the system is able to activate the pump automatically when the object is in the range of 2 cm to 8 cm. Under ideal conditions (distance 3-5 cm), the sensor sends a signal to the Arduino to activate the relay so that water flows precisely into the glass.
Overall, the system is capable of operating in real-time and providing a very fast response thanks to coding optimization. Reducing the delay value from 5000ms to 20ms has been proven to increase system reliability, where the pump shutdown response time is drastically reduced from 5.2 seconds to just 0.02 seconds, thereby completely eliminating the risk of water overflow. Furthermore, the use of Normally Open (NO) terminals on the relay ensures system safety during startup, so the pump does not turn on without a command. This shows that this contactless dispenser system works effectively and is very suitable for implementation as a hygiene solution at the household scale and public facilities.

Distance and Sensor Accuracy Analysis

The system's performance was validated through a series of distance tests to determine the effectiveness of the ultrasonic sensor.
Blind Spot Area (< 2 cm): Testing at a distance of 1 cm resulted in an "OFF" state for both the relay and the pump. This indicates a blind spot where sound waves return too quickly for the microcontroller to process accurately.
Optimal Operational Range (2 cm – 8 cm): The system remains consistently active (ON) within this range. An ideal charging condition was identified between 3 cm and 5 cm. This specific range ensures the glass is close enough to the fountain to prevent water splashing.
Safety Threshold (> 8 cm): When an object is moved beyond 8 cm, the sensor instantly detects the change and cuts off the water flow. At a test distance of 10 cm, the system successfully returned to a "Dead" or inactive state.

Response Time and Latency Optimization

The primary novelty of this research is the drastic reduction in system latency through coding optimization.
Before Optimization: Using a standard delay(5000), the system experienced a significant "Dead Time" (pump shutdown lag) of 5.2 seconds. This lag typically causes water overflow and resource waste.
After Optimization: By adjusting the delay to 20ms and optimizing the pulseIn function timeout, the response time for turning off the pump was reduced to 0.02 seconds.
Efficiency Gains: While the pump activation time (Life Time) remained responsive at 0.1 seconds, the improvement in shutdown speed effectively eliminates the risk of water overflow.

Hardware Reliability and Safety

The integration of the hardware components contributes to the overall stability of the dispenser.
Relay Logic: The implementation of **Normally Open (NO)** terminals on the relay ensures that the pump does not activate accidentally during system startup.
Signal Stability: The use of threshold filters and code optimization successfully minimized environmental noise, resulting in a stable operational graph with no fluctuations in the ideal detection range.

CONCLUSION

This research successfully designed and realized a microcontroller-based automatic touchless dispenser system by integrating the HC-SR04 ultrasonic sensor and relay module as the main control unit. Through optimization of coding parameters, especially setting the minimum delay and adjusting the timeout on the pulseIn function, the system is able to provide a responsive real-time response without any time lag, so that the pump can stop immediately when the object is removed. The implementation of Normally Open (NO) terminals on the relay and the use of thresholding logic are proven to increase system reliability in maintaining operational safety (preventing water spills) and minimizing interference (noise) on sensor detection. Overall, the integration of economical components with structured cable path management shows that simple automation technology can be a hygienic and efficient solution for household and public needs that is easy to implement.

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