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MICROCONTROLLER IMPLEMENTATION ON ULTRASONIC SENSOR BASED AUTOMATIC TRASH CAN SYSTEM

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Abstract : Waste management in Sei Beluru Village faces challenges due to population growth and increasing waste volume. This research aims to design and implement an automatic waste bin system based on microcontroller using Arduino Uno. The research uses experimental method with hardware and software development stages including system design, component integration, and testing. The developed system integrates HCSR-04 sensors for waste volume detection, infrared sensors for object presence detection, and servo motors for automatic opening-closing mechanism. Test results show that the system successfully detects waste levels with high accuracy and operates the opening-closing mechanism effectively. The implementation of this system proves effective in optimizing waste management in Sei Beluru Village by reducing physical interaction and preventing waste accumulation.

Keywords : arduino uno; HCSR-04 sensor; automatic waste bin; HCSR-04 sensor; microcontroller; waste management.

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INTRODUCTION

The rapid development of technology has encouraged various innovations in everyday life, including in terms of waste management. Public awareness of the importance of maintaining environmental cleanliness and hygiene continues to increase, but this has not been matched by the development of adequate supporting facilities. Conventional trash cans that are still widely used today have several obstacles, especially in terms of hygiene and ease of use. Users must directly touch the lid of the trash can which has the potential to be contaminated with various bacteria and germs, which can cause health problems [1].

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The development of information and communication technology has become very important to improve efficiency in various aspects of life. In this context, the utilization of technology-based automation and control systems can provide innovative solutions to everyday problems. With the right approach, this technology can help individuals and organizations manage information and increase productivity, which in turn has a positive impact on people's quality of life [2].

Technology plays an important role in improving efficiency and effectiveness in everyday life. One of the challenges faced is efficient waste management, especially in big cities. With the increasing amount of waste, innovative solutions are needed that are not only practical but also environmentally friendly. The design of this automatic trash can is one of the steps to overcome the problem, especially in the context of maintaining cleanliness during the COVID-19 pandemic [3]. In dealing with waste management issues, it is important to understand the social and environmental impacts of waste. People often lack awareness of the importance of keeping the environment clean. This research aims to increase public awareness about proper waste disposal and introduce technology that can facilitate the process, such as a microcontroller-based automatic trash can device [4].

In this modern era, waste management is a serious challenge, especially in educational environments such as Islamic boarding schools. The importance of innovation in waste management is felt, considering that dirty environmental conditions can cause various health and comfort problems. Therefore, efficient solutions that utilize technology to improve waste management are needed [5].

The use of Arduino Uno-based technology in an automated waste bin system can bring significant changes in waste management. This system not only improves the efficiency of waste collection, but also provides convenience for cleaners in carrying out their duties [6].

In addition, the application of Internet of Things (IoT) technology in waste management shows that microcontroller-based monitoring allows management to be carried out in real-time. With this system, managers can monitor and organize waste transportation more effectively, expected to have a positive impact on environmental hygiene and public health [7].

Advances in the field of electronics and microcontrollers open up opportunities to overcome these problems through the development of an automatic trash can system. By utilizing ultrasonic sensors as a user presence detector, the system can open and close the trash can lid automatically without the need to touch. This technology not only improves the hygiene aspect but also provides convenience for users in disposing of waste [8].

The implementation of microcontroller in automatic trash bin system is a promising solution to improve efficiency and cleanliness in waste management. This system uses an Arduino microcontroller as the main processing unit that controls the HC-SR04 ultrasonic sensor to detect the presence of the user and the servo motor as the driver of the trash can lid. When the sensor detects an object within a certain distance, the microcontroller will send a signal to the servo motor to open the trash can lid automatically [9]. This research aims to develop and implement a practical and hygienic au-

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tomatic trash can system using microcontroller and ultrasonic sensor. Through the development of this system, it is expected to provide solutions to the problems that exist in conventional trash cans while encouraging people to be more concerned about environmental cleanliness. This system is also designed by considering aspects of energy efficiency and ease of maintenance so that it can be used in the long term [10].

METHOD

Research Design

This research aims to design and imple- ment an automatic trash bin monitoring and control system using modern tech- nology. The methodology used includes hardware and software design, testing, and system evaluation to ensure the func- tionality and effectiveness of the system in meeting the research objectives.

Tools and Materials

In this research, various tools and materi- als are used to support the system design. The Arduino Uno microcontroller serves as the main controller of the system, while the HCSR-04 sensor is used to de- tect the volume of waste in the bin. In addition, an infrared sensor is utilized to detect the presence of objects in front of the bin. Servo motors are used to open and close the lid of the waste bin automatically, controlled through the microcontroller. An ESP8266 module is installed to provide internet connection and enable data communication between the system and the Blynk application. The Blynk application itself acts as a user interface, enabling real-time monitoring of the bin condition and providing notifications to the user.

System Design

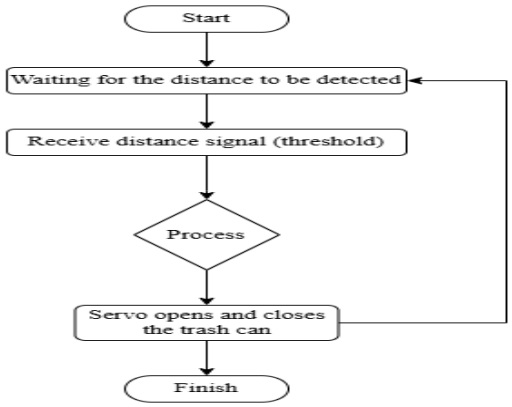

Figure 1. System Design

The system design includes the integra- tion of several key components to create a functional and efficient system. The HCSR-04 sensor and infrared sensor are connected to the Arduino Uno to detect the volume of waste and the presence of objects. The servo motor connected to the Arduino is controlled to open and close the trash can lid automatically according to the conditions detected by the sensors. The ESP8266 module is used to connect the system with the internet, so that the data obtained can be sent to the Blynk application. Through this application, users can monitor the status of the bin directly and receive notifications when the bin is full or in certain conditions.

Research Procedure

The research procedure begins with hardware design, where electronic components are arranged according to the pre-designed system diagram. After that, software development was carried out using the Arduino IDE, to control the sensors, motors, and internet connection. The next stage is system testing, which includes testing the sensors to detect the volume of waste and the presence of objects, the servo motor to ensure the responsiveness of opening and closing the

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bin lid, and the ESP8266 module to ensure the internet connection is running properly. The Blynk application is also tested to ensure the data from the system can be displayed correctly to the user. In the final stage, an evaluation is conducted to analyze the test results and determine the reliability and efficiency of the system as a whole.

Data Analysis

Data analysis was conducted based on the test results of the system. The param- eters analyzed include the accuracy of the waste volume measurement by the HCSR-04 sensor, the responsiveness of the system in opening and closing the bin lid according to sensor detection, and the reliability of the internet connection through the ESP8266 module in sending data to the Blynk application. The results of this analysis are used to evaluate the performance of the system and identify opportunities for further improvement.

RESULTS AND DISCUSSION

System Description

This automatic trash bin monitoring and control system is designed using Arduino Uno microcontroller and ESP8266 mod- ule. The system utilizes the HCSR-04 ultrasonic sensor to detect the volume of waste as well as an infrared sensor to de- tect the presence of objects near the bin. By utilizing this technology, the trash can is able to open and close the lid automat- ically without requiring direct physical interaction from the user [11].

System Component Analysis

The system consists of several main components that have specific roles in supporting its functionality. The Arduino Uno microcontroller acts as the control center of the entire system. With its small size and flexible programming capabili- ties, Arduino Uno can manage inputs from various sensors as well as control servo motors to open and close the trash can lid. Its flexibility in integration with various software libraries facilitates sys- tem development and optimization [12].

The HCSR-04 ultrasonic sensor is used to measure the distance of objects and detect the volume level of garbage in the bin. This sensor works on the principle of the travel time of ultrasonic waves that are reflected back after hitting an object. The resulting data allows the system to detect the capacity of the bin with a high degree of accuracy, whether it is empty, half full, or full [13]. Servo motors function as trash can lid movers with the ability to accurately con-trol the angle of rotation. These motors are often used in robotics and automation applications due to their precision of movement. With a feedback system, ser- vo motors allow for smooth and respon- sive position control, making them an ideal component for automatically man- aging the opening and closing of trash can lids [14].

The Arduino IDE, as the developer soft- ware, is used to write, compile, and up- load program code to the Arduino micro- controller. This IDE provides a simple yet powerful user interface, allowing both beginners and experienced develop- ers to develop programs with ease. Using the C/C++ programming language equipped with various additional func- tions and libraries, the Arduino IDE sup- ports the development of complex fea- tures as well as extending the capabilities of the designed project [15].

Testing Results

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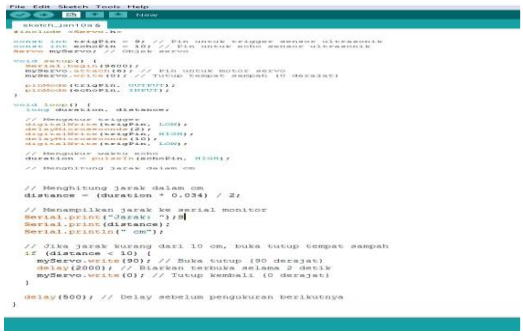

Figure 2. Program code in Arduino IDE

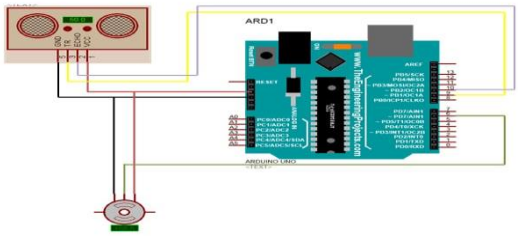

Figure 3. Automatic Trash Can Microcontroller Tool Set

System testing is done by checking the function of each component separately and as a whole to ensure the system works according to the design. The test results show that all components function properly. The ultrasonic sen sor test shows an adequate level of accuracy in detecting the user's distance from the trash can, so that the system can provide an appropriate response. In addition, test- ing the duration of opening and closing the bin lid showed a delay of two se- conds, which ensures the mechanism works efficiently and respo nsively.

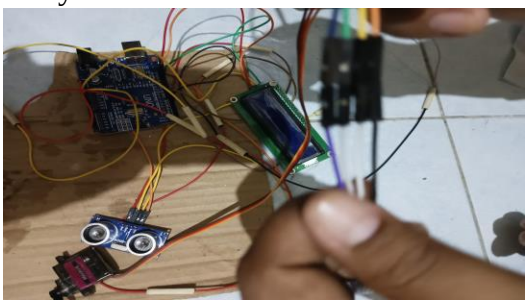

Figure 4. Tool Assembly

Figure 5. Tool Testing

CONCLUSION

The results of the research and testing that have been carried out, it can be concluded that the microcontroller-based automatic trash can system was successfully designed and implemented effectively in Sei Beluru Village. The integration of HCSR-04 sensor and infrared sensor with Arduino Uno showed reliable performance in detecting the volume of waste and the presence of objects. The use of servo motors for the automatic open-close mechanism proved effective in reducing physical contact with the waste bins, improving the cleanliness and hygiene aspects. The implementation of this system provides an appropriate technological solution in optimizing waste management at the village level.

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