WASTE COLLECTION DEVICE IN RIVER WITH ULTRASONIC SENSOR AND INFRARED PROXIMITY SENSOR

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Abstract. *A pile of waste in the river can block the river's flow and potentially cause flooding. Meanwhile, workers who specifically handle river waste are generally limited and unable to clean it effectively and efficiently. Therefore, there is a need for technology that can automatically collect waste in the river without relying on human labour, equipped with a real-time waste monitoring system. To address this issue, this research was conducted by designing a device with an ultrasonic sensor and an infrared proximity sensor equipped with an Internet of Things (IoT)-based monitoring system connected to a Wi-Fi network. This research focuses on the design of a prototype device for collecting bottle waste. The prototype device was designed using propellers as waste carriers, a conveyor as a waste transporter to the collection bin, and the Blynk application as an IoT-based monitoring system. This research is expected to read a distance of approximately 5 cm for bottle waste, allowing bottle waste to be transported and collected in the waste container with 4 seconds for bottle waste so that the transport motor and conveyor operate continuously.*

Keywords: *Internet of Things (IoT), Monitoring, River, Sensor, Waste.*

1. INTRODUCTION

Piles of waste in river are a common problem in urban environments (Agnes & Yesika, 2023). Based on data from the National Waste Management Information System (SIPSN), there are 19,071,915.46 tons of waste piles per year, and only 50.64% of the waste that can be handled is 50.64 tons per year. According to data from the West Java Environment Agency, the Citarum River, with an area of 11,323 km, has a pile of 15,838 tons of waste per day (Zulhadi et al., 2023). This is due to the low awareness of the public not to throw waste into the river, especially residents who live around the riverbank. As a result, there is a buildup of waste in the river, which causes a blockage of the river flow. River cannot hold enough water when rainfall is heavy, which could lead to flooding (Syarifah & Sudarti, 2023).

Numerous initiatives are still underway to address the issue of trash buildup along riverbanks. One of them is by making a ship to transport and sort waste operated downstream of the Ciliwung River, DKI Jakarta. However, the construction of this ship requires a fairly large cost, namely Rp. 1,398,761,820, with an operational cost of Rp. 252,921,124 (I Komang & Ni Putu, 2020). Waste that travels along the riverbed needs to be collected automatically, without the need for human work. As a result, time and trash transport workers are more efficient. In addition, there is a need for real-time data on monitoring the capacity level of waste bins to find out when waste is transported when the capacity has been met.

To create an automatic waste collection system in the river that does not depend on human labour, it can be done by utilizing the development of Internet of Things (IoT) technology. In addition, with IoT, the data of the waste pile can be known in real-time. Therefore, this research was conducted to overcome the problem of waste piles in river by designing and making waste collection devices in river using an IoT-based monitoring system. In addition, the device is designed to be able to connect to the Wi-Fi network by utilizing the WEMOS D1-R32 microcontroller utility, which is already equipped with WiFi and Bluetooth. With the existence of waste collection equipment in this river, there is no

need for waste collection officers who are directly involved in picking up waste in the river, nor is there a need to operate a waste transport and waste sorting ship that requires large operational costs so that it can improve the existing waste collection system.

2. LITERATURE REVIEW

The following explains some of the elements and underlying theories that were employed in this research:

2.1 Internet of Things (IoT)

The Internet of Things (IoT) is a microcontroller-based technology that can enhance the benefits of internet connectivity to make human activities easier and more efficient. IoT is a sensor that communicates using Radio Frequency Identification (RFID) technology (Wilianto & Ade Kurniawan, 2018).

Numerous studies demonstrate that IoT has advanced significantly across a wide range of scientific and industrial domains, including geography, healthcare, informatics, and others. Intelligent sensors have been built into everyday devices that can be controlled online. The smart sensor converts analogue data into digital data and then sends it to the processor in real-time. Thus, this architecture allows for the automation of remotely controlled equipment (Sri Melati et al., 2013).

2.2 Microcontroller

A microcontroller is an integrated circuit (IC) that is used for control purposes. A microcontroller has parts to support its control functions, such as a central processing unit (CPU), read-only memory (ROM), random access memory (RAM), timer, and I/O unit. The first microcontrollers and the basis for the use of microcontrollers are the Atmel, AVR, and MCS51. AVR has an 8-bit RISC architecture, which means that all instructions are packaged in 16-bit (16-bit word) code, and most instructions are done at one time, in contrast to MCS51 instructions, which take 12 times [8]. AVR has Reduction Instruction Set Computing (RISC) technology, while MCS51 has Complex Instruction Set Computing (CISC) technology. In general, AVRs include four classes: AT-Mega, AT-86RF-xx, and AT-Mega 32. Memory, peripherals, and functions are the main things that distinguish each class (Ahmad et al., 2021).

2.3 Arduino WEMOS D1-R32

The Arduino WEMOS D1-R32 is part of the Wi-Fi-based ESP32 module family. The core of the WEMOS D1-R32 is the ESP32 dual-core 32-bit Xtensa LX6, each of which has speeds of up to 240 MHz. The Arduino WEMOS D1-R32 also has dual-band Wi-Fi 802.11 n/802.11 ac and Bluetooth 4.2/5.0 BLE. It is similar in shape to the Arduino Uno R-32 and has an input voltage of 5 V to 12 V (I Putu Ardi et al., 2021).

The ESP32 is a chip with CPU processing capabilities and a microcontroller that can access Wi-Fi and Bluetooth networks. The ESP32 chip is typically placed alongside basic components such as resistors, capacitors, crystals, and flash memory before being embedded on the development board or D1-R32 board. The components are mounted on the surface solder of the circuit board to form modules (Muhammad Nizam et al, 2022).

2.4 HC SR04 Sensor

The HC-SR04 sensor is an ultrasonic distance sensor that detects objects in front of it by using ultrasonic sound waves. The transmitter sends ultrasonic waves to the sensor, which are subsequently reflected by the object and sent back to the sensor via the receiver. Nevertheless, the shape of the target or object being measured is not necessarily the same (Tri Nur, 2022).

At a frequency of 40 Hz, the HC-SR04 ultrasonic sensor can be used to measure

the separation between objects. According to its specifications, the HC-SR04 ultrasonic sensor has four pins: ground, echo, trigger, and V cc (Devita et al., 2024).

2.5 Proximity of SN-E-18-D80NK Sensor

The SN-E-18-D80NK Proximity Sensor is a sensor for detecting changes in the value of the surrounding environment which then emits an electrical signal in response. This sensor is also called an infrared obstacle detection sensor, because it uses infrared to detect objects in front of it. This sensor can detect objects within 3 centimetres to 30 centimetres. This detection distance can be changed by adjusting the trim pots (Mega, 2020).

3. RESEARCH METHODS

The research method used in this research begins by formulating the problem that will be used as the object of research. First, the real conditions in the field are examined in order to formulate the problem. Additionally, data collecting is done through literature reviews and system observation. In the design stage of the device and system, a prototype was designed to collect automatic waste in the river using the WEMOS D1-R32 microcontroller and display the reading results on the Blynk application on a smartphone. The device is put to the test in order to assess the research's results. This process also includes an assessment and analysis of the device's performance to ensure the device is functioning as expected.

4. RESULTS AND DISCUSSION

Figure 1 below shows a block diagram of the design of the device to clarify the components in the designed device

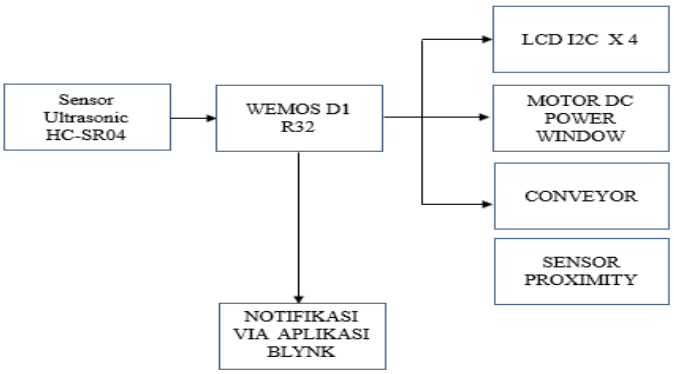

Figure 1. Block Diagram

Components used in manufacturing the prototype of the waste collection equipment in the river with an IoT-based monitoring system are as follows:

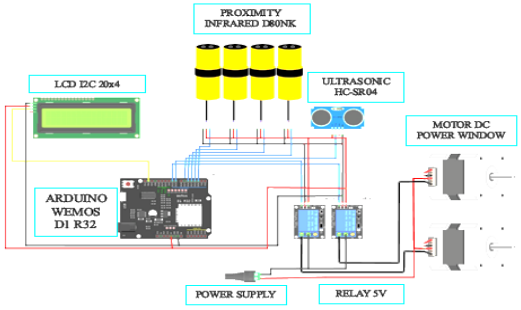

Figure 2. Designed Device

1. Arduino WEMOS D1-R32 Microcontroller

The Arduino WEMOS D1-R32 microcontroller functions as a controller and data processor for the input device and then forwards it to the output device. The WEMOS D1-R32 in this prototype provides commands for sensors and conveyor and propeller motors.

2. I2C LCD 20 x 4

The I2C LCD has the function to display the characters of the commands given by the WEMOS D1-R32 microcontroller and as a display of the working status of the device on this prototype.

3. HC-SR04 Ultrasonic Sensor

The HC-SR04 Ultrasonic Sensor is a sensor that uses ultrasonic waves to detect the presence of an object by estimating the distance between the sensor and the object. The ultrasonic sensor in this research is useful as a detector for the presence of waste passing through the river.

4. E-18 D80NK Infrared Proximity Sensor

The E-18 D80NK Proximity Infrared Sensor functions as a detector of the presence or absence of an object. The maximum distance of this sensor is 80 cm. The output of the sensor circuit is "1" or "high" if an object is in front of the sensor and within reach of the sensor. The E-18 D80NK infrared proximity sensor is a sensor for the capacity level of the waste collection and can see and determine the percentage of height of the waste bin. There are as many as four sensors used in this prototype.

5. 5 V Relay

A 5 V relay is a switch that automatically controls high current using a low current signal. In this prototype, the use of a 5 V relay was used to drive the DC motor from the conveyor and propeller.

6. DC Motor (Power Window)

A power window-type DC motor that is often used in vehicles by using a switch to operate it. The working system of the power window motor uses electrical energy and magnetic energy to produce mechanical energy. The operation of the motor depends on the interaction of the two magnetic fields. The DC motor in this prototype is indispensable for driving conveyors and propellers as waste carriers.

7. Power Source

The power supply has the function of converting the flow of electricity from the power source to energy to power electronic devices or converting 220 V power into electricity according to its output needs. With a voltage specification of 12 V and a current of 10 A, it can drive conveyor and propeller motors whose voltage source is 12V.

The use of this waste collection device begins with connecting it to a communication network such as Wi-Fi. If it is connected (yes), then the device is ready to monitor the presence or absence of waste objects. If there is a waste object (yes), then the motor moves the propeller, the motor moves the conveyor, sensors to detect the presence of waste, and sensors to detect the capacity level of the waste container become active. Then the BLYNK application connects to the server to update the waste monitoring data in the river. If there is no waste object (no), then the motor deactivates the propeller, the motor deactivates the conveyor, sensors to detect the presence of waste, and sensors to detect the capacity level of the waste collection tank are deactivated. Then the BLYNK application connects to the server to update the waste monitoring data in the river.

The test starts with an ultrasonic sensor that detects the presence of waste in the river. Once detected, the transport propeller will lift and move the waste onto the

conveyor. The conveyor then carries the waste to the reservoir. The reservoir is equipped with an infrared proximity sensor that functions as a capacity level sensor to monitor the capacity level of the reservoir. The following is a test with various types of time to find out the time of the safe distance for transporting waste that can be transported to the container by experimenting with using types of bottles waste.

Table 1. Results of Testing the Effectiveness of Bottle Waste Collection Time

No.	Time	Condition	Volume Container	Voltage
1	2 seconds	not up to 5 cm	empty	12 V
2	4 seconds	up to 5 cm	25%	12 V
3	6 seconds	up to 5 cm	50%	12 V
4	8 seconds	up to 5 cm	75%	12 V
5	10 seconds	up to 5 cm	100%	12 V

From the results of the test of HC-SR04 ultrasonic sensor waste detection test, it is true that the bottle waste used in this prototype can all be detected with the HC-SR04 ultrasonic sensor within 5 cm.

CONCLUSION

After conducting research and experiments, several conclusions can be drawn as follows: 1.The reading distance of the HC-SR04 ultrasonic sensor against bottle waste is no more than 5 cm away; 2. Bottle waste can be transported and collected in the waste collection bin with a time lag of 4 seconds on the ultrasonic sensor so that the conveyor motor and conveyor keep running; and 3. BLYNK can be accessed to display real-time data by connecting to an internet connection.

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