Smart system using programmable logic controller for seabin prototype

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Abstract. This research aims to design an automatic garbage collection system using a Programmable logic controller (PLC) and an Arduino Uno waste monitoring system. The function of this tool is to make people easier for clean marine debris, which is usually clean manually. In this case, operators or cleaners are only sufficient to wait for information in SMS if the trash bin is fully loaded. This study used an LDR sensor as input to respond to the state of the wastebasket and a DC motor used as a transmission system in transporting and moving the position of the wastebasket. In addition, using the ultrasonic sensor as input in the trash bin and a GSM SIM 900 A module functions as a medium for sending messages that the trash bin was full. Resultant of this study indicate that the tool can lift ±0.5 kg of waste per hour, with the heaviest weight that can be lifted ±0.7 kg and the lightest weight of ±0.5 kg with the most types of rubbish obtained in the form of plastic and other small debris.

1. Introduction
Coastal areas have the potential for beauty and comfort as a place of recreation and tourism. In addition, because of the ease of transportation and distribution of goods and services, a source of cooling water for industry, and waste disposal; then the coastal area serves as a center for settlements, ports, business activities, etc. Therefore, it is natural that more than half of the world's population lives in coastal areas, and two-thirds of the world's major cities are also located in this region [1].

Based on these facts, we cannot underestimate the pollution level in several coastal areas and oceans. Garbage or everything that floats on the sea surface, ranging from plastic bottles, paper, oil, and other household waste, will be very scattered and damage the coastal ecosystem and the sea. The international world's attention to plastic waste in the sea (Marine Plastic Debris) has recently increased. One stunning example is that Indonesia was declared the second largest contributor of plastic waste to the ocean globally in 2010, after China, with an estimate of 0.48–1.29 million metric tons per year [2]. Currently, Indonesia is in an inferior condition. The primary sources of coastal and marine pollution consist of three types of activities on land, namely industrial activities, household activities, and agricultural activities. Meanwhile, sources of pollution originating from various activities at sea include sea transportation and ships carrying oil, mining activities, and offshore energy [3].

Many studies have been doing it to solve environmental damage caused by waste, especially plastic waste. For example, the research [4], [5], [6] introduced the design and development of an innovative green environment of a waste monitoring system by measuring the level of waste in real-time using ultrasonic sensors to measure the level of junk and the monitoring system using IoT. There are also several studies conducted in the management of marine and coastal waste. For example, in the research
[7], [8], an automatic ship prototype was made to search and collect garbage at sea. Then in the study [9] made a garbage collection vehicle is applying near the beach sand. Based on these problems and previous studies, this paper focuses on handling and managing waste in coastal areas. In this paper, designing an automatic suction and garbage transporter above sea level can transport waste previously stored in a basket and dispose of it automatically without human assistance. In the working system of this tool, the vacuum cleaner will suck the garbage around the tool by using a pump as a suction device and using a PLC as a connecting device. Programmable Logic Control (PLC) is an electronic system that operates digitally and designs industrial environments [10]. This system uses a programmable memory for the internal storage of instructions that implement specific functions such as logic, sequence, timing, controlling a DC motor in regulating the direction of rotation of the motor, either clockwise or counterclockwise [11]. Then the PLC can also control 3 phase electric motors such as water pumps [12].

The next step at TPS (Temporary Disposal Sites) will be an SMS Gateway system that makes it easier for operators to monitor trash bins, so they don't need to see them every time. This study using an SMS Gateway because it adapts to the conditions of the community where the device is testing. Based on the survey, using SMS notifications in real-time is more comfortable than adding applications on their cellphones. In addition, the System for Mobile communication (GSM) technology can be used with the Arduino platform, which makes it possible to receive/send SMS to/from the manager's cellphone as needed and is more user-friendly [13], [14].

This system uses an ultrasonic sensor to detect garbage when complete, indicating the garbage's proximity to the sensor. In addition, the active sensor will make the SIM 900 A functional by sending an SMS to the operator notifying that the TPS (temporary disposal site) is ready for cleaning [15]. This design makes it easier for workers to clean up the garbage on the sea and help maintain the beautiful coastal environment to protect the marine ecosystem.

2. Methods
2.1. Mechanical Design
As shown in Figure 1, it is a design used in this study. This study uses four DC motors for two motors as a single system: a lifting system for up and down, a right-left carrier system, and an exhaust system. In addition to motors, this study uses three limit switches, one LDR sensor, one PLC controller box as a lifting system controller, and one Arduino controller box as a monitoring system. The minimum distance of the wastebasket that has been install with the LDR sensor at sea level is 1 meter. Following previous research [15], the optimal space to put the basket is 1 meter from the seabed.

![Figure 1. Mechanical Design](image-url)
2.2. Hardware Design
Figure 2 is a hardware design consisting of two parts, and the first is the input section; there is a limit switch and LDR for PLC and ultrasonic for Arduino. The ultrasonic sensor determines the accuracy of the distance from a predetermined objective and can measure the liquids' level (oil and water) [16], [17]. The process section consists of PLC and Arduino devices, and at the output section, there is a DC motor and water pump for PLC and SIM 900 A for Arduino.

![Figure 2. Hardware Design](image)

2.3. System Planning
The system design consists of two parts: the first part using a PLC system and the second using the Arduino system, as shown in Figures 3 and 4. The system design consists of the input and output processes. For the input process: an LDR sensor, limit switch, proximity sensor as a source for input into PLC and Arduino systems. In contrast, the output consists of a motor and SIM 900 A, which will work when receiving information or signals from sensor input.

![Figure 3. Arduino Software Design](image)
3. Result and Discussion

Before the data retrieval process, testing the entire device is carried out to work optimally during the implementation of the device. The device combines all components, including power supply, PLC, DC motor, limit switch, LDR sensor, Arduino, GSM SIM 900 A, and ultrasonic. This test begins by testing the LDR sensor in conditions at sea and on land to determine the resistance value generated in each place. This lifting device will work if the LDR sensor placed on this tool does not get light due to the closed sensor by garbage. Next, this sensor connects with a comparator circuit consisting of IC 741 to get a comparison value that serves as the determining value of the sensor work. This circuit reads from the input voltage value and a reference voltage influenced by a given resistance value. When the reference voltage is smaller than the input voltage, the output voltage approaches the source voltage (high), and this voltage using as input to the PLC and vice versa. When the reference voltage exceeds the input voltage, the output voltage approaches the ground value (low). After the sensor is active, the sensor will signal the PLC to turn on the motor.

This research tool works to use a signal based on the input provided by the LDR sensor and will work to detect which is marked by a reduced resistance value due to insufficient light caused by garbage that fills the basket. When the basket is full, or the marking sensor is turned off as a whole, the sensor will be activated to turn off the water pump and start the DC motor to move the net to the surface, and then motors 1 and 2 will dynamically pull at the same time and bring the basket to the top. Motors 1 and 2 will stop when they touch the limit switch 1. After limit switch one is connected, motor three will be

![Diagram](image.png)

**Figure 4.** PLC Software Design
active, marked by the basket moving to the right towards the TPS (Temporary Disposal Place) by following the rope's movement until it touches the limit switch 2. The activation of limit switch two will activate motor 4 to pull the wastebasket to remove the contents (garbage). This process uses a timer as a control. Furthermore, after the timer on motor four has finished operating, motor three will be active and moving the basket to the left until it touches the limit switch 3. Then after the limit switch, three is connected, motors 1 & 2 will be active and move the basket down for 20 seconds, and the system works again.

At the TPS (Temporary Disposal Site), an ultrasonic sensor embedded with a SIM 900 A. The sensor functions as a detector for the capacity of the trash can. The system will monitor the garbage in the trash. If the height of the garbage approaches a predetermined distance, the sensor will send a signal to be processed by Arduino; then SIM 900 A will send information in the form of a message containing the bin is full.

Data collection had carried out for 4 hours a day for five consecutive days. Data collection is carried out in high tide conditions because the device the designed to transport sea surface waste and is equipped with a holding basket installed with an LDR sensor with a minimum basket distance from sea level of 1 meter. The first day of testing shows that the device can get waste with an overall weight of 1.1 Kg. The second day of testing gets 0.5 Kg of garbage, the third day of testing gets 0.5 Kg of garbage, the fourth day of testing, the tool can transport waste with a total weight of 1.2 Kg. Then finally, on The fifth day of testing, the importance of the garbage lifted was 0.7 Kg. The results obtained in the first test until the fifth day, the average weight of waste per hour is ± 0.5 Kg.

Overall the designed device can work well according to the concept created. The device is capable of sucking up floating garbage around it and storing it in a net. The design of the control system using a PLC also makes the work of this garbage suction device more effective and efficient when compared to using only a microcontroller, as was done in research [15]. Where the device will work, continue if it is not control manually. By using a PLC, we can maintain the pump work and at the same time can carry out the control and switching process so that it will be more energy-efficient. This device can use in tourist attractions near the coast, so it is very appropriate for the management of Smart cities for sustainable development. The drawback is that the device is less effective at night because the automatic net pulling system works according to the LDR sensor input. The LDR sensor works based on the received light intensity input [18], [19]. So it is necessary to find an alternative sensor that is effective, which can be used in water to detect garbage.

4. Conclusion
This study concludes that the tool can work well in protecting the environment by lifting garbage on the sea surface to a Temporary Disposal Site (TPA) on land. This device can raise an average of 0.5 kg of waste every hour with a long operating time of 4 hours a day in its implementation. The total waste obtained during execution is 4 Kg. The amount of garbage got also depends on the amount of garbage on the sea surface. The most significant amount of waste received is obtainable during high tide conditions. This device will significantly assist the waste management process and reduce marine debris on the coast. So it is hoped that its implementation in Smart cities for sustainable development.

5. References
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