ISONAR (IoT System for Organic and Non-Organic Waste Sorter) as An Innovative Automated Solution for River Cleanliness and Ecosystem Protection

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Abstract

This research presents the development of ISONAR *(IoT System for Organic and Non-Organic Waste Sorter). This product was developed based on IoT and some concerns about flooding due to piles of garbage that people throw into rivers.* ISONAR *(IoT System for Organic and Non-Organic Waste Sorter) presents several features that are very helpful in activities regarding the collection and sorting of waste in both organic and non-organic forms.* ISONAR *(IoT System for Organic and Non-Organic Waste Sorter) uses several important components such as ESP8266 as a liaison between users and Ultrasonic distance sensors as a waste detector that follows the river current. To avoid the wrong entry of waste into other waste containers, there is a tool in the form of a Water Pump that helps create an artificial current so that waste does not enter the wrong place and cause an imbalance between organic and non-organic containers.* ISONAR *(IoT System for Organic and Non-Organic Waste Sorter) brings multiple benefits, including reducing manual labour, saving energy, and minimising river waste*. ISONAR *(IoT System for Organic and Non-Organic Waste Sorter) was also created with the hope that the product is compact, user-friendly, and can work in all weather. And with the creation of this product can open the eyes of the community especially the younger generations as the successors of the nation to be more concerned with the environment and open their eyes that technology is not limited to things that smell of work, traffic and gadgets in each person's life. Future developments allow for better sensors and neater and more concise cable arrangements.*

Keywords: IoT (Internet of Things), Organic Waste, Non-Organic Waste, River Cleanliness, Ecosystem Protection

1. Introduction

The researchers dedicated their time and resources to develop ***ISONAR*** (**I**oT **S**ystem for **O**rganic and **N**on-Org**a**nic Waste Sorte**r**), a device that automatically captures and sorts river waste into organic and non-organic categories to protect ecosystems.

1.1 Background

Indonesia is home to nearly thousands of rivers, ranging from small streams to large waterways, spread across various islands. These rivers often extend across regions and can even serve to separate one city from another. In Indonesia, Rivers possess important benefits for the life of its people. They are frequently used for supplying drinking water, fish farming, irrigating rice fields, tourism, and transportation. But these days, rivers in Indonesia are contaminated by waste. These contamination comes both in the form of organic and non-organic waste.

Organic wastes are wastes that are produced from organic materials [1]. The examples of organic wastes are food waste, green waste, landscape waste, and pruning waste. Meanwhile, non-organic wastes are wastes that are produced from industrial processes and take a very long time to be renewed by nature [2]. The example of non-organic wastes are plastic, iron, glass, and electronic devices. These two types of wastes harm the ecosystem of the river and pollute the water. It can cause the fishes, shrimp, and other sea creatures stuck in them, killing the living organism. Also, because of the polluted water, it can no longer be used for drinking and irrigating fields. These dangerous wastes that are found on the river came from the people who threw the rubbish into the river irresponsibly.

The river contamination is caused by the thoughtless people who litter the rivers. It is known that river contamination in Indonesia is very high [3]. BPS (2020) reports that of the 70 thousand rivers (large and small) recorded in the country, 46 percent of them are heavily contaminated [4]. The data shows a severe pollution crisis in Indonesia's rivers, badly impacting aquatic organisms. So, it is our responsibility as the citizens of Indonesia, especially the young generation, to ensure that the rivers are no longer contaminated and give solutions to the damage done so that it can be used for the benefits of the people.

In this regard, the solution offered to overcome the problem of river pollution in Indonesia is to create a river filter device that can automatically sort organic and non-organic waste. We need to start using technology to clean our rivers, which are crucial for our survival. We can use the Internet of Things (IoT) for the system to be effective and efficient. Internet of Things is the integration of things with the world of Internet, by adding hardware or/and software to be smart and so be able to communicate with each other and participate effectively in all aspects of daily life, so enabling new forms of communication between people

and things, and between things themselves, that's will change the traditional life into a high style of living [5]. IoT offers advantages in the form of cost reductions, productivity, and efficiency [6].

Through the in-depth study regarding the condition of rivers in Indonesia and the potential of the Internet of Things for the effectiveness and efficiency of the system, an innovation is needed that can make optimal use of the IoT as a medium for a solution for the contaminated rivers in Indonesia. Therefore, this research aims to create an IoT-based cleaning system for the rivers. The presence of *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) is the right solution to remove contamination from the rivers in Indonesia.

1.2 Problem Formulation

Based on the background, the problem formulation that will be discussed in this research is:

1. How does *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) work?
2. How can *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) accurately differentiate between organic and non-organic waste in river ecosystems to improve waste management?
3. How is the feasibility of *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) as a river cleaner?

1.3 Research Objectives

In this research, the following is a description of the objectives we intend to achieve:

1. To describe how *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) works.
2. To describe the accuracy of *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) in differentiating between organic and non-organic waste in various river conditions to optimise waste management process.
3. To describe the feasibility of *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) as a river cleaner.

2. Method and Experimental Details

2.1 Methods

ISONAR (IoT System for Organic and Non-Organic Waste Sorter) was developed through several stages, the first stage was carried out by selecting sensors and IoT modules that were suitable for this project. In this project we use three sensors, namely Infrared Proximity Sensors, Capacitive Proximity Sensors, and Inductive Proximity Sensors.

These three sensors will be connected to the NodeMcu ESP8266. This sensor is used to detect various types of waste so that it can be separated later.

To test whether *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) can

function as predicted, we carried out laboratory tests, with a miniature river in the shape of an aquarium. This test is very important because it will be a reference for the success of *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter).

From these laboratory tests, we will collect data using qualitative methods with a focus on the accuracy of the sensor in detecting the type of waste.

ISONAR (IoT System for Organic and Non-Organic Waste Sorter) has many advantages in everyday life, especially in waste management by sorting waste according to type. Apart from that, *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) also reduces manual labour because the system can work automatically in sorting waste.

2.2 Materials and Tools

In making *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) project, several tools and materials are needed, such as:

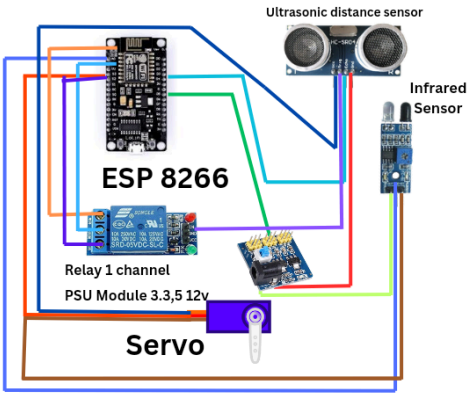
1. NodeMCU ESP8266: NodeMCU ESP8266 is an open source IoT-based platform. Consists of hardware in the form of System On Chip ESP8266 [7].
2. Servo: Servo motors are electrical devices used in industrial machines that function to push or rotate objects that require precise control high in terms of angular position, acceleration and speed [8].
3. Proximity Sensors:
    1. Infrared Proximity Sensor: The infrared proximity sensor is a sensor that can be used to detect objects or obstacles within a certain distance using the infrared light reflection method which has excellent accuracy and response [9].
    2. Capacitive Proximity Sensor: Capacitive sensors are sensors that can detect metallic and non-metallic materials and work based on the capacitive concept [10]. The detection range of the sensor is 5 mm. The process of reading objects is influenced by the surface area of the object, distance and type of object material.
    3. Inductive Proximity Sensor: Inductive proximity sensors are a type of proximity sensor that can be used to detect metal. Inductive proximity sensors have a very high level of sensitivity. The reading range is 1mm and the process of reading objects is influenced by the surface of the object and distance [11].
4. Breadboard
5. Water Pump
6. Relays
7. Wrapping Mesh
8. Aquarium

2.3 Procedure

The procedures carried out in this project are:

1. Buy all the items needed.
2. Install the triangular infraboard.

3. Assemble and install the servo to cover the organic and inorganic waste bin.
4. Install a water pump as an artificial flow generator.
5. Install other hardware, such as sensors and wrapping mesh.
6. Connect the water pump cable to one of the pins on the ESP8266.
7. Connect the three sensors to the pins on the ESP8266.
8. The servo is connected to the relay and the relay is connected to the ESP8266 (power supply).



Non-Organic	Organic

3. Result and Discussion

3.1 Result

People in Indonesia are becoming less aware of the importance of not littering, and it's seriously concerning. As more and more waste is discarded, they eventually go to rivers. This causes water contamination on the river, resulting in the water becoming undrinkable and harmful for humans. It can also harm the ecosystem as living organisms are harmed by the waste.

Our product aims to address these challenges by automating the draining as well as sorting the organic and non-organic system in a river. This automation reduces the need of manually filtering the water to remove waste and manually separating between the organic and non-organic waste.

3.2 Discussion

3.2.1 How *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) Works

ISONAR (IoT System for Organic and Non-Organic Waste Sorter) is a system designed by researchers to promote river sustainability. This system will automatically catch the wastes the river has and differentiate it into either organic or non-organic waste. In this system, the user will use Internet of Things to sort organic and non-organic waste automatically, thus enabling them to treat the different types of refuse immediately without sorting it manually. The researchers had made the system in such a way that suits the needs of the people. And so the researchers hope that with *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) the people will use it for the common good, maintain river cleanliness and protect the ecosystem. This is the appearance of *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter).

The way this system works is as follows:

1. ESP8266 is activated with electrical power.
2. The proximity sensors, which are connected to the pin at ESP8266, will detect the waste

near it with the help of code from ESP8266.
3. The servo's arms are also connected to the ESP8266. If organic wastes are detected by the sensor, then the servo's arms will close the path to the non-organic mesh. If non-organic wastes are detected by the sensor, then the servo's arms will close the path to the organic mesh.
4. The wastes will be contained in the mesh until it is picked up.

3.2.2 Accuracy of *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) in Sorting Organic and Non-Organic Waste

ISONAR (IoT System for Organic and Non-Organic Waste Sorter) uses three types of proximity sensors, namely the infrared, capacitive, and inductive proximity sensors. The infrared and capacitive proximity sensors can detect all types of materials. Meanwhile, the inductive proximity sensor can only detect things made out of metal.

The researchers had made the sorting system of organic and non-organic wastes by *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) accurate. When an organic material gets near the sensors, the infrared proximity sensor will light up, as the researchers had stated before that the sensor can detect all sorts of materials. Meanwhile, the capacitive proximity sensor won't light up as the researchers had done the coding that it will only light up on non-organic materials. So when all types of non-organic wastes except metal get to the sensor, both the infrared and capacitive proximity sensors will light up. Meanwhile, when the non-organic metal wastes get to the sensor, all three sensors will light up. The inductive proximity, based on the earlier research on its detection, will light up whenever there's a metal that passes by.

This mechanism ensures the accuracy of *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) in sorting organic and non-organic waste on the river.

3.2.3 Feasibility of *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter)

Feasibility of a product can be determined from three factors, namely the benefits, advantages and disadvantages, as well as the impact of the product's implementation. These three factors are the directive of the making of *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter). So, the defects of the system can be avoided and it can be optimally used for the cleanliness of rivers and the protection of the ecosystem.

ISONAR (IoT System for Organic and Non-Organic Waste Sorter) is a new breakthrough that implements the use of IoT in the sorting of organic and non-organic waste. *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) can give real impact benefits, namely:

1. For the people

ISONAR (IoT System for Organic and Non-Organic Waste Sorter) can be used to sort organic and non-organic waste automatically as well as to detect hazardous material easier. *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) can be used to sort organic and non-organic waste with the help of IoT. This automatic sorting technology will make the treating of different types of waste easier. The organic materials can be treated immediately for the production of something useful such as fertiliser, and the non-organic materials can be recycled. *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) can also be used to detect hazardous material more easily. These hazardous materials can be disposed of safely, thus protecting the people.

2. For the government

   The use of *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) will be in line with the government's effort especially the ministry of environment and the ministry of agriculture. *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) can help the ministry of environment in increasing the cleanliness of the river. Meanwhile *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) can also help the ministry of agriculture by improving the quality of water provided in rivers for irrigation.

With the wide range of benefits provided, *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) of course has its own advantages if it is being compared to a regular human-based waste management system. This is the comparison between *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) and a regular human-based waste management system.

No.	*ISONAR* (IoT System for Organic and Non-Organic Waste Sorter)	Regular Human-Based Waste Management System
1.	Automating the trash-catching process in rivers.	The trash in rivers needs to be picked up manually.
2.	Automating the sorting of organic and non-organic waste in rivers.	The sorting process of the trash in rivers needs to be done manually.
3.	Doesn't need any labour cost	Needs labour cost
4.	Removes the need of direct contact of human to hazards in the river	Can expose human to hazard

From the table, we get the information that *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) has four advantages compared to a regular human-based waste management system.

4. Conclusions and Suggestions

4.1 Conclusion

ISONAR (IoT System for Sorting Organic and Non-Organic Waste) is a significant innovation for reducing river pollution in Indonesia. By automating the collection and sorting of waste, it distinguishes between organic and non-organic materials, improving river water quality, supporting aquatic life, and benefiting ecosystems and communities. Leveraging IoT technology, *ISONAR* (IoT System for Sorting Organic and Non-Organic Waste) operates efficiently and highlights the potential of modern tools in tackling environmental challenges.

The development of *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) addresses the need for sustainable river waste management in Indonesia. Beyond technical waste collection and sorting, it fosters environmental awareness, particularly among youth. By reducing health risks and environmental impacts of river pollution, *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) showcases technology's role in tackling pollution effectively. Its contribution to cleaner rivers supports a healthier environment and advances water sustainability efforts in Indonesia.

The implementation of *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) has a significant environmental impact, as it reduces pollution levels while protecting life in the aquatic environment from the threat of unmanaged waste. Organic and non-organic waste can potentially harm fish and other riverine species, disrupting the balance of the ecosystem. With its accurate waste sorting and cleaning technology, *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) can help maintain river ecosystems while reducing health risks for communities around river environments that depend on rivers as a primary resource.

Compared to some traditional waste management methods, *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) has many technical advantages. By automating the sorting process and method, this technology can minimise labour, increase accuracy in workmanship, and reduce the risk of human exposure to hazardous materials and waste. This technology could set a new standard in the environmental protection movement, showing how IoT innovations can significantly improve waste management practices and the health of the natural environment.

ISONAR (IoT System for Sorting Organic and Non-Organic Waste) offers an efficient solution to river pollution by combining sensors with IoT connectivity to sort waste carried by currents. This system enhances river cleanliness, supports ecosystem preservation, and benefits nearby communities while aiding government environmental efforts. With further development, *ISONAR* (IoT System for Sorting Organic and Non-Organic Waste) can serve as a model for similar technologies and drive impactful change in environmental management and

public health, showcasing technology's role in addressing ecological challenges.

ISONAR (IoT System for Organic and Non-Organic Waste Sorter) has a good fit and is in line with Indonesia's national program sustainability goals by supporting various government efforts to improve water quality and environmental hygiene. Its function complements the objectives of the Ministry of Environment and the Ministry of Agriculture, and helps to clean rivers so that they can be used for irrigation and provide clean water for community use. This contribution strongly supports Indonesia's highly impactful sustainable development initiatives, by offering an efficient tool for the management of Indonesia's environmental and agricultural sectors.

4.2 Suggestions

Here are the suggestions to enhance the *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) project:

1. Implement Solar Power for Sustainability: To enhance the ISONAR (IoT System for Organic and Non-Organic Waste Sorter), it is recommended to equip it with solar-powered panels for an independent and sustainable energy source. This would eliminate the need for inefficient cables and enable effective operation in river environments without reliable access to electricity. Solar power makes ISONAR more eco-friendly and applicable to polluted rivers in remote areas, increasing its effectiveness and sustainability.
2. Integrate Recycling and Disposal Options for Captured Waste: Consideration to further review the waste processing process after being separated through *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) is a suggestion that might be done considering that organic and non-organic waste can still be utilised after being separated using *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter), consideration for processing the collected non-organic waste can add value to the use of tools that not only separate waste and collect waste from the river, but can provide solutions for processing the collected waste, for Organic waste can be considered to be processed into fertiliser which can be used for soil fertility around the river area or agriculture and plantations that can be used for agriculture.
3. Conduct Educational Workshops to Promote River Health Awareness: The use of tools to overcome river pollution is indeed very helpful for us to do so, but to do it all first it is necessary to instil awareness to the entire community of the importance of preserving the environment, especially the river environment which is a vital object of resources in human life, river cleanliness can affect how humans move, therefore it is necessary to instil awareness of river cleanliness

which can be done through counselling or other community services, for this it can be done in collaboration with the government or educational institutions that can educate the public about awareness of river cleanliness.

4. Partner with Recycling Companies for Circular Waste Management: Collaborating with recycling companies could create a closed-loop system where collected non-organic waste is directly routed to recyclers.

   The use of *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) in the sustainability of the river environment can be carried out in collaboration with various companies or organisations that depend on and pay attention to the cleanliness of the river environment, with this collaboration it can help us in the development of waste management tools such as *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) which of course this tool requires support from various parties to develop it so that it can be produced in sufficient quantities to be applied to various river conditions in Indonesia. With this collaboration, it can also help us in financing the manufacture and development of waste management tools that can be applied to various river conditions in Indonesia.

These suggestions would not only increase the technical capabilities of *ISONAR* (IoT System for Organic and Non-Organic Waste Sorter) but also can improve its usability, sustainability, and impact, making it a stronger solution for river conservation and waste management system and method.

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