CHAPTER I
INTRODUCTION

A. Background

Waste is discarded by human activities, and some of them can naturally decompose and reintegrate into the environment. Once the waste is not managed correctly, it will pollute the environment (Puadi & Hambali, 2022). Based the statistics data of domestic waste in Indonesia, plastics waste is at the second position with an amount of 64 million tons each year, or 14% of the total waste production (Siregar, 2022).

Plastic materials are essential, but if plastic consumption is increase every year, it will causes an increasement of plastic waste (Widianti & Hadi, 2022). There are several types of plastic, such as Polyethylene Terephthalate (PET), High-Density Polyethylene (HDPE), Polyvinyl Chloride (PVC), Low-Density Polyethylene (LDPE), Poly Propylene (PP), and Poly Styrene (PS). Among those types, polyethylene terephthalate (PET) is often used for bottles (Novia, 2021). Plastic waste has a relatively long decomposition period so it can cause pollution to the environment on the ground and in the water (Enda et al., 2019).

The underwater plastic waste is produced by household and industrial waste (Mathangi, 2023). Therefore, we need to develop a new technology to detect the underwater plastic waste. Autonomous Underwater Vehicle (AUV) is one type of underwater robot that has been developed in recent years. Unlike the Remotely Operated Vehicle (ROV), which can be manually controlled using a remote, AUVs can move automatically without direct control from the user as long as the robot's program conditions are met. With unpredictable movements and disturbances, the stability of the robot can be very vulnerable. Therefore, conditions that can stabilize its movement are necessary, especially at any depth (Yudi, 2023).

Several studies have been conducted on a system to detect underwater waste using a ROV equipped with a deep learning algorithm. They built their dataset consisting of three types of underwater waste and created an underwater environment for simulation. The ROV was used to take pictures of the underwater waste, which were then transmitted to the computer for analysis, enhancement, and recognition. The internal structure of the ROV includes a Raspberry Pi 4, a camera module, and a battery. The external structure of the ROV has a submarine-like shape. Rubber strapping is used as a protection measure at the joints to prevent water ingress. The system successfully detected underwater waste using the ROV equipped with the YOLOv4 framework (Wu et al., 2020).

Another study on detecting plastic waste in rivers using the YOLOv5 algorithm focused on developing a new system that applies the YOLOv5 algorithm to detect plastic waste and garbage in the river environment. Researchers used Raspberry Pi model 4B as a microcontroller for design and implemented a 5MP camera module and USB camera to take pictures of plastic bottles floating in the river. The algorithm training procedure was conducted initially by creating a custom dataset and processing it on a computer. Based on the measured metrics and the evaluated confusion matrix, the model produced an overall accuracy of 84.298% in detecting plastic bottles in the river. In addition, the model also provided a precision rate of 79.14% and a recall rate of 57.37%, indicating quite good quality for object detection (Sio et al., 2022).

In this research, the development will focus on integrating Raspberry Pi with deep learning models to design a prototype of plastic waste detection underwater. The development will include integrating sensors and underwater cameras with Raspberry Pi to obtain the visual data needed by the model. This research aims to test the prototype designed using deep learning models such as YOLOv3 in detecting underwater plastic waste. The prototype will be tested in several varying water turbidity conditions, and the amount of plastic waste detected at each turbidity level will be carefully recorded. The data collected will include variations in water turbidity relevant to real environmental conditions. The expected outcome of this research is the development of a prototype capable of accurately detecting plastic waste in various water turbidity conditions, which is expected to improve the effectiveness of waste management and cleaning processes in underwater environments.

B. Research Questions

Based on this background, the research question are:

1. How to design a prototype of underwater plastic waste detection based on Raspberry pi?
2. How to integrate the YOLOv3 model with the underwater plastic waste detection prototype?
3. What is the maximum turbidity level that still allows objects to be effectively detected underwater?

C. Research Aim

Based on the research question, the aim of the study are:

1. Design a prototype that can detect underwater plastic waste.
2. Assess the performance of the prototype that has been integrated into the model.
3. Define the maximum turbidity level of water that still allows objects to be effectively detected underwater.

D. Research Benefit

Based on the research aim, the benefits of this research are:

1. Develop effective prototypes to maintain environmental cleanliness, especially underwater.
2. Improve effectiveness in waste management and cleaning process.
3. Optimize the use of the underwater detection prototype in water conditions with different levels of turbidity, which can be applied in the real world.