Vol. 4, No. 2, October 2023, page 244-253
JTTM: Jurnal Terapan Teknik Mesin
p ISSN 2721-5377| e ISSN 2721-7825
http://jurnal.sttmcileungsi.ac.id/index.php/jttm

Design and build a machine for transporting bottle trash in ditches with a gamepad control

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Submitted: 05/07/2023 Revised: 21/07/2023 Accepted: 22/07/2023

Abstract: In Indonesia, flooding is frequently brought on by the issue of trash in ditches. Plastic bottle garbage is one kind of waste that is frequently seen. To lift the bottle garbage in the ditch, a gutter bottle collection device must be created. The operator can use a gamepad to control this DC motor-driven equipment. A chain transmits the rotation of the DC motor to the engine driving wheel. An altered chain is used as a conveyor in the system for transporting trash from the gutters to the storage tanks. The wheel holder can be manually moved to change the wheel width from 80 cm to 120 cm. This device can move forward or backward over the ditch at a speed of 0.041-0.042 m/s, lift rubbish with a success rate of 76.6%, and transfer up to three waste bottles at once. This device can significantly help with efforts to clean the gutter environment and lower the possibility of flooding brought on by rubbish clogging.

Keywords: DC motor, gamepad, sewer garbage, chain conveyor

1. INTRODUCTION

The issue of waste management is still a top priority in the majority of Indonesian communities [1][2]. Plastic bottle garbage is one kind of waste that is quite prevalent and frequently observed. Due to the widespread usage of bottled beverages and the practice of carelessly discarding plastic bottles, there is a severe issue with bottle waste. As a result, packaging waste frequently fills sewers and the surrounding area, which can obstruct streams and result in floods during the rainy season [3]. Therefore, it is crucial to develop a workable solution to the bottle waste issue [4].

This study's objective is to create a bottle collection device that can run under gamepad control in a ditch. This machine's primary goal, the sorting of bottle waste, is dependent some of factors. First, since plastic bottle trash is one of the most prevalent types of garbage, solving this issue can significantly improve waste management as a whole. Second, because the machine must be able to overcome these challenges, plastic bottles that are light and effortlessly swept away by water currents are emphasized in this research. This research is intended to help solve the bottle waste issue that endangers environmental hygiene and public health by concentrating on the creation of bottle waste collection devices for gutters.

The earlier garbage-collecting device that was the subject of this investigation was a stationary device that didn't move around like a car. The computer had a few restrictions when it was built in 2019, according to the earlier study. The device does not move forward or backward; it remains in place. This makes it difficult to access waste that is hidden in places that are out of reach for equipment. Because of this, the machine is only successful at picking up rubbish that is within reach when it is positioned and is ineffective when dealing with larger gutters or regions where there is a lot of waste laying around [5].

A similar experiment was conducted in the prior study in 2022 using almost the same apparatus. As garbage detectors, the gadget uses an Arduino Uno and ultrasonic sensors [6][7]. Mobility restrictions, though, continue to be a big problem. This heavy machinery is nevertheless constrained in its capacity to move and reach rubbish that is in difficult-to-reach spots, even if it has utilized sensors to detect waste [8][9].

As a result, the primary goal of this research is to design and create a bottle trash carrier that can travel forward and backward and that can be operated by a gamepad. It is intended that with more mobility, this instrument would be able to get around existing limitations and be more productive while cleaning ditches and the surrounding area. It is envisaged that this research can offer better solutions for overcoming the issue of waste in the gutters and make a beneficial contribution to efforts to maintain cleanliness and environmental sustainability by creating more advanced and mobile equipment.

2. METHOD

In this project, a machine for disposing of bottle waste with gamepad control was developed over some steps. To gather the essential knowledge and insights, research on comparable machines was done prior through a literature review. Additionally, prototypes of machines with mechanical and electronic components were designed and made. To make sure the machine operates correctly and is in line with the specified aims, testing procedures for the system, the mechanical components, and the electronics are carried out. The machine's capacity to move bottles of rubbish in the ditch, its rate of movement, and its response to gamepad inputs were all put to the test. To assess the operation of the device and make sure it can operate correctly in a variety of circumstances, the obtained data is evaluated. This approach guarantees the methodical and effective construction of a bottle trash-crushing device, which is anticipated to deliver positive outcomes and contribute favorably to efforts to uphold cleanliness and environmental sustainability. These phases are visible in **Figure 1**.

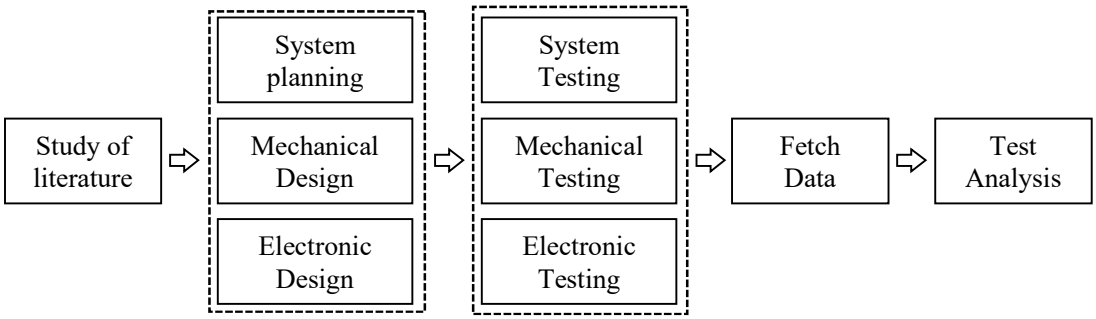

Figure 1. Stages of research implementation.

2.1. System planning

This system needs to be designed, and the design needs to be explained in a block diagram that can show how the system functions as a whole. The intended block diagram illustrates the need for a hardware system and software system, or mechanical device, for the system. **Figure 2** displays the total system design.

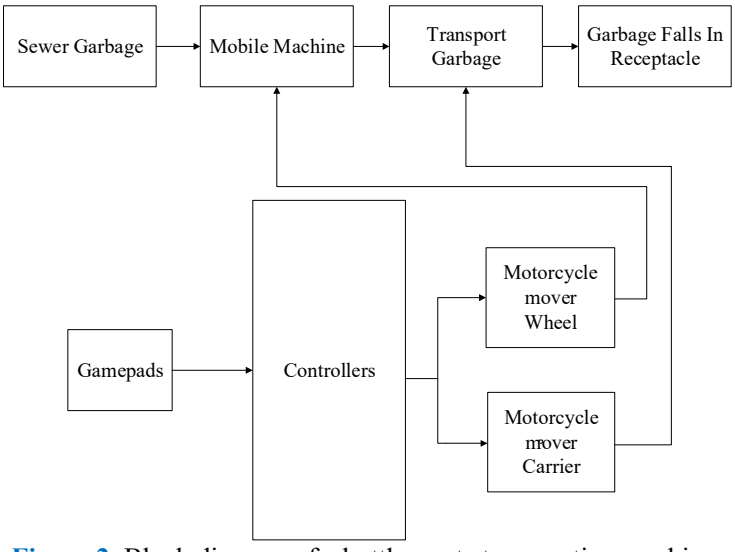

Figure 2. Block diagram of a bottle waste transporting machine.

In **Figure 2**, the primary system makes use of a microscale controller or processor circuit, in this case, an Atmega8535 microcontroller, and a gamepad for input [10][11]. Sewage trash is found using ultrasonic sensors, and if any is found, the gamepad can be used to command the controller to move the wheels so that the machine travels to the garbage [12]. Once there, the gamepad issues a new command to direct the garbage collector in the direction of the container. If there is further sewer waste after the procedure is finished, it will be repeated

The wheel drive module and the garbage lifter module are the two motor modules that the microcontroller outputs. This module employs a wiper motor type DC motor, which is popular in cars due to the power being rather high and the size being relatively small for equipment [13][14].

2.2. Software design

The flowchart or flowchart of the system work process shows that software is required to handle the microcontroller's work process. **Figure 3** shows the flowchart for the sewage waste transfer system.

The Atmega8535 microcontroller can be programmed using the software used in this project, MIDE Programmer.

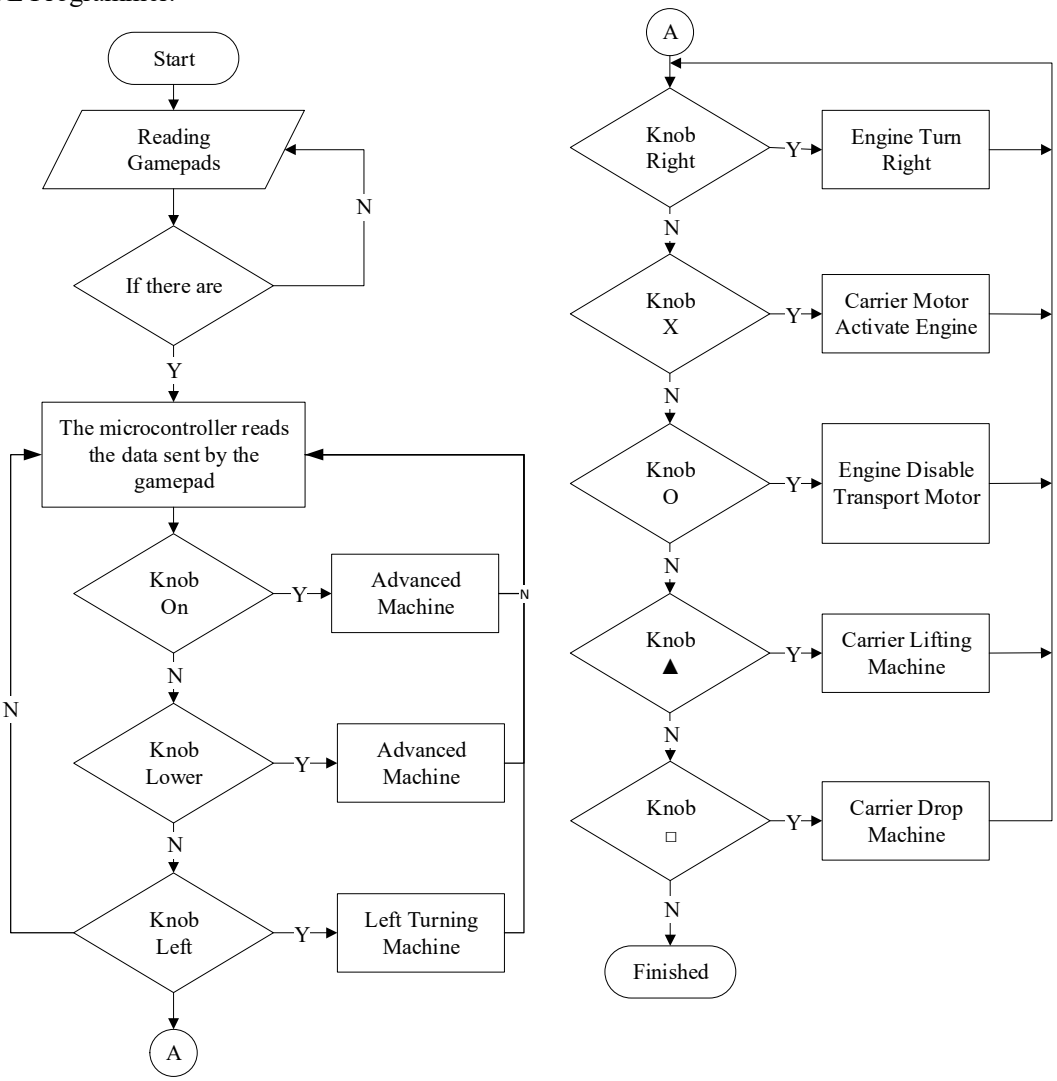

Figure 3. Flowchart of bottle waste transport machine.

As seen in **Figure 3**, when the machine is first turned on, the microcontroller reads the gamepad first. Once it has done so, the button designated to carry out movement operations will then give the microcontroller instructions as intended. For instance, pressing the up button on the gamepad will

instruct it to rotate the motor to advance. Similar to the prior example, the other preset buttons can also be terminated by just flipping the power switch.

2.3. Machine design

The following sections are part of the mechanical design of the sewer garbage transport machine [15]:

2.3.1. Overall Machine Mechanical Design

The overall mechanical design of the machine that has been made can be seen in **Figure 4** for the front view and the rear view in **Figure 5**.

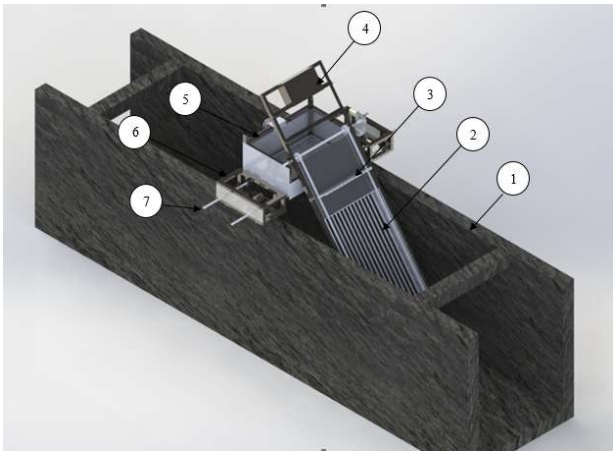

Figure 4. Front view machine mechanical design.

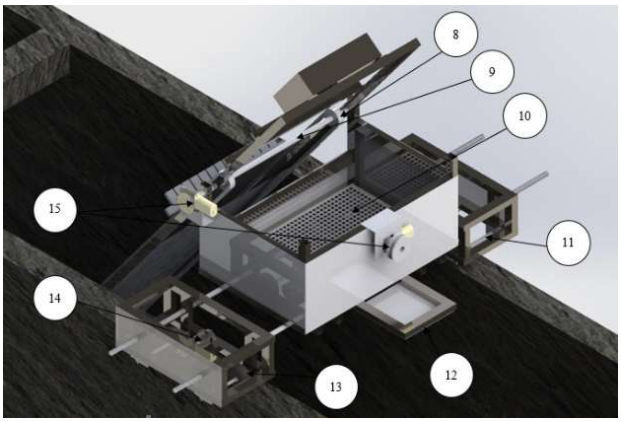

Figure 5. Rearview engine mechanical design.

Information:

1. Sewers
2. Carrier Frame
3. Brace Wire
4. Ballast
5. Garbage Container
6. Wheel Base
7. Threaded Shaft
8. Sprocket
9. Shaft
10. Reservoir Net
11. Wheel Axle
12. Balance Frame
13. Wheels

14. Wheeled DC Motors
15. Power Window DC Motors

Angle iron is used as the primary material for the machine's frame in its mechanical construction, as can be seen in **Figure 4** and **Figure 5**, as well as in the description of the machine's parts. The machine is propelled by a DC motor, however, it is generally moved by regular wheels. The garbage collector is propelled by a DC motor.

2.3.2. Electronic Design

In the electronic design, the design will be designed as follows:

a) Single chip circuit

Because the ATMega8535 microcontroller has numerous input outputs and a sizable data memory that may be utilized, as illustrated in **Figure 6**. The single-chip circuit is utilized as the main control circuit.

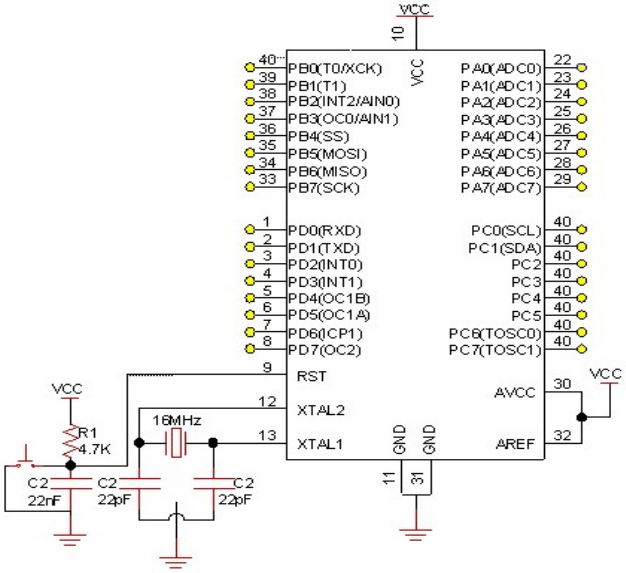

Figure 6. Single-chip circuit.

b) Motor driver circuit.

The motor's speed and rotational direction can both be changed using this electronic architecture. This final project's electronic setup consists of some MOSFET-equipped H-Bridge drivers. **Figure 7** depicts the circuit image that was utilized.

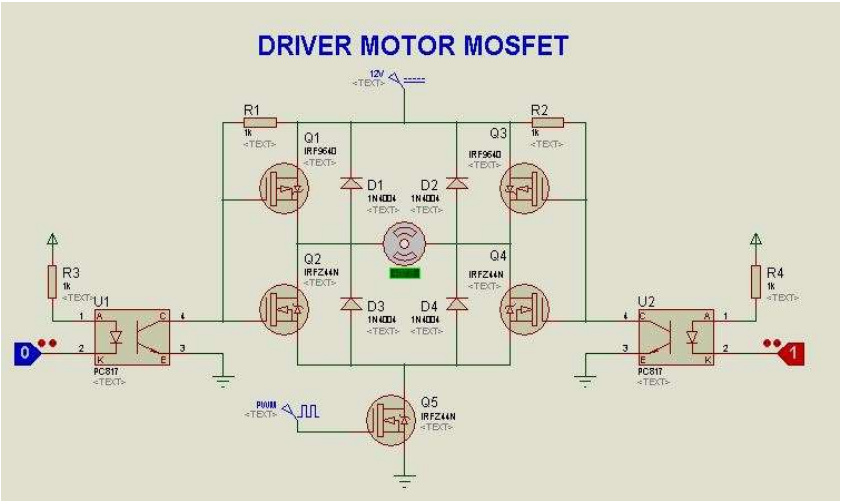

Figure 7. H-Bridge driver circuit with MOSFET.

The robot driver in **Figure** *7* has three inputs: input 1, input 2, and PWM input. The motor will turn clockwise if inputs 1 and 2 are both low. In the meantime, the motor will revolve counterclockwise when inputs 1 and 2 are low and high, respectively. The DC motor's rotational speed can be changed via the PWM input. The motor will rotate more quickly the higher the duty cycle provided.

c) Serial communication circuit.

The ATMega8535 microcontroller may receive commands from the gamepad using this electronic setup. The ATMega8535 microcontroller's joystick interface circuit is shown in **Figure 8** and is as follows.

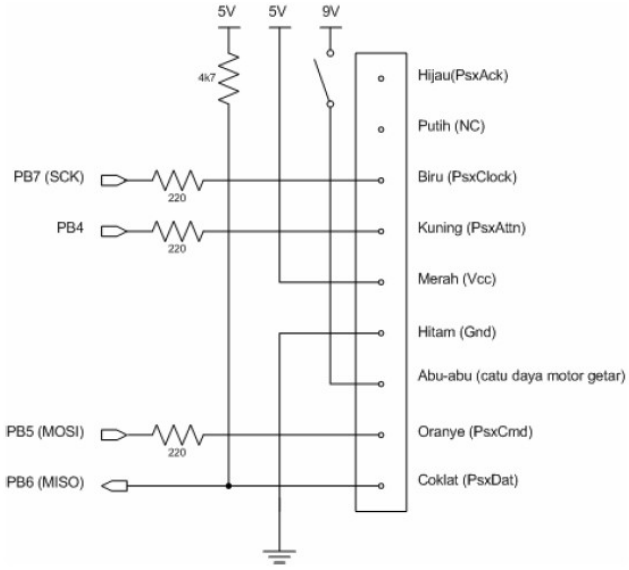

Figure 8. PS Joystick Interface Circuit with ATMega8535 Microcontroller.

Three 220 resistors and one 4k7 resistor are used as pull-up resistors in Figure 8's serial connection. PsxCmd, PsxClock, and PsxAttn are directly linked by the circuit and don't require a 220 resistor, however, this is done to safeguard the I/O lines. Since the PSX Dat pin is an open collector, a pull-up resistor is required. According to the circuit, the microcontroller needs three outputs (PB7/SCK, PB5/MOSI, and PB4) and one input (PB6/MISO).

3. RESULTS AND DISCUSSION

To put the intended mechanical design into practice, a successful prototype of the bottle trash collection device has been created. Studying the literature on related studies, creating mechanical and electronic systems, and testing various components to make sure engine performance is as predicted are all steps in the design and fabrication of this prototype. **Figure 9** depicts the prototype's overall appearance, while **Figure 10** depicts the prototype in the gutter.

Figure 9. Prototype of the bottle waste transporting machine.

Figure 10. Prototype of machine tool for transporting bottle waste in ditches.

3.1. Garbage collection test

This test was run to find out how efficient the gadget was at moving rubbish in bottles and how long it would take. Thirty garbage bottles were made available for this test. The test was designed to gather 30 bottles of bottle waste because this machine collects waste manually by using garbage collection equipment that is attached to it. The amount of waste that may be delivered in a single machine rotation is constrained by the collection device's size and capacity limitations. 30 bottles are therefore considered to be a suitable amount to measure the percentage of success of the machine in collecting garbage bottles to generate data that is sufficiently representative of the success of doing so. It was determined how many bottles were transported from the 10 rounds of operation out of the 30 bottle wastes. The amount of rubbish transported and the number of rounds required for the garbage to be hauled is then used to compute the success percentage.

Table 1. Testing the Success of Garbage Collection and Time Required.

Test-to-	Chain Loop	Results	Time(s)
1	1	3	15
2	2	5	31
3	3	8	46
4	4	10	62
5	5	12	77
6	6	15	92
7	7	17	117
8	8	29	131
9	9	21	146
10	10	23	152

From **Table 1** it can be seen from the 30 waste bottles that can be transported 23 bottles with 10 turns of the chain. The percentage of transported waste can be calculated as follows:

$$\frac{23}{20} \times 100\% = 76{,}6\% \quad (1)$$

Waste collection efficiency is 76.6%. This estimate is multiplied by 100% and then divided by the volume of bottled garbage that was transported.

The average turnover of waste transported can be calculated as follows:

$$\frac{23 \text{ botol}}{10 \text{ putaran}} = 2{,}3 \text{ Botol} \quad (2)$$

Table 1 the average carrier managed to collect 2.3 bottles of waste.

3.2. Forward Speed Testing

This test is conducted to establish the forward speed at which the ditch machine will advance in the direction of the garbage once it is ready for transfer. The test is conducted by moving ahead a predetermined distance of 1 m, then timing how long it takes to cover that distance in 1 m. The

intended result, which is the speed of the machine moving forward or backward, is then calculated by dividing the distance by the required time.

Table 2. Forward Speed Testing.

Test-to-	Time (s)	Distance (m)	Speed (m/s)
1	23,65	1	0,042
2	22,73	1	0,043
3	24,12	1	0,041
4	23,78	1	0,042
5	24,09	1	0,041
6	24,21	1	0,041
7	24,13	1	0,041
8	24,18	1	0,041
9	22,93	1	0,043
10	23,54	1	0,042
Average Speed			0,0417

Table 2 shows that the forward speed is between 0.041 and 0.043 m/s, which is caused by the motor's slow RPM and the ditch's flatness, which is typically uneven. As a result, the motorbike's slow speed is hampered by the ditch's flatness, which is quite wavelike.

3.3. Joystick control response testing

Testing the gamepad's response is a crucial part of the design process for a machine that will transport bottles of rubbish in a ditch to guarantee optimum performance and operation. This test tries to determine whether the gamepad can precisely and quickly control the device in response to commands. It is anticipated that by doing a thorough gamepad response test, it will be possible to verify that the machine control system is reliable and offers a positive user experience when operating the bottle waste disposal machine in the gutters.

The test evaluates the Gamepad controller's performance in terms of how well or poorly each button and function perform. Utilizing the lead as an indicator, testing is done. Each button will be marked (✓) if it operates correctly and fulfills its intended purpose, and (X) if it does not.

Table 3. Control response test.

Testing to-	Gamepad Button Response				
	Proceed	Back off	Garbage on	Lift track	Lower track
1	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓
3	✓	✓	✓	✓	✓
4	✓	✓	✓	✓	✓
5	✓	✓	✓	✓	✓
6	✓	✓	✓	✓	✓
7	✓	✓	✓	✓	✓
8	✓	✓	✓	✓	✓
9	✓	✓	✓	✓	✓
10	✓	✓	✓	✓	✓

Information
√ = Good
X = Not good

The computer responds to gamepad commands received in the forward, backward, garbage collection, garbage collection orders, and garbage collection down directions 100% of the time, as shown in **Table 3** which shows that all buttons function as intended with all stated tables (√).

3 CONCLUSION

Several inferences can be made from a set of tests and analyses performed on the Sewer Bottle Garbage Transporting Machine Final Project. First, with a success rate of 76.6%, this machine can transport bottled garbage. With an average speed of 0.042 m/s, this machine may also travel forward and backward in the ditch. Additionally, the joystick control's responsiveness to commands for machine movement has a success rate of 100 percent. Last but not least, this device can only move a maximum of three garbage bottles per spin. This conclusion demonstrates that the sewer bottle trash collection device is effective in resolving the gutter waste issue. This device can significantly help with efforts to improve the gutter environment and lower the chance of flooding brought on by rubbish clogging.

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