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DEVELOPMENT OF WATER TRASH COLLECTOR

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ABSTRACT

Domestic waste disposal into rivers or lakes leads to drop-in water quality and ultimately will have a more vital impact on water pollution. Several countries built a semi and fully automation craft that equipped with the new system and came along with the technology development to facilitate the garbage collection task. The development of automation vehicle is meaningful for reducing the garbage as well as the manpower consumption for handling the cleanliness process. This project focuses on designing a high stability of Water Trash Collector (WTC) model and fabricate this vehicle with the high stainless-steel material. catamaran model is the suitable hull-type to collect a load of the garbage on the water surface. Besides, the objective for the electrical part is to develop the remotely WTC by using SkyFly controller and battery as the main power source. 3D Catamaran model is sketched in Siemen NX10 software based on USV element information gathered. Trash Bin collector and waterwheel are added in the design for collecting purposes and movement respectively. Square hollow mild stainless steel is a suitable material to create the frame for WTC because it is low cost, high corrosion resistant, sturdy and long-lasting materials. The power system in WTC is equipped with SmartDrive Duo-30, SmartDrive Duo-10, two high torque electric scooter motor, DC gear worm motor and FlySky Controller. WTC was performed well on the lake without any leakage on the both hull after attached the shafts and propellers. WTC is operated and moved as the motors are being driven by the controller. For future work, an embedded system of WTC needs to be autonomous for collecting the garbage.

1.0   INTRODUCTION

Domestic waste disposal into rivers or lakes leads to drop-in water quality and ultimately will have a more vital impact on water pollution. As noted by Briones (2018), waste disposal issue was frequently occurred and still cannot be solved although diverse alternatives had been done in various places (Briones et al., 2018). Many countries had spent a lot of money to contain this problem such as; greenery and preserve a contaminated river. In the other hand, development of automation vehicle is one of the community's efforts to collect the un-accumulate garbage on the water reservoirs.   Several countries built a semi and fully automation craft that equipped with the new system and came along with the technology development to facilitate the garbage collection task.

In 2016, Jogi et al. designed a garbage collector vehicle by upgrading the kayak hull and employed a pedal for human. This vehicle is convenient for collecting the waste debris at the small water route (Jogi et al., 2016). However, this process will depend on the manpower usage and the time for collecting process will limited to the working hour. The development of automation vehicle is meaningful for reducing the garbage as well as the manpower consumption for handling the cleanliness process. In 2017, Prakash et al.

were ideally creating a new prototype of WTC to remove the waste debris from the water bodies. This mechanism was static at the one place and used an automatic system to moves a conveyor which are used as the garbage collector (Prakash et al., 2017).

Commonly, Water Trash Collector is known as WTC which consists of three crucial elements whereby, hull, power system, and NGC (Navigation Guidance and Control) system to assist this collector cleaning the water surface. The concept of WTC commonly implemented several compartments of onboard USV (Shamsuddin et al., 2020). In 2007, Wagh and Munde developed WTC prototypes which equipped with the Arduino controller and the Bluetooth model for monitoring the whole system from a distance (Wagh & Munde, 2018). Besides, by employing a water level sensor, Arduino controller will receive a command of water level data and send a new instruction to control the conveyor motor.

In addition, Akib et al. were developed a new system to guide the movement of the WTC by using a smartphone (Akib et al., 2019). In addition, Hossain et al. introduced a deep neural network system where it was employed ultrasonic sensor and Raspberry PI controller and camera to analyze object on the water (Hossain et al., 2019). Remotely operated automated vehicles require materials for the construction that do not corrode in the marine environment

and do not contribute significantly to the weight of the structures. Previous experiments faced the corrosion problem and suggest a several solutions such as coating, painting and coupling technique to detain the oxidation process (Prakash et al., 2017).

Besides, the current prototypes and complex working WTC commonly used renewable energy as the primary source and non-renewable energy also used as backup plan energy to perform the task (Sayad et al., 2019)(Abdullah et al., 2019) (Khekare et al., 2019). However, automated WTC not able to function when the fuel runs out to support the vehicle moving in the middle of the water.

The researchers design WTC with the convenient structure and material for make sure the doggedness of this vehicle during the task. A level of buoyancy is a crucial measurement in a watercraft development. hull designed plays the main role for making WTC more stable and floating during the task performance. Based on the previous research, catamaran-type is the primary hull design where Catamaran is defined as a multi-hulled watercraft which has two parallel hulls and laterally spaced by elongated connectors that have a load above hull (Masters, 1993).

The advantages of the catamaran are higher stability where it comes from the wide length which is the distance between two hulls (Kader et al., 2015); the larger surface is than single hull design which creates a higher stability, faster, than single hull which more apparent wind experience, and higher pressure making them perform better. In depth, many researchers were selected the Catamaran-type hull due its stability and decrease the risk of capsizing in rough water along with providing greater payload capacity and redundancy.

This project focuses on designing a high stability of WTC model and fabricate this vehicle with the high stainless-steel material. catamaran model is the suitable hull-type to collect a load of the garbage on the water surface. Besides, the objective for the electrical part is to develop the remotely WTC by using SkyFly controller and battery as the main power source.

2.0 PLATFORM ARCHITECTURE

This part will be divided into three major elements which are; three-dimensional (3D) model, body fabrication and system fabrication. 3D model is visualizing the requirements and specification of the whole WTC design. Body fabrication will emphasize the selection material components for each part of the WTC while system fabrication will explain the detail about each components of fabrication process.

2.1 3D Model

3D Catamaran model is sketched in Siemen NX10 software based on USV element information gathered. Trash Bin collector and waterwheel are added in the design for collecting purposes and movement respectively. After completing gathering information and consider the element

in WTC component, 3D catamaran WTC model were sketch in Siemen NX10 software. The sketching model can be referred in figure 1.0.
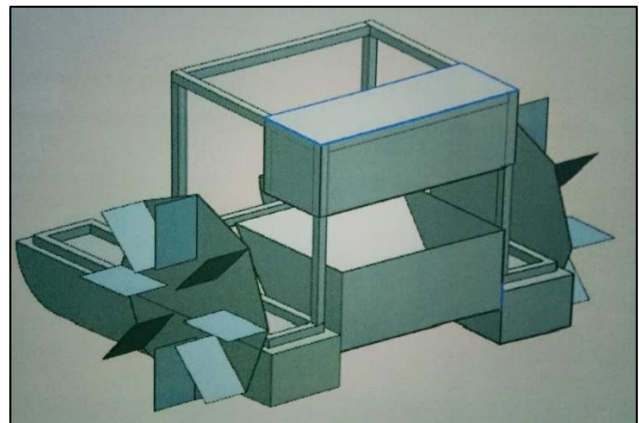

Figure 1: Isometric View for WTC Design

2.2 Body Fabrication

The whole body of WTC containing four crucial part including body, garbage collection storage, Conveyor and power system consumption. Every fabrication process for each element is customize based on the specific function.

2.2.1 WTC Body

By selecting incorrect materials to make the body for WTC, the probability of sinking is higher. The primary function of the body is to float the body. Square hollow mild stainless steel is a selected material to create the frame for WTC because it is low cost, high corrosion resistant, sturdy and long-lasting materials.

2.2.2 Garbage Collection Storage

Garbage collection storage used stainless steel sheet for creating the compartment which is high potential of corrosion resistant. This material also is sturdy and high endurance to support all the load involves in the WTC including the electrical component and batteries. This will prevent the unwanted bending on the hull after assembles all the component of the WTC.

2.2.3 Conveyor

Conveyor system consists two main part which are conveyor belt and roller. Chain is the supporting device for belt and cargo of a belt conveyor. The rectangular of 1.3m x 0.13m was sketch on the plane. Next, draw the arc at the both end of the rectangular. Then, extruded to a width of 0.003m as a frame of conveyor. The conveyor is put the hook at every stainless-steel stud using nylon cable tie. This experiment is
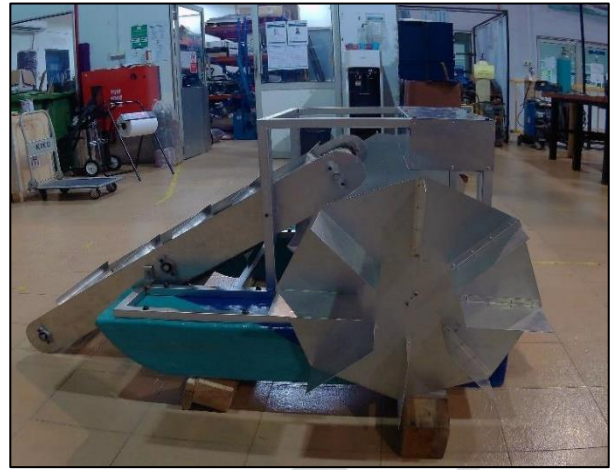
Figure 2: WTC Prototype

Figure 3: Final Product

used the prevent collision cushion as the roller and put the Wire Mesh (2.5m x 0.47m) at stud using nylon cable tie. Next, conveyor is implemented with the body and the system is test with the electrical part.

2.3 System Fabrication

The power system in WTC is equipped with SmartDrive Duo-30, SmartDrive Duo-10, two high torque electric scooter motor, DC gear worm motor and FlySky Controller. All the electrical and electronic components are assembled and connected to the SmartDrive Duo and FlySky receiver and being programmed by using T6config. Referring to the Figure 3, the power system in WTC will be equipped with the components of SmartDrive Duo-30, SmartDrive Duo-10, high torque electric scooter dc motor (right), high torque electric scooter dc motor (left), dc gear worm motor (conveyor), battery and FlySky controller. SmartDrive Duo

and FlySky controller is chosen because it is easy to be used and programmed.

The components of power system in WTC are arranged and wired neatly in the main body part of WTC and connected to the power supply. In sum, the power system in WTC is customized and developed by using SmartDrive Duo, high torque electrical scooter DC motor, DC gear worm motor and FlySky controller. All the components are being programmed by T6config software. T6config software is required for the development of power system in WTC in order to program the FlySky controller. This, in turn, will run the power system in WTC. Thus, the smart motor driver, DC gear worm motor and electric scooter DC motor will be connected to the controller receiver and programmed by T6config. Therefore, T6config software will be used in the implementation of power system in WTC which is easy to setup it to the controller.
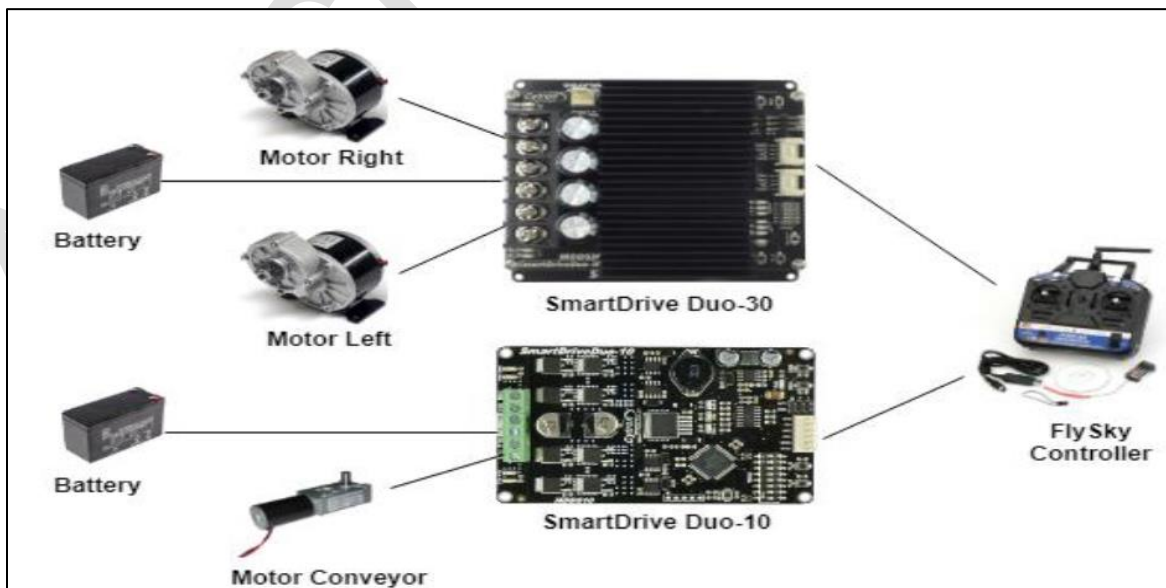

Figure 4. Electrical Hardware Development Process

3.0 RESULTS AND DISCUSSION

The several experiments are done to evaluate the performance of the whole system in WTC. Figure 5 shows WTC was tested on the lake at Universiti Malaysia Pahang, Pekan. The WTC is departed at the surface water to evaluate its performance during the garbage collection task. During the experiment, WTC was performed well on the lake without any leakage on the both hull after attached the shafts and propellers. This test was succeeded when the WTC is passed to float on the water surface without any trace of water in the both hulls. On the hand, the WTC also afford to carry all the forces on it. The position of WTC also in stable equilibrium state on the front side and the back side.

The power system in WTC is first tested in the laboratory and all the components are functioning well as planned. WTC is operated and moved as the motors are being driven by the controller. The controller operated properly which is can change the direction and movement according the condition given. In this situation, the WTC performance depends on the battery self-discharge rate. When the time performance of WTC increase, the battery self-discharges

rate will be short. Figure 6 shows the WTC mechanism has taken a moved for collecting the garbage in the forward direction. Table 1 shows the distance and the time taken recorded during the experiment.

Table 1. WTC's Motion Experimental Result

Time Taken, s	Distance Travelled, m	Velocity, m/s
0	0	0
10	2	0.2
20	0	-0.4
30	0	0
40	1	0
50	0	0
60	1	0
70	0	-0.5
80	2	0.4
90	0	-0.2
100	0	0

Figure 5. WTC was tested at UMP Lake

Figure 6. WTC was tested at UMP Lake

Figure 7 shows the distance-time graph while Figure 8 presents the velocity-time graph. The velocity of the WTC was manually calculated based on the distance measured from the starting point. Both graphs describe the path taken by WTC during the collection task. During the first part, 0s until10s, WTC was moved 2m away from the lake side that travelling at constant velocity of 0.2 m/s. During the next part, 10s until 15s, WTC had travels 0m in 5s. It is stationary for 5 seconds. During this time, WTC was remotely stopped by the human in order to reduce the force on the conveyor system. Then, WTC was move -2m in 5s. It was slowing down of -0.4m/s. During 20s until 30s, WTC stopped to collect the garbage on the water surface, and it was stationary for 10 seconds. Lastly, during 90s until 100s, WTC was moved at a -0.2m/s back to lake side.
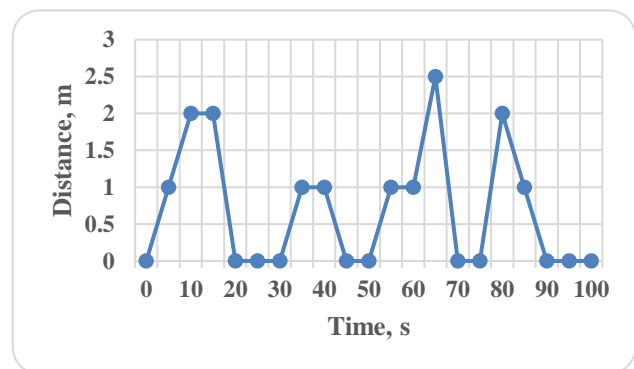

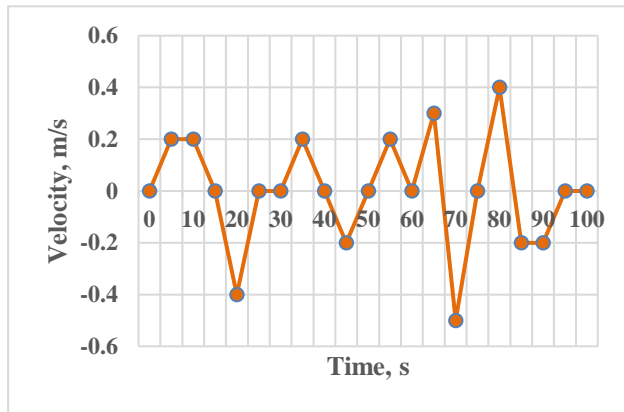**Figure 7:** The Distance Taken by WTC

Figure 8: Velocity versus Time

4.0 CONCLUSION

This paper has addressed the development of water trash collector by implementing the concept of USV element. Catamaran-type is selected on designing the hull of WTC for highest stability and hold the trash collector in between space hull. SmartDrive Duo and FlySky controller are used in developing the power system as well as the control system for performing the collecting task. The employment of WTC able to reduce the risk of water pollution in small lake and drain clogging problem. Supplying the power system with the battery usage support the environmental-friendly manner.

In order to classify more waste categories and guide the vehicle towards garbage autonomously, this project can be improved in the future through the implementation of the navigation, control and guidance systems (NGC), such as the neural network system and guidance method. The introduction of more sensors such as GPS, accelerometer, distance sensor and gyroscope allow WTC to perform the collection task in water without human intervention.

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