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Development of Surveillance Hovercraft via Arduino

Muhammad Naufal Mansor[1,*], Syahrul Affandi Saidi[1], Wan Azani Mustafa[1], Roejhan Md Kawi[1], Mohd Aminudin Jamlos[2], Noor Anida Abu Talib[1], Mohd Zamri Hasan[1,3]

[1] Faculty of Electrical Engineering Technology, Universiti Malaysia Perlis, UniCITI Alam Campus, Sungai Chuchuh, 02100 Padang Besar, Perlis, Malaysia
[2] Faculty of Electronic Engineering Technology, Universiti Malaysia Perlis, Malaysia
[3] Centre of Excellence for Intelligent Robotics & Autonomous Systems (CIRAS), Universiti Malaysia Perlis, Arau, 02600, Perlis, Malaysia

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ABSTRACT

The current research focuses on the development of hovercraft via Arduino. The vehicle is designed with bag skirt structure in order to reduce friction for smooth operation. Nowadays, there are a lot of natural disaster occur in everywhere especially flood. However, hovercraft is a vehicle that need a driver to drive which can cause a danger to the rescuer. Based on this problem, a wireless hovercraft is needed to develop. This study explains a hovercraft which is able to control the movement of the hovercraft from the surface. The design of the hovercraft was successfully made by using AutoCAD software. Furthermore, the material of the body was made from the insulation foam while the microprocessor is Arduino UNO R3. There are two brushless DC motors and one servo motor that used for this hovercraft. The first brushless DC motor which is located below the hovercraft is used as a hover operation, while the second motor located behind it is used to ensure the hovercraft move forward. In addition, the performance of the hovercraft was successfully tested on the 3 different surfaces. As a result, the highest performance is on the cement while the lowest is on the grass.

1. Introduction

Between 1950 and 1960, British innovation produced the first functional hovercraft design. Nowadays around the world, hovercraft is used for public transportation, travel, agriculture, forestry, sport activities, recreation, and other areas [1-6]. These vehicles are supported in a variety of methods. The hovercraft is a vehicle that can drive like a car, travel on water and land, and float like a boat [7-11]. Another name for a hovercraft is a "Air Cushion Vehicle" (ACV). In addition, this type of vehicle which is hovercraft able to generate greater speed than other marine vehicles and may also perform effectively on difficult surfaces such as land and water [13-14]. Usually, this type of vehicle is installed with one or two engines to produce air pressure in the cushion in order to make the body is hover and also to create thrust force to make the hovercraft able to move in desired direction.

* *Corresponding author.*
E-mail address: naufal@unimap.edu.my

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Nowadays, there are a lot of natural disaster occur time by time due to the heavy rain and the drain system problem. This disaster has caused certain place to flood. So, the normal or common vehicle such as ambulance, truck or motorcycle are not able during the search and rescue operation. So, the hovercraft is needed due to their ability which can travel on the land and also water. According to the Steve Lague, the Fire Chief North Muskegon Fire Dept. North Muskegon, MI USA, since 1985, 255 people have been rescued and removed from Muskegon area lakes by using the hovercraft [15-20].

However, the rescuer or driver should drive the hovercraft to that place which can give high risk that can cause an accident to the rescuer. Thus, the project will be focusing to develop the wireless hovercraft. Moreover, there are various style, size and material in designing the hovercraft. The material of the body must long lasting and not too heavy to make the body hover from the ground. From the previous research [17-19], the body of the hovercraft was made by using styrofoam and recycled plastic which is not efficient. Thus, the project will be focusing to develop the hovercraft by using the material that is light in weight and have the highest durability which is the insulation foam.

As a body and cushion material is a major role to ensure the hovercraft is able to hover, this study will develop the hovercraft that made from the insulation foam for the body part and the material of the air cushion made from the high-density recycled bag plastic. There are 2 brushless DC motor use for the fan system in this hovercraft which is one for the hover and another one use for the thrust.

2. Methodology

The main component that acts as the brain for this project is microcontroller or more specified is Arduino UNO R3 as can refer in the block diagram in Figure 1. With the Arduino UNO R3, the servo and the brushless DC motor can easily control.

For powering brushless DC motor, 3S Li-Po battery which provides around 11V has been chosen. For the wireless communication, the nRF24L01 Transceiver module has been chosen. It is used to receive the signal transmitted by the transmitter. This module is connected to the Arduino board. Its range can go up to 700 meters when used in an open area and with a lower baud rate.

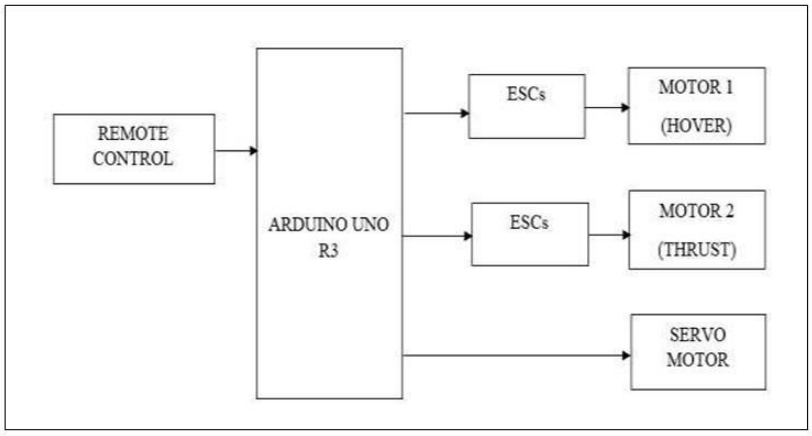

Fig. 1. The block diagram for function of the hovercraft

To push the hovercraft forward, the motor with propeller has been installed at the back of the hovercraft. Then, the servo motor has been attached to the hovercraft rudder to make the hovercraft able to change direction. The system works together to hover while constantly managing servo as a controller of the direction. In addition, the remote is used to control the hovercraft. This is because the hovercraft will receive the movement command from the remote control and the nRF24l01 is

used in the circuit to receive information about the commands. Hence the commands are processed by the microcontroller and the motors in preferred directions by the users.

2.1 Prototype

Figure 2 below show the complete design and prototype of the hovercraft with the label of the description. The base of the hovercraft was made by using insulation foam. Besides, the air cushion or the skirt was made from the high-density recycled plastic.

Moreover, there are 2 brushless DC motor (BLDC). the first BLDC was located at the middle of the body for hover operation while the second BLDC was installed at the back of the hovercraft for thrust operation. Next, the servo motor was installed at back and attached with the rudder to control the direction of the hovercraft. In addition, the dimension of the hovercraft is 30cm x 20cm with the weight is 750gram.

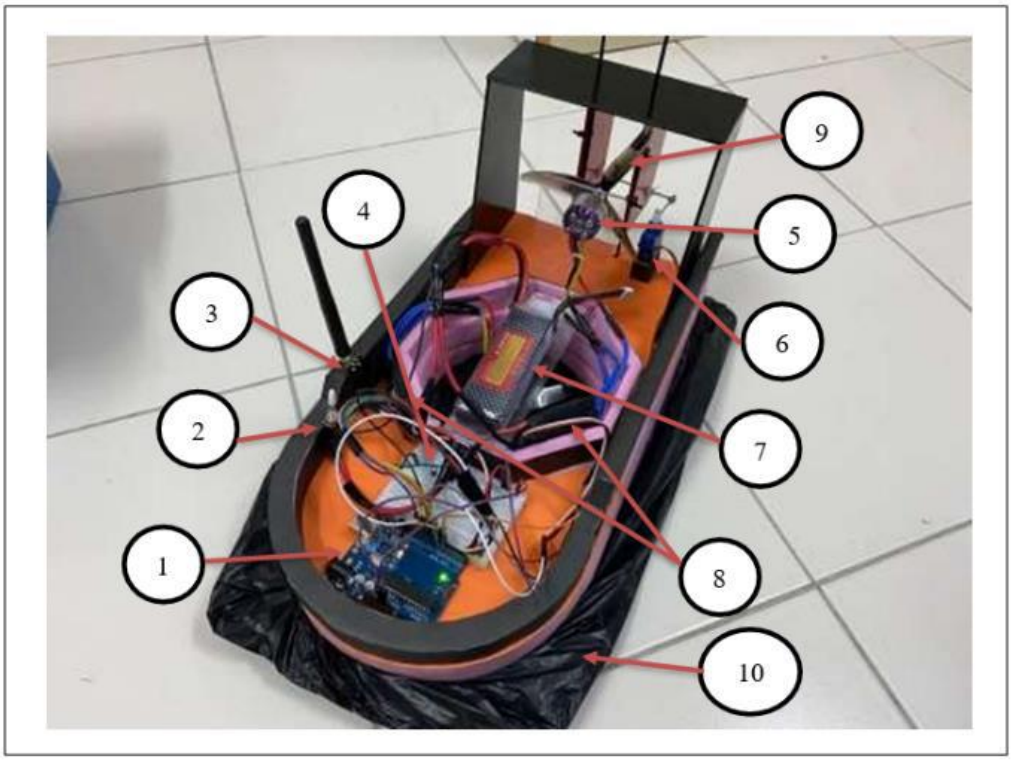

Fig. 2. Hovercraft prototype

Table 1
The label and description on the hovercraft

Label	Description	Function
1	Arduino Uno R3	Microcontroller to control the entire process
2	Toggle Switch	To switch the power source
3	nRF24L01 with Antenna	A wireless transceiver that uses radio waves to transmit and receive data
4	Capacitor 10uF	To stable the signal, receive from transmitter
5	Brushless DC Motor 1000kV	As a fan system for the hovercraft
6	Servo Motor	To control the direction of the hovercraft
7	3s Lippo Battery 11.1V	Power supply
8	ESC 3A	To control the current flow in the brushless DC Motor
9	Propeller with 3 blades	To transform the rotational power of an engine to make the body move.
10	Recyclable plastic	To store the air to ensure the hovercraft can hover

3. Results

The performance of the Hovercraft has been tested on the various type of the surface. There are 3 type of surface conditions which are cement, grass, and water. The data has been shown in the table below.

3.1 Performance of the Hovercraft on the Cement, Grass and Water.

The table of the performance of the hovercraft on the 3 different surface below show the constant variable is the voltage which is 11.1V (Table 2 to 4). Besides, the manipulated variable is the value of the resistor. Next, the respond variable is the speed of the hovercraft. Based on the table, the speed of the hovercraft is zero when the value of the ohm is below from the 5k ohm. The motor is not afforded to produce more power to move the hovercraft. The hovercraft starts to move forward when the value of the resistor achieve 5k ohm and above.

Table 2
Performance of the hovercraft on the cement

No.	Voltage (V)	Ohm (k)	Average time to travel 10m (s)	Speed (m/s)
1	11.1	0	0	0
2	11.1	2.5	0	0
3	11.1	5.0	23.56	0.42
4	11.1	7.5	11.11	0.90
5	11.1	10.0	10.58	0.94

Table 3
Performance of the hovercraft on the grass

No.	Voltage (V)	Ohm (k)	Average time to travel 10m (s)	Speed (m/s)
1	11.1	0	0	0
2	11.1	2.5	0	0
3	11.1	5.0	107.48	0.093
4	11.1	7.5	101.49	0.098
5	11.1	10.0	93.74	0.106

Table 4
Performance of the hovercraft on the water

No.	Voltage (V)	Ohm (k)	Average time to travel 10m (s)	Speed (m/s)
1	11.1	0	0	0
2	11.1	2.5	0	0
3	11.1	5.0	32.96	0.303
4	11.1	7.5	22.25	0.449
5	11.1	10.0	15.83	0.63

3.2 Analysis Performance of the Hovercraft

Figure 3 below shows the analysis of the performance of the Hovercraft via speed. Based on the graph, the speed of the hovercraft is influenced by the value of the ohm. So, the higher the ohm, the higher the speed.

Based on the graph obtain, the performance of the hovercraft on the cement is the highest. This is because the surface of the cement is smooth compared to another surface. Besides, the performance on the water must consider the condition of the water such as the velocity of the flow

of the water and the wave of the water. This aspect may affect the performance the hovercraft on the water. Next, the performance on the grass is the lowest because of the surface may not smooth and flat.

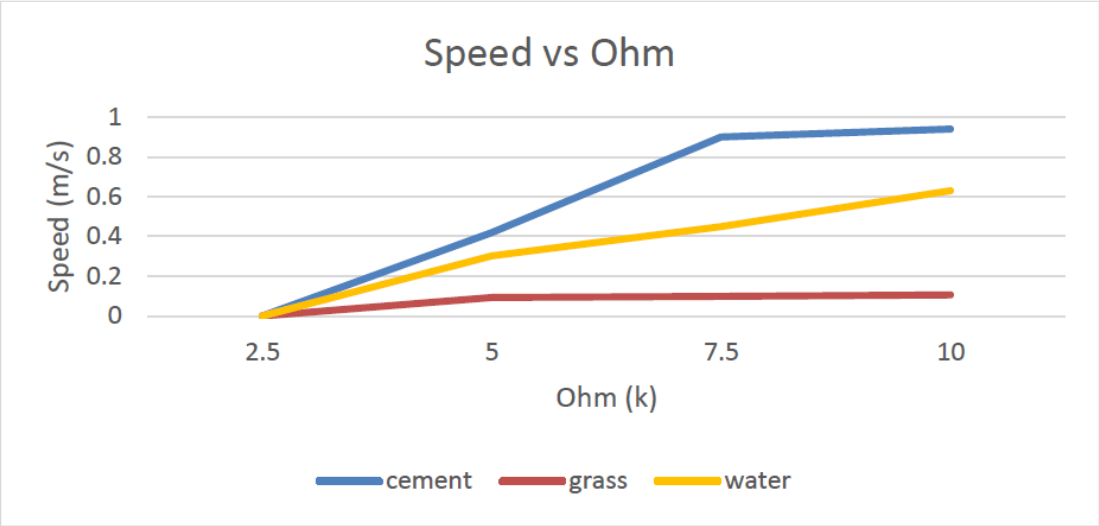

Fig. 3. The Performance of the hovercraft on variety surface

4. Conclusions

This paper has proposed a design and development of the hovercraft which is able to control by wireless. For the wireless connection, the Arduino UNO R3 was used to receive the signal from the nrf24L01 from the controller. The design was successfully made by using AutoCAD software while the programming was successfully built by using Arduino IDE. To test the performance of the hovercraft, there are 3 different types of the surface have been considered. There is cement, grass, and water. Based on the data obtained from the testing in the previous section, the performance of the hovercraft on the cement is the highest and the lowest performance is the grass. Thus, the result significantly demonstrates the performance of the hovercraft on the variety of the surface.

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