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Hydrostatic Release Unit (HRU) By Adding Water Sensor

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Abstract: Self-rescue devices are essential in an emergency, and one of the self-rescue devices is a life raft. However, the rescue raft has a problem in automatic launching using the Hydrostatic Release Unit (HRU). HRU is one of the components where it needed to release life raft automatically when emergency happens. Unfortunately, the effectiveness of the HRU is questionable because severalstudies are stating that the HRU cannot function. These because the component that being used in HRU mostly a steel where the pin is attach with the spring and make ittight to release the spring. One of other things is, HRU can be function when it reaches1.5m until 4m unless it has an enough pressure that exerted on the HRU, if not the diaphragm cannot be uprise and release pin from spring. Therefore, this study aimed to fabricate a prototype of HRU that use water sensor. This study uses several components such as Arduino, water sensor and servo motor. The programming C++ being used in this project to make servo motor and water sensor work automatically. There were 3 specimens that being used as a testing to ensure that this product work nicely which is thread, rubber band and fishing line. The result came out with thread and rubber band can be cut while fishing line cannot be cut. This because of material of fishing line more strong than other specimens. However, with high hopes that this study can be carried out in good condition and the main target is to increase the level of effectiveness of HRU in saving many lives.

Keywords: Hydrostatic Release Unit (HRU), Water Sensor, Arduino, Servo Motor

1. Introduction

As the extent of sea ice shrinks, the Arctic region is experiencing rapid expansion in commercial maritime activity in places that were previously deemed inaccessible to most ships for long portions of the year [1]. This increase has led to economic development but may increase the risk of unwanted incidents [2]. A Hydrostatic Release Unit (HRU) is one of the components in the life raft, which is used to release the life raft from the vessel tank. The life raft is one of the saving appliances that beingused for the crews in an emergency [3]. The HRU used the concept of hydrostatic pressure to be activated

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where high pressure from outside causes water to enter the HRU chamber and release the spring. If there is not enough pressure, the HRU will not activate. The HRU control system based on the application of a water sensor can overcome those situations where HRU can immediately activate when it senses water. This is because the water detector electronic device is designed to detect thepresence of water.

When there is a ship accident due to bad weather and so on, the life raft is very important as a saving appliance to the victim [4]. Life raft been used in saving appliances when emergency occur with the ships such as shipwreck by the wave of ocean. The action of HRU quite slow to release the life raft. HRU will only succeed in cutting the rope when it reaches a depth of 1.5m to 4m. Surviving a catastrophic shipwreck while being evacuated to a life raft in strong weather conditions is challenging, and it would take a lot of work on the part of rescue organizations as well as the survivors themselves [5]. Because of that, the risk of fatality will be higher. Other than that, with the usage of steel pin, there are probability that the pin to rust. The pin holds the spring in place, so, the spring cannot be released to cut the rope and release the life raft because of rusty pin [6].

By implementation of water sensor, there is no need for HRU to meet the requirement of water equilibrium to release the life raft. It can work at any water level because the sensor will directly send the input signal to Arduino to operates the HRU. The water sensor will trigger the servo motor to release the spring and let the blade cut the rope.

The paper aims to propose a control system of mechanism in HRU using electrical components. This research also to design a control system of HRU that can work fully automated by using Arduino. Lastly, to get the actual result, the fabrication prototype of HRU that using water sensor needed.

2. Methodology

A block diagram is used to represent the layout and structure of the system that is involved. The design of the project will be described. Figure 1 illustrates the block diagram for the project.

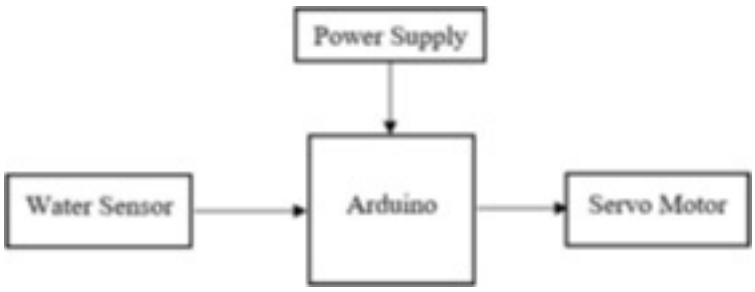

Figure 1: The block diagram of the project

Based on Figure 1, there is one input and one output. The inputs are water sensor, where it detects of water and send signal. The output is servo motor that receive a signal from water sensor and release the spring.

2.1 Circuit Diagram

After the installation of programming in the Arduino, the circuit will setup based on the programming. A circuit diagram is a diagram that depicts an electrical circuit in graphical form. A circuit diagram, also known as an electrical diagram, elementary diagram, or electronic schematic, is a graphical depiction of an electrical circuit that is simplified. Circuit diagrams are used to design, build, and maintain electrical and electronic equipment. Figure 2 shows an installation for circuit diagram of HRU.

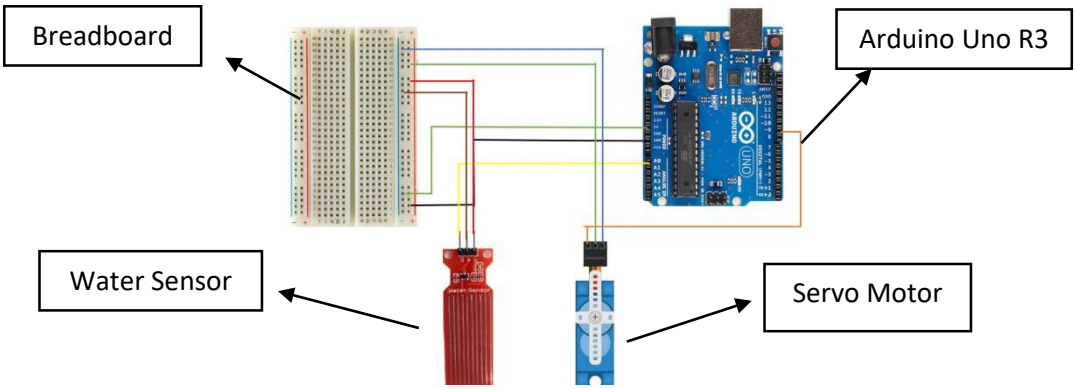

Figure 2: Circuit Diagram of HRU

2.2 Software Development

In order to generate servo motor, the Arduino will send the input to servo motor after sensor detect a water. To program the Arduino, C + + will be used for programming language for setup the Arduino. In C+ + will create the flow on how HRU will function from the start until the ends. Figure 3 shows the arrangement in write the C+ + programming language, the steps is to identify the inputand the output.

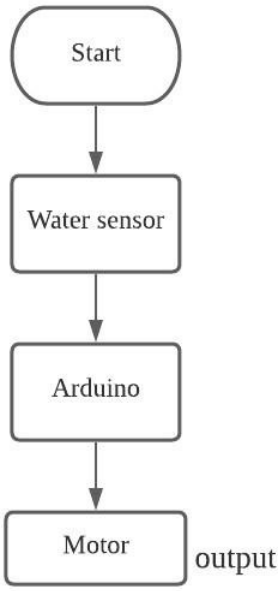

Figure 3: Arrangement of C+ + programming language HRU

In order to create C+ + programming, Arduino cloud software will be used in this project. Arduino cloud can easily install in laptop or by using phone. Furthermore, using Arduino cloud will much easier because it could directly update the C+ + programming into Arduino Uno R3 using cable.

2.3 Hardware Development

Table 1 shows list of components that use for Hydrostatic Release Unit by adding water sensor.

Table 1: List of components

Component	Function	Operating supply
Arduino Uno R3	Control system	5V input, 3.3V output
Water Sensor	Detect water	Range 3V-5V

Servo Motor	Actuator	Operating voltage 5V

2.4 Specimen of Testing

There were 3 specimens prepared to be tested. The purpose of the testing is to identify either the specimen can be cut or otherwise. Figure 4 shows the 3 specimens prepared to be tested.

(a) Thread (b)Fishing line (c)Rubber band

Figure 4: Specimen of Testing

The specimen was taken by different strength of material. Based on Figure 4, (a) is thread, (b) is fishing line and (c) is rubber band. The testing is to observe either the blade can cut all the three specimen or otherwise.

3. Result and Discussion

Analysis of materials suitable for the development of the mechanisms was taken into account in the fabricate prototype of HRU. Overall, this chapter will represent the result of control system by using Arduino that be applied to HRU and the final result for prototype of HRU.

3.1 Circuit Layout of HRU

The actual circuit of HRU been connected to each component based on the circuit diagram that been made at methodology process. The process was clearly following the steps carefully to avoid from short circuit happen. Based on Figure 5, there are 4 main components which is water sensor (a) servo motor (c), Arduino Uno R3(b), breadboard (b). The components are connected using male to male and male to female jumper wire.

Firstly, water sensor (a) was connected with arduino (b) and breadboard (b) using female to male jumper wire. So, water sensor (a) will send the signal to arduino (b), where the input from the sensor was processed. Then, servo motor (c) was connected with arduino (b) and breadboard (d) using male to male jumper wire. After, the signal from sensor was processed in arduino (b), it will send the output to servo motor (c).

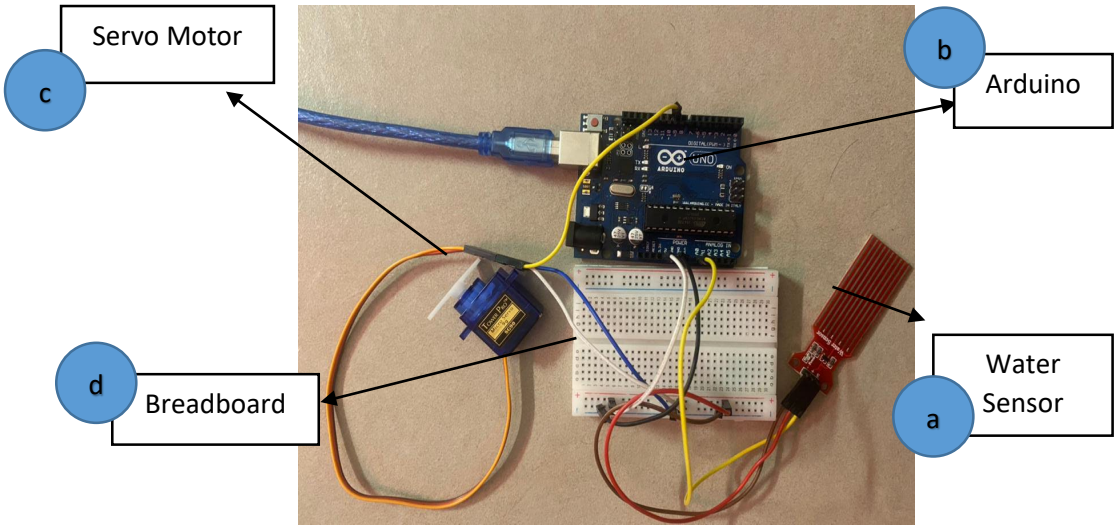

Figure 5: Actual Circuit of HRU

3.2 Prototype of HRU

Finished circuit have been installed into the casing of HRU and all the components was attached with the casing to form a HRU. Based on Figure 6, to ensure that the prototype of HRU can work properly the testing must be done. The data from the testing will shows what type of rope that prototype of HRU capable to cut.

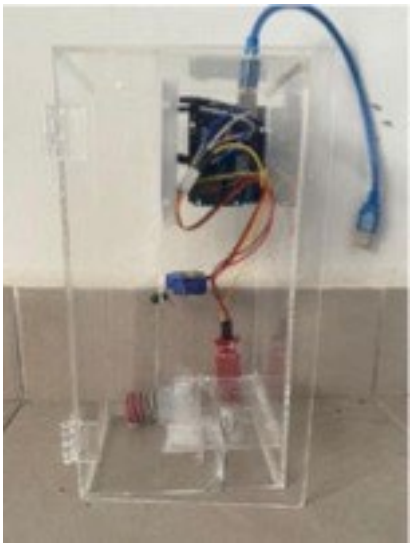

Figure 6: Prototype of HRU

Based on Figure 7 shows the result how the HRU will function. The C+ + programming for Arduino should be able to control all the system by sending the information to each component in HRU.

The system started with a water sensor that sensed or detect water when submerged in the water. When it happens, the water sensor sends the input or information to the Arduino board. Then Arduino generated the input and immediately send the output to the servo motor. The servo motor started to move and release the spring that blocks a compression of spring. At the end of the spring, the blade cut the rope.

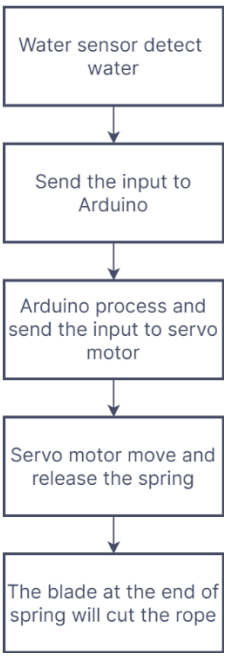

Figure 7: The Flow of HRU

3.3 Prototype of Performance

There are 3 specimens prepared for testing which is thread, fishing line, and rubber band. The specimen was inserted into HRU and the arduino was connected with power supply. Then the HRU was immersed in the water. The HRU prototype performance was monitored for 3 specimens which is thread, fishing line and rubber band. Based on Figure 8 shows that the result of prototype perfomance on thread.

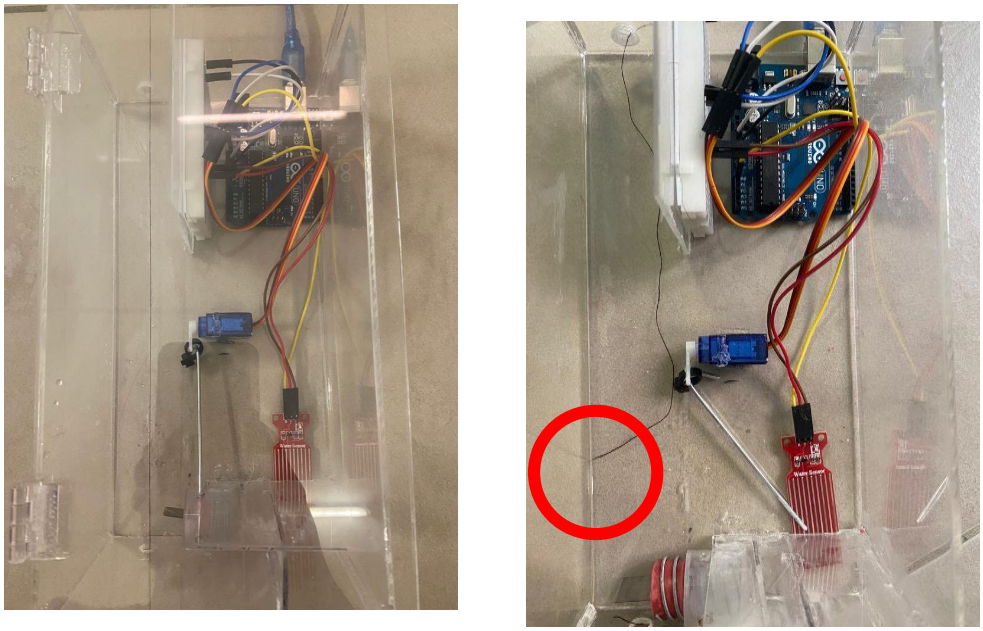

Figure 8: Testing Specimen for Thread; (a) Before HRU Immersed in Water; (b) After HRU Immersed in Water

All the specimens were chosen to have a different based on strength of material. Figure 8 above shows a testing for thread. Figure 8 (a) shows that the thread was inserted into HRU then the HRU was immersed in the water. The thread inserted will be tensioned to be more precise to hit the blade then water sensor was triggered, and it send the signal to Arduino for processing. Then, Arduino generated the input and immediately send the output to the servo motor. Servo motor will move and release the spring to cut the thread.

Figure 8 (b) shows that the blade was successfully cut the thread. This is because, thread has low mechanical strength where the tenacity of polytetrafluoroethylene (PTFE) in thread is between 2.5 and 4.0 gram per denier (gpd) depending on the type of material and color [7].

Besides, thread will become weak when the excessive stretching happens [8]. This is because, the fiber contained in the thread is very thin, when stretched happen the fiber will tear and it easy to be cut by the blade.

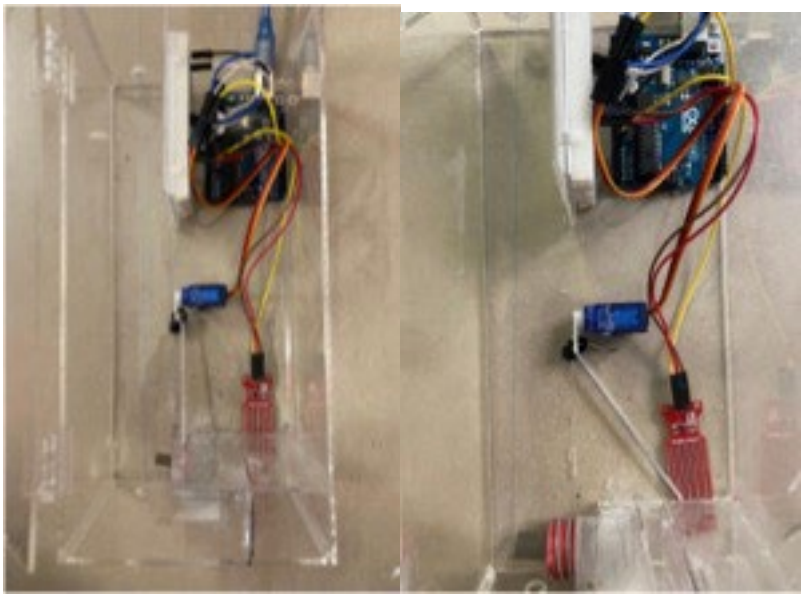

Figure 9: Testing Specimen for Fishing Line; (a) Before HRU Immersed in Water; (b) After HRU Immersed in Water

Figure 9 above shows a testing for fishing line. Figure 9 (a) shows before HRU immersed in water. The fishing line was inserted into HRU then the HRU was immersed in the water. The fishing line inserted will be tensioned to be more precise to hit the blade then water sensor was triggered, and it send the signal to Arduino for processing. Then, Arduino generated the input and immediately send the output to the servo motor. Servo motor will move and release the spring to cut the thread.

However, in Figure 9(b) shows that the fishing line was not successfully cut. This is because, it has a strong abrasion resistance where it more strength and it not easy to break. Most commercially available fishing line is made from polymer materials, such as nylon and polyethylene

Fishing line has high-performance line produced by thermal bonding of small fibers is called thermal filament and has a smaller diameter per pound test than monofilament [9]. The fishing line also has a less stretch where it harder than others.

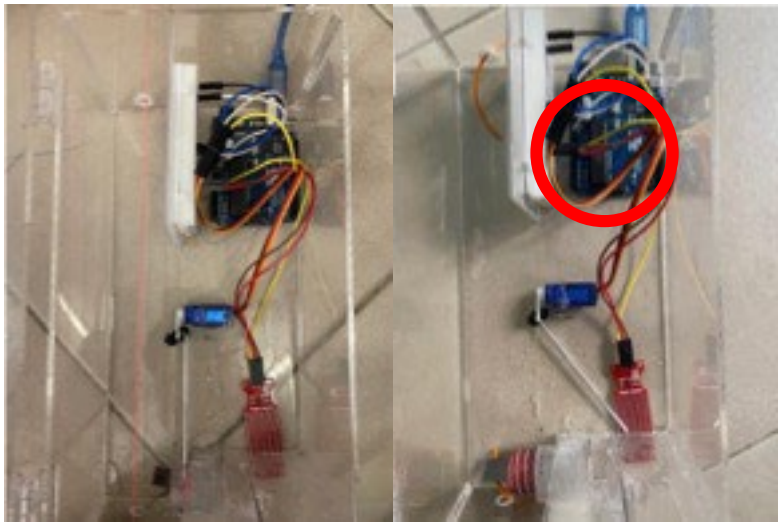

Figure 10: Testing Specimen for Rubber Band; (a) Before HRU Immersed in Water; (b) After HRU Immersed in Water

Figure 10 above shows a testing for rubber band. Figure 10 (a) shows before HRU immersed in water. The rubber band was inserted into HRU then the HRU was immersed in the water. The rubber band inserted will be tensioned to be more precise to hit the blade then water sensor was triggered, and it send the signal to Arduino for processing. Then, Arduino generated the input and immediately send the output to the servo motor. Servo motor will move and release the spring to cut the thread.

In Figure 10 (b) shows that the blade was succesfully cut the rubber band. This is because rubber band was elastic and viscosity [10]. The material of rubber band does not have strength to stand with the sharp of blade. Rubber band showed a greater increase in force decay as the extension length increased. It easy to cut when the blade was released. The result can be sum up in a table. Based on table 2 shows that the result for 3 specimen which thread, fishing line and rubber band.

Table 2: Result of Specimen

No	Specimen of Testing	Successfully cut (Yes/No)
1.	Thread	Yes
2.	Fishing Line	No
3.	Rubber Band	Yes

4. Conclusion

In conclusion, Hydrostatic Release Unit was successfully developed. This product was very important as a saving appliance when the emergency happens. It is an automatically release the life raft when the shipwreck. Development of this product should be useful for those who take safety while on board as priority.

In order to develop this product, there were 5 main part which are water sensor, Arduino Uno R3, servo motor, spring and blade. This project was developed by using an Arduino software as a platform for programming the control system. The programming was successfully installed in Arduino in order to run water sensor and send the signal to the servo motor.

From the result in previous chapter, it has been tested by 3 specimen which are thread, rubber band and fishing line. The result shows that thread and rubber band was successfully cut while fishing line cannot be cut. The result depends on material of strength for each specimen.

4.1 Future Improvement

This project used a lot of electronic components where it exposed to humidity and water. Because of that, the electronic component should be kept at safe place where it did not break because of water. Thehousing part for HRU need improvement to cover from water. Besides, spring should be stronger and elasticity, which is it will give more power to release and push the blade to cut the rope. Spring is the important part in HRU in order to cut the rope. More power that produces from spring will easy the blade to cut the rope.

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