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Smart Boat Controller to Assist in Rescuing Flood Victims

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Abstract: The fire department or rescuing squad is faced with a manpower shortage when the flood is occurring. To resolve this issue, there has been a suggestion for a smart boat controller. The invented boat rescue controller is convenient and simple to use. It is designed with a built-in system that can be controlled manually or automatically. The microcontroller NodeMCU ESP32 is used to construct the controller. The Blynk server is used to set the location to the safe zone for this automation system. Some sensors have been added to the system for an autonomous mode to detect obstructions and command the NodeMCU ESP32 to adjust the boat's path. The Blynk application on a smartphone might be used to manually operate the rescue boat. By using a smart boat control system, the victim can protect themselves from harm and significantly lower the frequency of flood-related fatalities or injuries.

Keywords: Automation, Smart Boat, Obstruction Detection

1. Introduction

In Malaysia, floods are a common natural disaster, particularly during the monsoon season. They are caused by heavy rainfall, overflowing rivers, and high tides. These floods can have a significant impact on the country, causing damage to infrastructure, homes, and crops, and disrupting transportation and other services. In addition, unexpected heavy precipitation events from mid-December 2021 to early 2022 caused disastrous floods in seven states of Malaysia that killed 54 people, harmed more than 125,000, required roughly 70,000 people to flee in a single day, and caused damages of up to MYR 6.1 billion or USD 1.46 billion [1]. Therefore, it is strongly advised to utilize a smart

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boat controller when floods occur in order to save more victims without having to wait for the rescue crew or another person to save a life.

In essence, an integrated control system combines manual and automated systems into a single system. This allows for a more efficient and effective way of controlling a process or system. The integration of manual and automated systems allows operators to have more control over the process, while also allowing for automated control and monitoring of the system. This can lead to improved safety, efficiency, and performance. An integrated control system is often used in industries such as manufacturing, power plants, oil and gas, and transportation. It allows for the automation of repetitive and dangerous tasks, while also providing operators with the ability to manually intervene and take control of the system if necessary. The use of advanced technologies such as sensors, actuators, and control algorithms in integrated control systems can improve the monitoring and control of the system, making it more reliable and accurate.

Smart Boat Controller could have a wide range of applications, including rescue operations during floods and for recreational use. The boat would be equipped with various sensors to gather data on its environment, such as water level, weather conditions, and the location of other boats or obstacles. The navigation system would use this data to guide the boat to its destination, while the motors would be used to propel the boat forward. The inclusion of GPS technology would allow the boat to be located and tracked in real-time, which would be particularly useful in rescue operations. This could also be integrated with a cloud-based system, allowing approved fire departments or other rescue teams to monitor the boat's location and status remotely, and even take control of the boat if needed. Additionally, the system could be equipped with a wireless communication module, allowing for communication between the boat and the rescue team and other boats in the area. This would improve coordination and safety during rescue operations.

Numerous research initiatives in the field of boat control systems with an emphasis on autonomous boats have been established [2-5]. In an Autopilot Unmanned Smart Boat Vehicle (AUSV) by [6], the Autonomous Boat automatically transmits boat coordinates to the control station through LoRa, allowing users to determine the boat's actual position and whether it has arrived at the stated coordinates. Some other cutting-edge controller produced by [7] used an Ardupilot system controller. The Pixhawk4-based control system was done with an RC boat, which can be seen with the original RC controller behind it and the Pixhawk4-controlled (air) propellers visible.

The Ardupilot system can be used for autonomous boats, but most of the previous project is just using RC boats for automatic system purposes [8]. To proceed on a real rescue boat, it need so much knowledge and experience for heavy duty transportation. Floods are a major natural disaster in Malaysia and a rescue boat is a critical tool for helping victims during such events. The development of an integrated control system for a rescuing boat that can be controlled both manually and autonomously would be very beneficial. In autonomous mode, the boat would use sensors such as LiDAR or cameras to detect obstacles in its environment and navigate around them. The navigation system would also use data from other sources such as weather forecasts and water level data to plan its routes and avoid areas that are particularly dangerous. The ability to switch between manual and autonomous control would provide the rescue teams with more flexibility and options to handle different scenarios and increase the safety of the rescue operation.

Overall, the development of such an integrated control system for a rescuing boat would have great potential to improve the efficiency and safety of rescue operations during floods and other natural disasters in Malaysia.

2. Materials and Methods

This project mostly made reference to previous paper on manual control and wireless control created by [9],[10] and [11]. The NodeMCU ESP32 microcontroller, waterproof ultrasonic sensors to detect obstructions, and a GPS module to track location were the major components utilized. The main controller, servo motor, trolling motor, GPS module, and sensors will all be turned on after the system has been turned on. The NodeMCU ESP32 used as the main controller in the project is supplied with 5 VDC. This control system serves as the system's brain and regulates all operations and components, including the motors, GPS module, and sensors. The sensors are used to detect any nearby boat obstacles. The sensor will alert the main controller to locate an alternate route if an obstacle was inside boundaries. A person must activate the power supply on the smart boat, and the user must choose whether to utilize a manual or automatic controller on Blynk. In the case that the automated controller option is selected, the program will carry out the autonomous operation, which entails the rescue boat moving autonomously toward the safe area that has been set on the Blynk server. If manual control is selected, the user must control the direction of the rescue boat using the Blynk app on their smartphone. Figure 1 illustrates the block diagram of the project whereas Figure 2 shows the algorithm of the controller system.

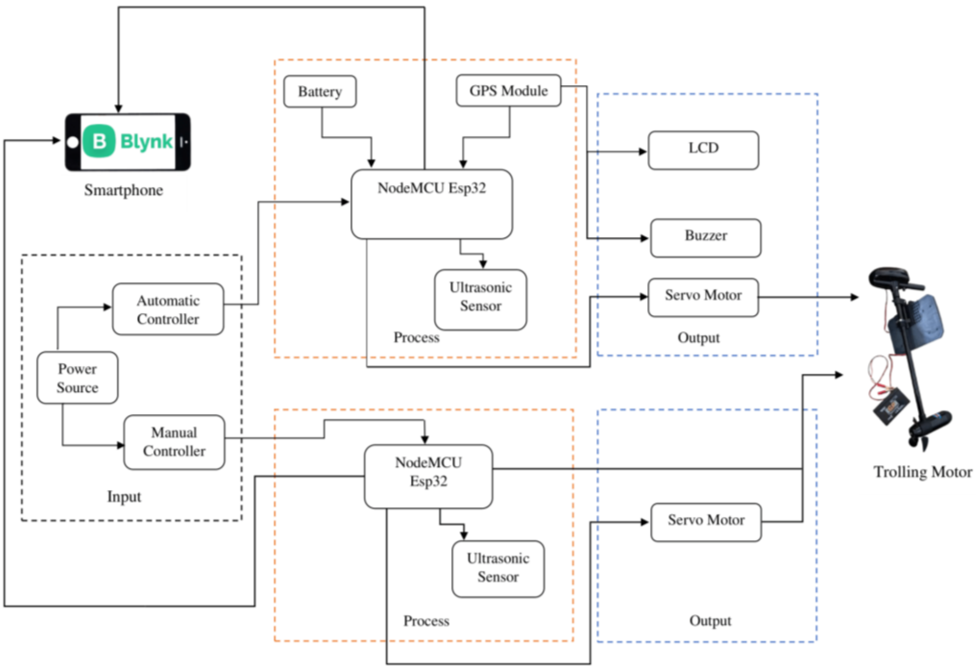

Figure 1: Block diagram of the project

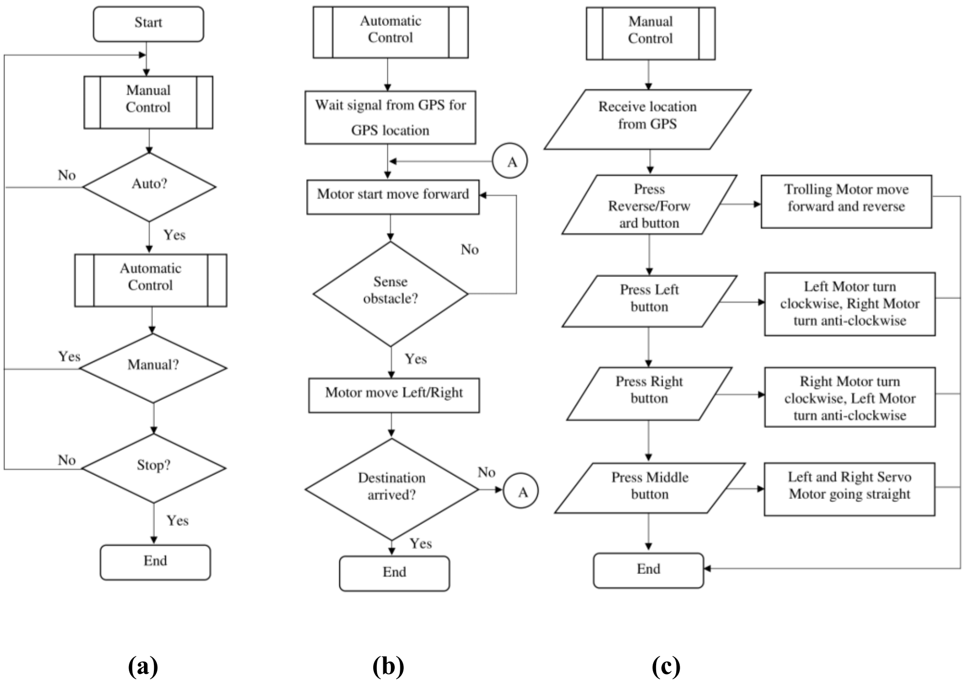

Figure 2 : (a) Main function algorithm; (b) Automatic control mode algorithm; (c) Manual control mode algorithm

In rescue boat system, three sensors have been introduced which placed in front, right side and left side of the boat. All sensors will always sense the condition surrounding of the boat and provide the feedback in kind of liquid crystal display (LCD) display and buzzer. After the setup is complete, the motor will begin to rotate in order to move to the point specified by GPS. While the boat is moving, the sensors will activate. When the sensors detect an obstruction within a certain distance of the boat, the sensors will provide feedback to the main controller, causing the pathway to be rearranged. The LCD will show left, right and middle distance between the sensors and obstacles. The buzzer also sounds if the sensor detects any obstacle. The NodeMCU ESP32's output signal is a servo motor and trolling motor when used manually. The motor will be controlled by a servo motor in response to a signal from the NodeMCU ESP32 that has been set for the path in the Blynk server. The user will control the trolling motor and servo motor by smartphone. If users see any obstacle, they need to avoid it by themselves from the Blynk server button on their smartphone. Then they can move the trolling motor forward and backward also by smartphone. Figure 3 shows the interface of Blynk application in smartphone for automatic and manual control of the smart boat and Figure 4 shows the whole smart boat controller system after being install.

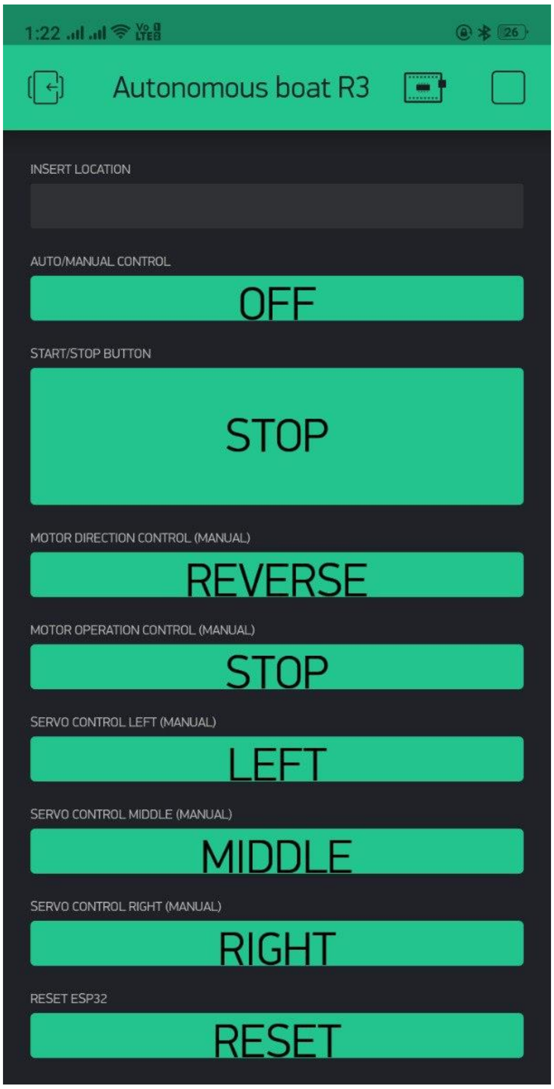

Figure 3: Blynk server

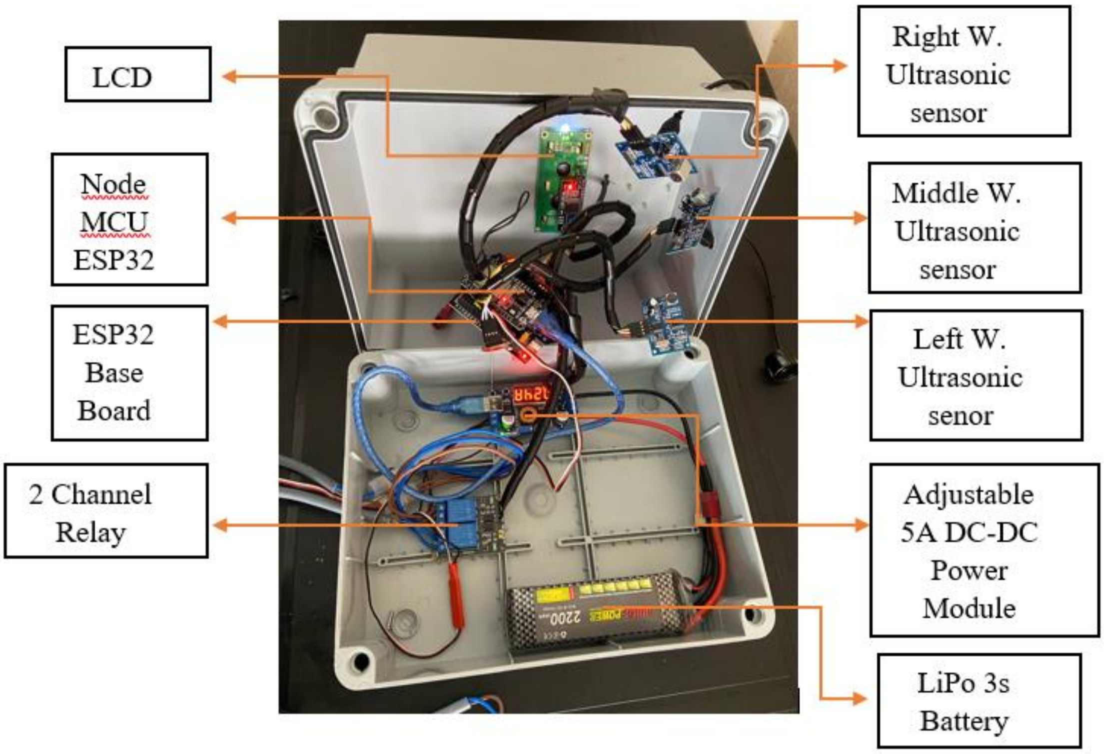

Figure 4: Smart Boat Controller system

3. Results and Discussion

The Smart Boat Controller to Assist in Rescuing Flood Victims concentrated on exact location, sensor performance, control and directional mechanism. Data gathered by experimentation and observation of the LCD display while it is operating automatically. A GPS module is utilized to determine the separation between the boat and the safe area. The final location on Blynk will be determined using the safe zone's coordinates. The wrong heading will then be displayed on the LCD screen to make sure the user is facing in the appropriate direction as the distance between the rescue boat and the safe zone is then calculated in real-time.

The boat must be in the proper position during testing to allow the GPS module to receive satellite signal. Given that the signal is identical to a phone signal, the signal transmission time is divided into short (1 to 5 minutes) and long (more than 5 minutes). The entire system is ready to use once the GPS module has received the satellite signal. Table 1 displays the findings of how long it took the GPS at various locations to get the satellite signal. It demonstrates that GPS may pick up the signal more quickly in open areas like Segamat and the pool at shared facilities than in closed areas like the Block B laboratory at UTHM Pagoh.

Table 1: Time Consume to Receive the Signal by the GPS Module

Location	Time consume	
	Short (1-5 minutes)	Long (above 5 minutes)
Hometown at Segamat	√	
Block B Laboratory UTHM Campus		√
Shared Facilities Pool	√	

As for the sensors, tests have been performed on the waterproof ultrasonic sensor JSN-SR04T to determine its maximum range, angle of detection, and the area that the sensor can cover. Operational distance for the ultrasonic sensor is 25–450 cm. The duration it takes for the wave to reflect increases along with the obstacle's distance from the sensor. Figure 5 shown the way that signal wave being transmitted and received by the waterproof ultrasonic sensor.

Distance (cm) = Speed of sound (cm/μs) × Time (μs) / 2

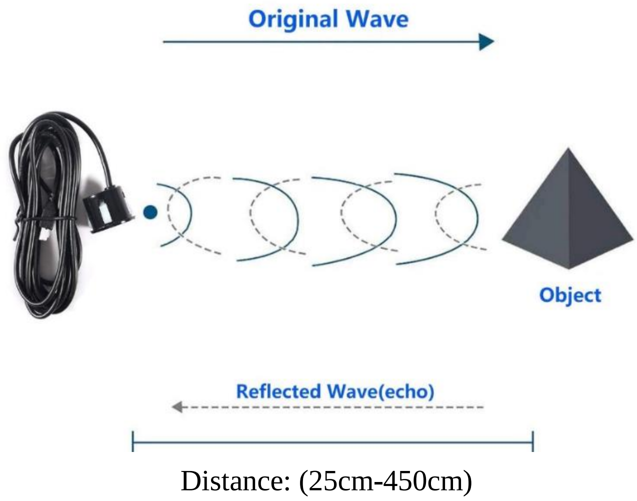

Figure 5: Signal wave transmission by the waterproof ultrasonic sensor

Following a study of the ultrasonic sensor's effectiveness, the same kind of sensor was mounted on the boat's front, right side, and left side. Figure 6 shows the position of the waterproof ultrasonic sensors installed on the boat. The boat's movement has been controlled by the three ultrasonic sensors in order to automatically avoid obstacles as it travels to the safe area. When the sensors spotted an obstacle close to the boat, a variety of actions have been designed to assist the boat avoid it. Depending on where the obstruction is, the boat will shift its path in the opposite direction, either to the right or to the left.

Figure 6: The position of left, right and middle waterproof ultrasonic sensor

During this situation, the LCD will show the distance range between sensors and obstacle below 30cm to show that the obstacle is near to the rescue boat. The buzzer also sounds to alert the user. For example, LCD is show that the range of all the sensors is above 200cm when there is no obstacle as in Figure 7a. In Figure 7b, the LCD show that the left sensor has detected obstacle as the range is below 30cm.

(a) (b)

Figure 7: (a) No obstacle detected; (b) Left sensor detect an obstacle

In manual system, Blynk server is use to control the servo motor and trolling motor without set up the location. All the buttons on the Blynk interface can manage to control the smart boat. The serial monitor will display the rescue boat's current motion as it is moving, whether it is going straight, left, or right. Figure 8 shows the interface button for the manual system while figure 9 shows the result in serial monitor when the buttons in Blynk is pushed.

Figure 8: the interface button for the manual system.

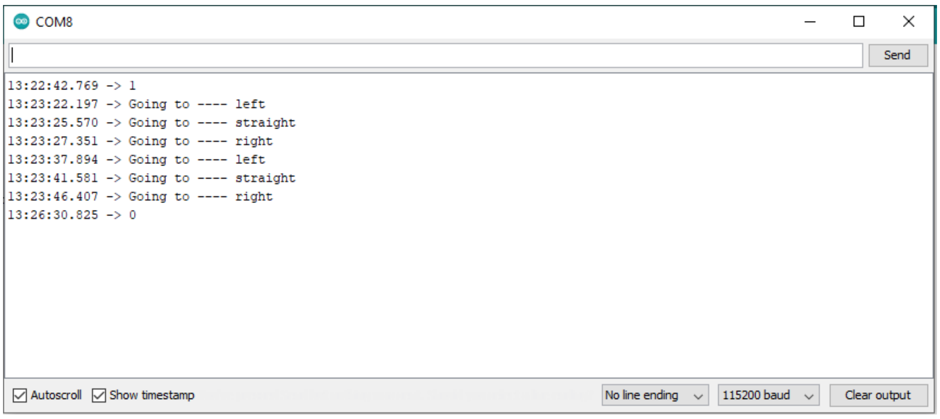

Figure 9: the result in serial monitor.

Product testing has been carried out to test the effectiveness of the automatic system on the boat. Testing is done in a shared facilities pool to facilitate testing. The switch on the trolling motor is turned on and the location will be set in the Blynk apps to guide the boat to move. After that, the boat will move towards the set location. At the same time, a test of the waterproof ultrasonic sensor is done by pointing any obstacle at the sensor to make the boat avoid and change direction. After that, the boat will continue towards the designated location and stop when it reaches the destination. In figure 10a the boat initial condition after set the location in Blynk. Then, figure 10b the boat is moving forward and having obstacle from the right side of the boat. Moreover, figure 10c, the boat changes the direction and heading towards the location. Therefore, figure 10d the boat finished to arrive at the destination.

(a)

(b)

(c)

(d)

Figure 4.14 (a) the boat initial condition; (b) the boat having an obstacle; (c) the boat change and move towards the location; (d) the boat finished the destination.

4. Conclusion

In a conclusion, the smart boat controller and the entire process were successfully set up. An integrated system that is both automatically and manually controlled allows the boat to be controlled. In automatic mode, the bot system may locate the set location and proceed in that direction. If there is an obstacle, the boat's sensors can find it and shift the boat's path to avoid it. To make sure the user is heading in the appropriate direction, error heading is shown on the LCD. To help the user determine whether there is an obstacle nearby, the distance between the three sensors and the obstacle is also shown on the LCD. The user also can be alert if the buzzer sounds when sensors detect any obstacle. In manual control using Blynk application on smart phone, the user have to observed the obstacles and can control manually by push the buttons on smart phone to avoid the obstacles. The motor begins to accelerate after the hardware has been installed and is connected to the power source Overall, both automatic and manual operation of the boat were successful. This integrated control system lifeboat can help flood victims and rescue teams by allowing individuals to rapidly and safely transfer to a safe zone on their own.

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