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Development of An Integrated Control System for Rescue Boat

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Abstract: During flood season, fire department or rescuing team are facing the situation which is lack of man power. To overcome this problem, an integrated rescuing boat control system has been proposed. The developed rescuing boat controller is convenience and easy to handle. It has been built with an integrated system which could be handled manually or automatically. The controller is developed using microcontroller Arduino. For an autonomous mode, some sensors has been introduced to sense the obstacles and giving the instruction to the Arduino to changed the direction of the boat. For manual control, rescuing boat could be controlled by Blynk application through smart phone. By introcuding an integrated rescuing boat control system, the victim can save their own from dangerous and reduce dramatically the number of death or injuries due to the flood.

Keywords: Autonomous, Integrated system, Obstacles avoidance

1. Introduction

In Malaysia, flood can be categorized into two situations which are flash flood and monsoon flood. Flash flood happen in sudden without any warning which can create chaos among people. Northeast monsoon winds and Southeast monsoon winds possibly make the monsoon flood to occur. Yearly, Northeast monsoon typically occurs within November until March whilst Southeast monsoon occurs within May until September. According to [1], flash flood is exceedingly dangerous than monsoon flood because it can turn a river overtopped, water extends over the flood plain and sweeping everything in its path downstream. Thus, an integrated rescuing boat is highly suggested to be used when floods happening to save more victims without waiting for the rescue team or someone else to save a life.

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The integrated control system basically combine an autonomous and manual control into one system. An autonomous technologies are made to help people in many aspects which include services, medical application, household, military and others. An autonomous boats also known as an auto-drive boats, auto-pilot boat, drive-free boat, driverless and so on is one of the human transportation that utilizing autonomous technologies. The autonomous boat could be used in many conditions such as rescuing during flooding season or during leisure time. Usually an autonomous boat are equipped with sensors, navigation system and motors. Some of an advanced boat has an additional screen that function to navigate the boat to the save zone. For the tracking system, the current location of the boat could be synchronized in cloud and it can be control by authorized fire department wirelessly in case the person in the boat have difficulty to drive the boat to the safe zone.

Numbers of projects regarding to the boat control system has been developed by researchers mainly focussing on an autonomous maneuvering [2-5]. In a mini-ASV prototype developed by [6], they introduce a powerful STM32F103ZE microcontroller on-board to give command and drive the actuators of the vehicle. Additionally, a Global Positioning System (GPS) unit and a mini Inertial Measurement Unit (IMU) are also integrated to accuire the position and orientation information. Another advanced controller system made by [7] used backpropagation neural controller. Their system also equipped with radio control to control the signals whilst retrieving the values from the controller's console screen. To maneuver their vessel, a compass sensor is acquire the heading data, and a forward and side velocities were obtained from the accelerometer and the timing controller.

The autonomous vessels can be used for various applications, but currently it still required crews onboard to control some vessels operations [8]. Even the crews onboard is still needed, numbers of the crews to operate the ships could be reduced. As the flood is the bulk disastrous natural disaster experienced in Malaysia, typically the rescuing boat is the most important things that needed during the flood. Hence, the autonomous boat could help rescue teams to help the flood victims. In this project the aims are to to develop an integrated control system for rescuing boat which can be control manually and automatically. In autonomous mode, the rescuing boat could be able to avoid an obstacle using sensor detection.

2. Materials and Methods

This project mainly referred to the previous work on wireless control and manual control developed by [9] and [10]. The main components used were Arduino Mega 2560 as microcontroller, ultrasonic sensors for sense obstacles and GPS Module to trace location. When the system has switched on, the main controller, motor controller, GPS module and sensors will be activated. The Arduino used as the main controller in the project is supplied with 5 V_{DC}. This main controller is a brain of the system that control the whole processes and components including the sensors, GPS module, and motors. The sensors are used to sense the obstacle of the boat surrounding. When an obstacle existed in bounds, the sensor will give a signal back to the main controller to find another way out. After the system has been connected with power source, user has to decide to use manual or automatic control mode. If the automated controller mode has been chosen, the program will execute the autonomous process where the rescue boat will move on their own towards the safe zone which has been preset in the microcontroller program. If the manual control mode has been chosen, user has to use blynk application in smart phone to maneuver the direction of the rescue boat. Figure 1 illustrates the block diagram of the project whereas Figure 2 shows the algorithm of the controller system.

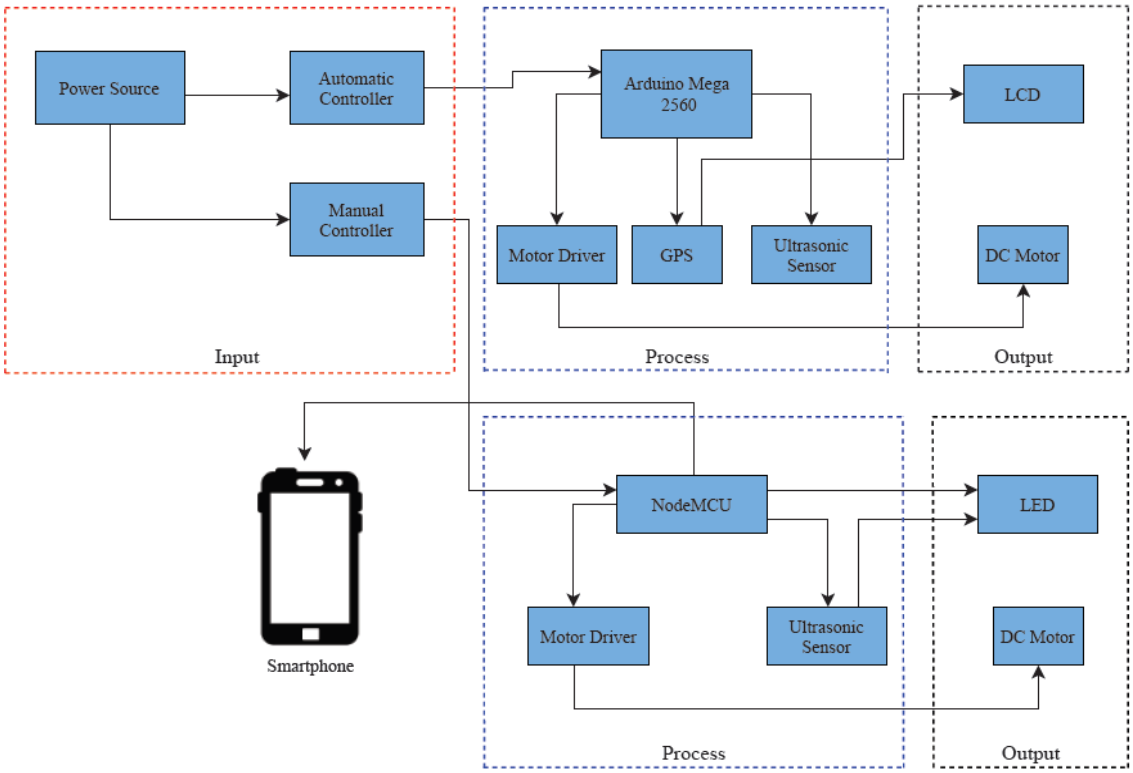
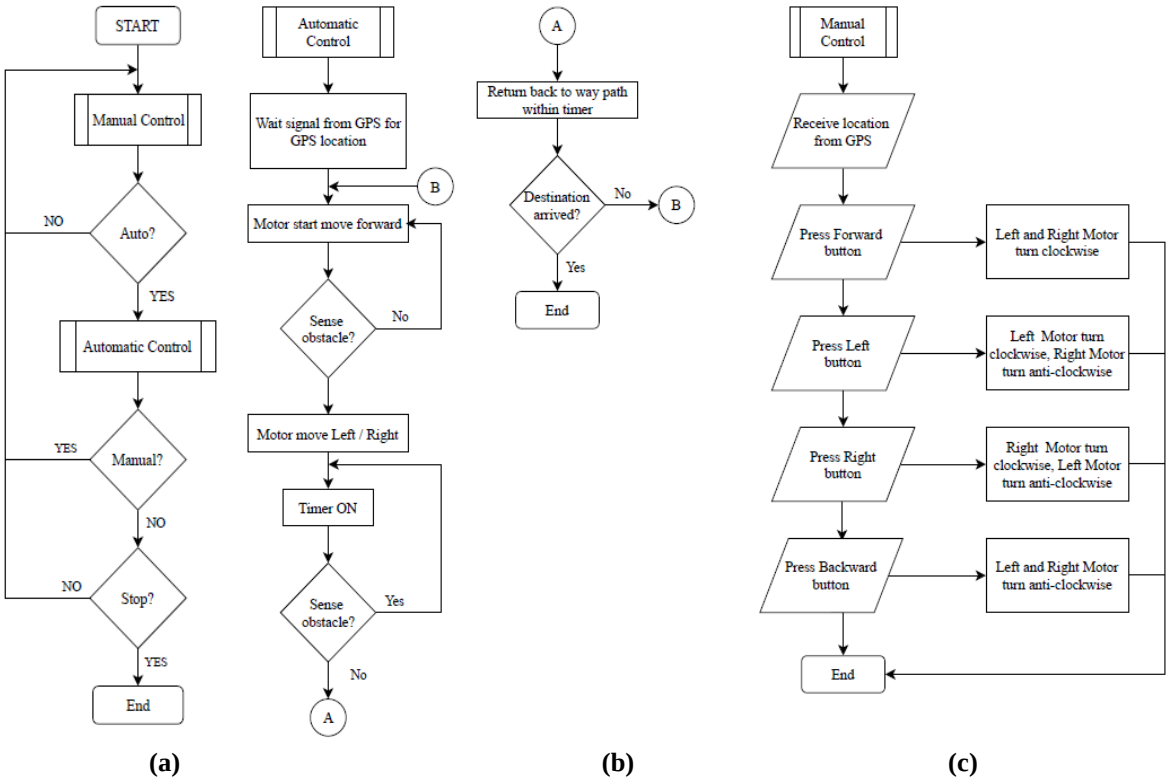


Figure 1: Block diagram of the project



(a) **(b)** **(c)**

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

In rescue boat system, three sensors has been introduced which placed infront, right side and left side of the boat. All sensors will always sense the condition surrounding of the boat and provide the

feedback inkind of light emitting diod (LED) blinking. Three LEDs has been installed in the boat system and for manual control by using Blynk application, the LED icon will appear on top of the smart phone screen. The LED icon in Blynk application will always shows the real situation occur at the real physical LED on the rescue boat. To monitor the obstacle around the boat, LED1 will light up in green colour whenever the sensor in front of the rescue boat sense any obstacles. Another LED which are LED2 and LED3 both will light up in yellow or red colours whenever the sensor at right side or left side of the boat sense any obstacles. At the bottom of the Blynk application, a joystick is appear to maneuver the boat direction. When the joystick is slided up, the boat will move forward. When the joystick is slided to the right, the boat will move to the right and when the joystick is slided to the left, the boat will move to the left. Figure 3 shows the design of Blynk application in smart phone for manual control of the rescue boat and Figure 4 shows the whole rescuing boat controller system after being assembled.

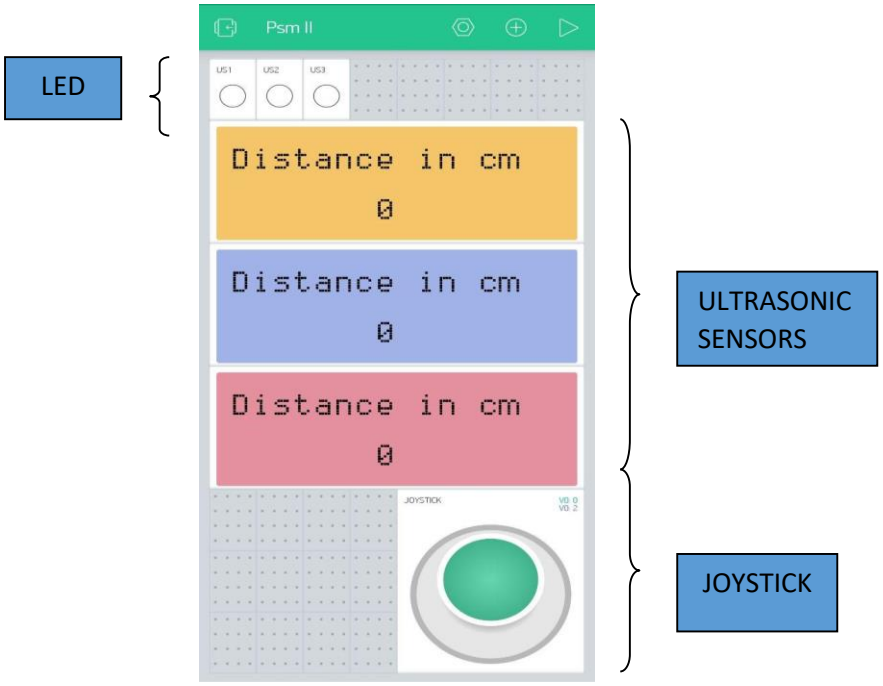


Figure 3: Blynk application

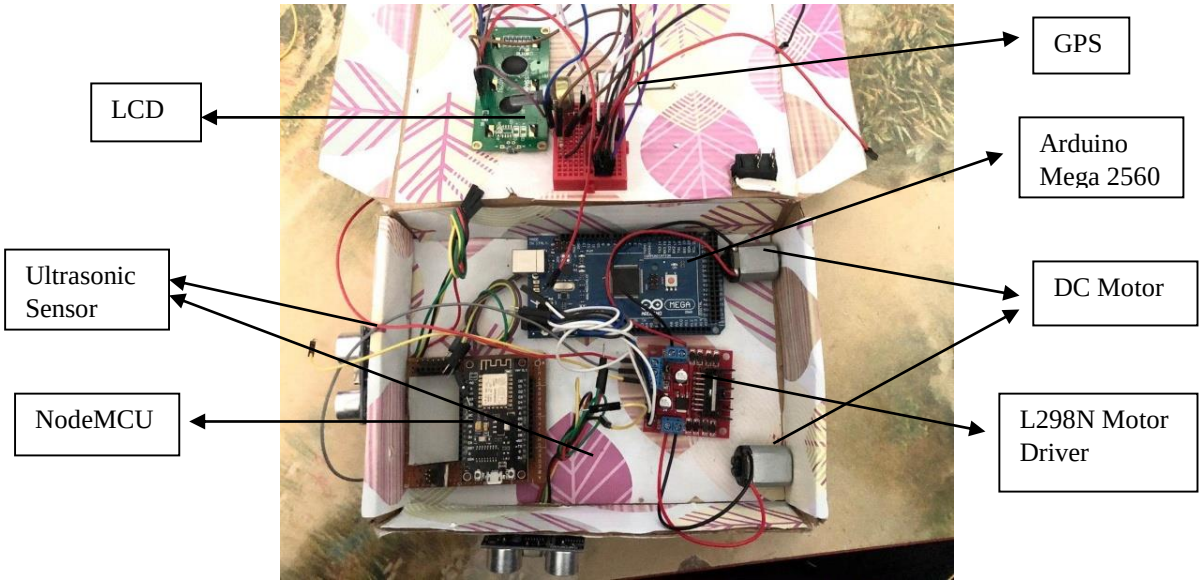


Figure 4: Rescuing boat controller system

3. Results and Discussion

The development of integrated control system for rescuing boat is focused on the capturing real time location, sensor performance and integrated controller system. The data captured through experiment and screen observation on smart phone in manual controller mode. To calculate the distance between the rescue boat and the safe zone, a GPS module is used. A safe zone coordinate will be set as the final location which has been programmed in the microcontroller. Then the distance between the rescue boat and the safe zone is calculated in real time.

During the location testing, the boat has been placed in several location to let the GPS module capture the signal from satellite. Then the time consume to received the signal has been observed. Based on the results, the waiting time to get a reading can be from few seconds up to several minutes. The time consume to received the signal are categorized to short (1-5 minutes) and long (above 5 minutes). Once the GPS module had captured the signal from the satellite, the whole system is ready to function. Table 1 shows the results of time taken for the GPS to receive the signal from the satellite at different places. It shows that at a wide area like field and playground, GPS could capture the signal faster compared to the narrow area like home yard.

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

Location	Time consume	
	Short (1-5 minutes)	Long (above 5 minutes)
Home yard		√
Field	√	
Playground	√	

For sensoring part, an ultrasonic sensor HC-SR04 has been tested for its range and angle detection to know its distance limit and area that can be reached by the sensor. From the measurement, the range distance that could be reached by the ultrasonic sensor is from 2 cm up to 2000 cm. As the distance of obstacle increase from the sensor, the voltage detection also increase. Figure 5 shows the relation between voltage and obstacle distance from the sensor. Based on the observation, the changes of the voltage start from 2 cm and increase linearly as the distance of the obstacle changes.

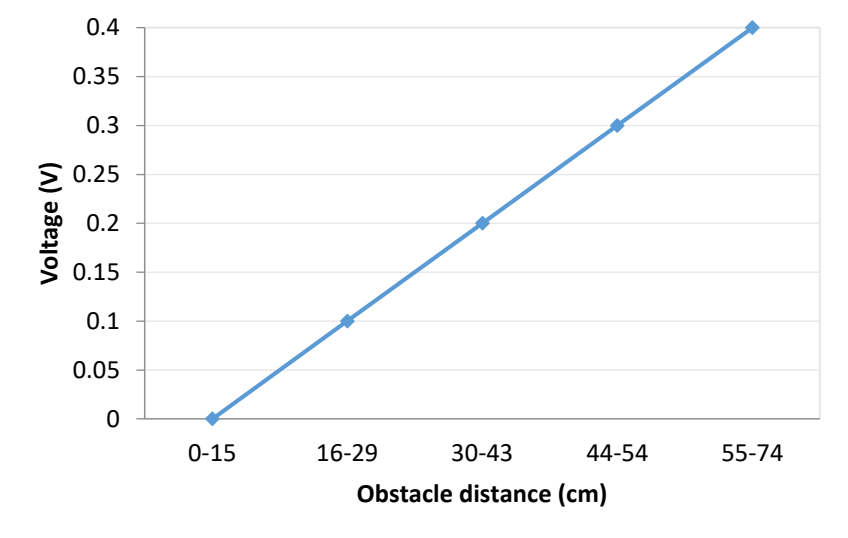


Figure 5: Voltage against distance of the obstacle

After performance of the ultrasonic sensor has been analysed, the same type of sensor has been installed infront, right side and left side of the boat. The three ultrasonic sensors have been used to control the movement of the boat in order to avoid the obstacles automatically along the way to the safe zone. There are several actions have been programmed for the boat to avoid the obstacles when the

sensors detected an obstacles near to the boat. The boat will change the direction opposite to the obstacle either to the right or to the left depending to the location of the obstacle. During this situation, the LED will light up to show that the obstacle is near to the rescue boat. For example, LED is not light up when there is no obstacle as in Figure 6a. In Figure 6b, the front and right LEDs will light up when they senses an obstacle at the corner of the front-right of the rescue boat.

(a) **(b)**

Figure 6: (a) No obstacle detected; (b) Sensor 1 and 2 senses an obstacle

In manual control, user need to maneuver the rescue boat by themselves using joystick which has been designed by Blynk application in smart phone. When the rescue boat is moving, the serial monitor will shows the current process of the rescue boat either it is moving forward, left or right. If any obstacle has been detected and the distance between the boat and obstacle is near, the LED will light up and user need to change the boat direction manually by themself. The Blynk application will always shows the distance of the boat and obstacles in the middle of the smart phone screen. Figure 7 shows the Blynk app showing the distance between the boat and the obstacle in front, left and right of the boat.

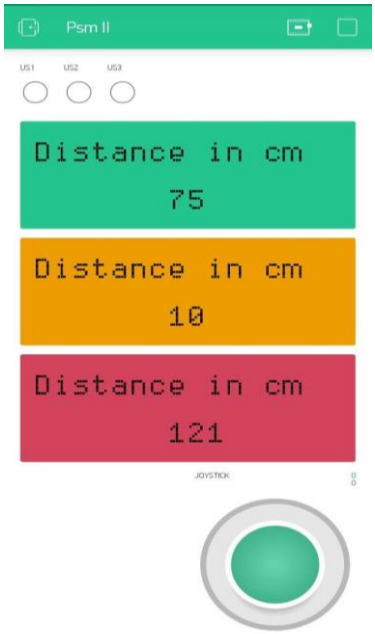


Figure 7: Distance display in smart phone screen based on the Blynk application design

4. Conclusion

The integrated control system for rescuing boat has successfully developed. The performance of the whole system was collected and analyzed and they are perform properly as desired. The boat is able to control by using an integrated system which are automatically and manually. In automatic mode, the boat system able to detect current boat location and instruct the boat to move to the safe zone. If there is any obstacle, sensors of the boat would sense it and change the direction of the boat to avoid the obstacle. After passing the obstacle, the boat will continue to move to the safe zone. Along the movement, user could able to monitor its current location and the distance towards the safe zone on LCD. In manual control using Blynk application on smart phone, the user have to observed the obstacles and can maneuver the boat manually by sliding the joystick on smart phone to avoid the obstacles. This integrated control system rescuing boat could provide benefits to the flood victim and rescue team where people can evacuate to the safe zone by themselves easily and safely.

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