iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** V **Month of publication:** May 2022

DOI: https://doi.org/10.22214/ijraset.2022.42532

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue V May 2022- Available at www.ijraset.com

Boat Detection and Tracking Using RSSI Signal in A Device-Free Environment

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Abstract: This project presents a device-free human detection method for using Received Signal Strength Indicator (RSSI) measurement of Wireless Sensor Network (WSN) with packet dropout based on ZigBee. Packet loss is observed to be a familiar phenomenon with transmissions of WSNs. The packet reception rate (PRR) based on a large number of data packets cannot reflect the real-time link quality accurately. So, it raises a real-time RSSI link quality evaluation method based on the exponential smoothing method. Then, a device-free human detection method is proposed. Compared to conventional solutions which utilize a complex set of sensors for detection, the proposed approach achieves the same only by RSSI volatility. The experimental measurements are conducted in laboratory. A high-quality network based on ZigBee is obtained, and then, RSSI can be calculated from the receiver sensor modules. Experimental results show the uncertainty of RSSI change at the moment of human through the network area and confirm the validity of the detection method.
Keywords: RSSI Signal, Detection and tracking

I. INTRODUCTION

The Boat detection and tracking using radio signal strength in indoor wireless networks has attracted a great deal of interest from the research community because this technology can be applied in many applications including intrusion detection and tracking in buildings, monitoring and tracking in emergency situations and monitoring for controlling automated devices. In many scenarios, the boatss to be monitored cannot be expected to carry any radio device. Consequently, a device-free boat detection and tracking system, that works by monitoring and analyzing the changes in received signal strength patterns, is used to fulfill such a requirement.

The first function is developed for measuring and collecting RSSI signals affected by boat movement, while the second function is developed for detecting and tracking the boat using a predefined threshold and a zone selection method. The novelty of our proposed system is that the communication protocol can avoid signal interference and packet loss in the network, and the detection and tracking method can specify an actual zone that the human is present by taking an optimal predefined threshold and a level of RSSI variation in each zone into consideration.

To detect and track boat movements, RSSI information is widely used because most wireless devices have RSSI circuits built into them. Thus, no additional or extra hardware is required. This helps reduce the hardware cost and power consumption of the system. The major challenge in the use of RSSI is that the measured RSSI is time-varying and unreliable in general. It often fluctuates over time due to multi-path effects caused by reflection, diffraction, and scattering of radio signals in a physical environment. High variation of the RSSI can cause significantly high levels of detection and tracking errors, and inaccurate results can lead to poor decisions in the overall system. Due to the RSSI variation problem, an acceptance level for the detection and tracking accuracies is required (depending on the application). The issue of the balance between the detection and tracking accuracy and the complexity of the method should also be considered. In addition, from a wireless communication perspective, for RSSI measurement and collection, the signaling overhead generated by communication protocols, the power consumption of wireless devices, and communication reliability are also major concerns. Therefore, in the design and development of boat detection and tracking system using RSSI, the mentioned requirements are very challenging and need investigation.

A. Proposed Work

In the proposed system, the boat distance can be measured using the received signal strength received from the RSSI Transmitter (boat). By using this RSSI, we can find the location of the boat in the sea. Whenever the boat reaches the border, the APR voice, alert the concern person in the boat and at the same time boat will automatically turn OFF.

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B. Block Diagram

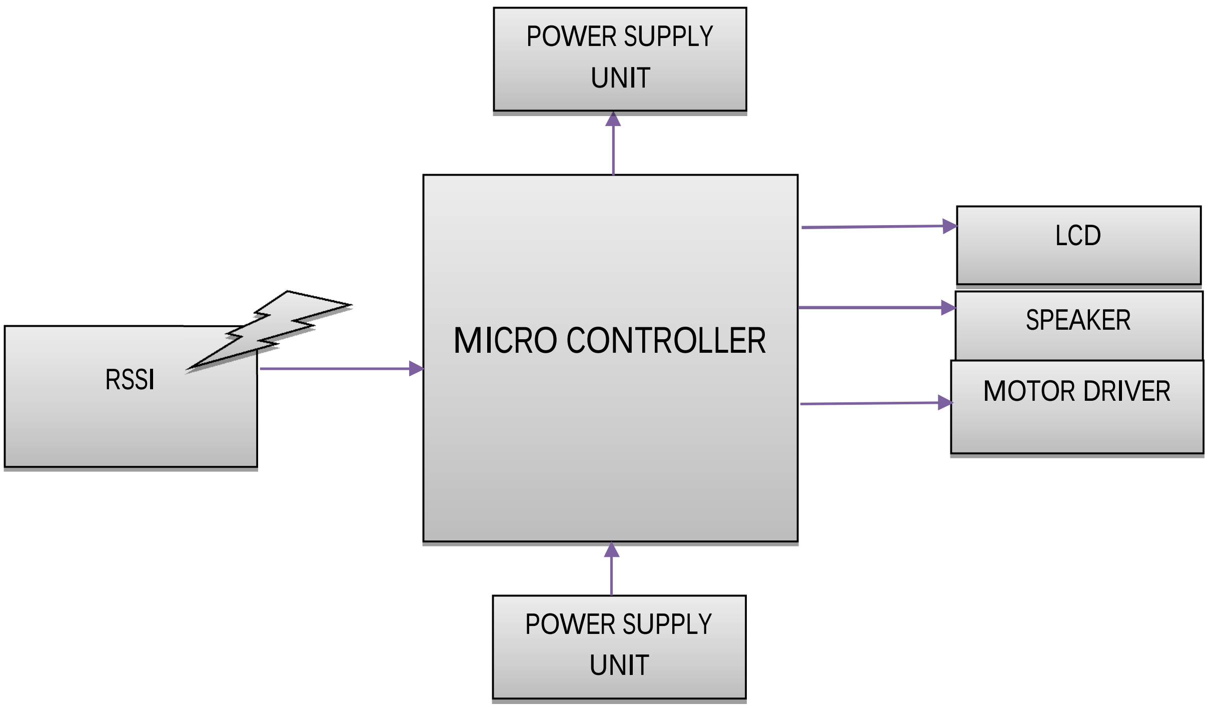

Figure 1: Block Diagram for Transmitter Side

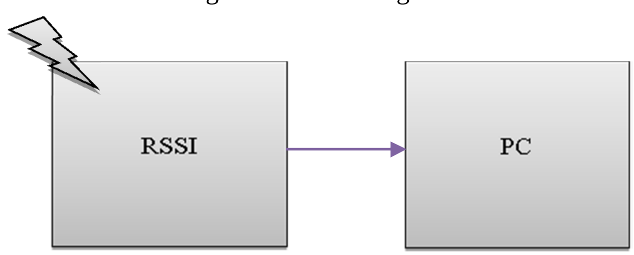

Figure 2: Block Diagram for Receiver Side

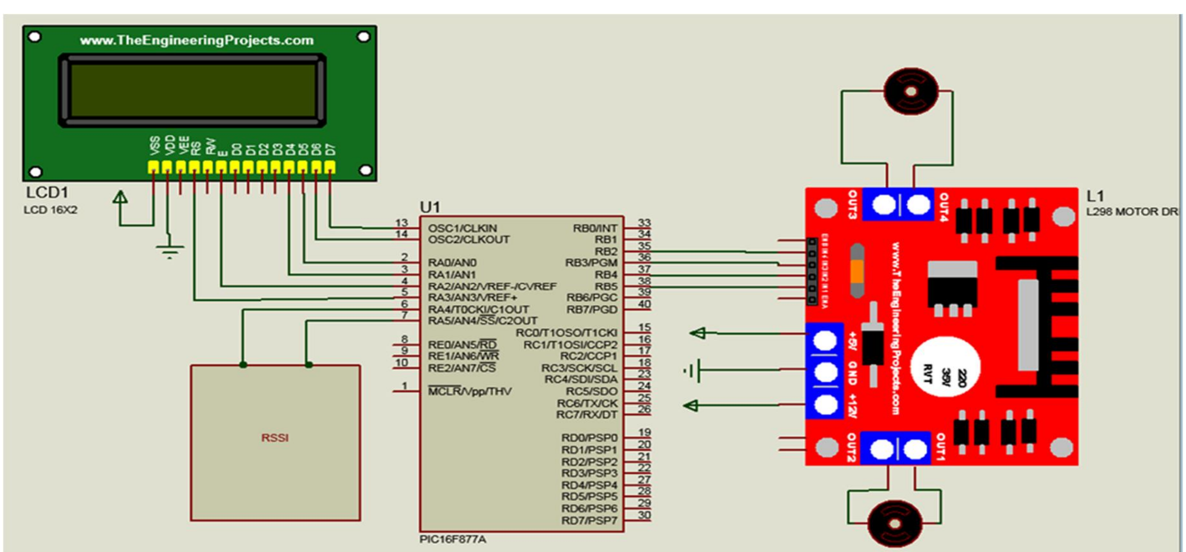

Figure 3: Circuit Diagram for Boat Detection

C. Component Requirement

1) Hardware Requirements

a) Microcontroller
b) RSSI Module
c) Motor Driver
d) DC Motor
e) LCD Display
f) Speaker
g) Power Supply Unit

2) Software Requirements

a) PIC CC
b) MPLAB IDE
c) Embedded C

D. The Simulation

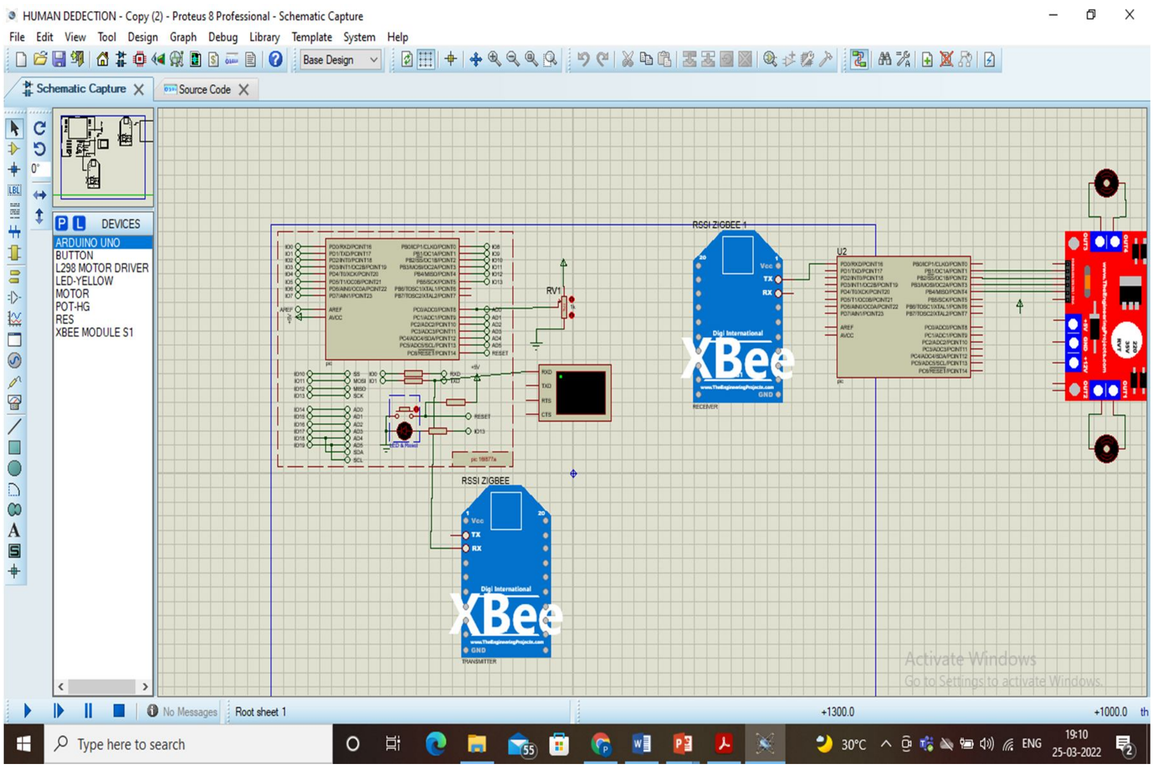

Figure 4: Simulation Diagram for Boat Detection

1) *Step 1:* Run the proteus 8 professional software application by clicking the icon on the desktop.
2) *Step 2:* Next, a workspace appears with interface buttons for designing circuits. Notice that there is a blue rectangular line in the workspace
3) *Step 3:* Select the library components. Select Library → Device/Icon from the menu bar. Then the window shown below will open, it is another way to select the components. There is a toolbar on the left side of the work area. Click the component mode button on this toolbar or choose from the library
4) *Step 4:* Select all components from the library, these components will be added to the device list. To change the angle of the component, click on the component with the Rotate button. Then click on the canvas and then the selected component will be placed on the canvas.

5) *Step 5:* Place all devices in the workspace and place the cursor on the pin end of the component, then draw the connections with the pen symbol. Connect all the components according to the circuit then the designed one.
6) *Step 6:* If any modifications needed in the component, place the cursor over the component and click the right button on the mouse, the option window will open.
7) *Step 7:* The components can be connected using the wires or it can be connect using the wire label by giving command on wire label.

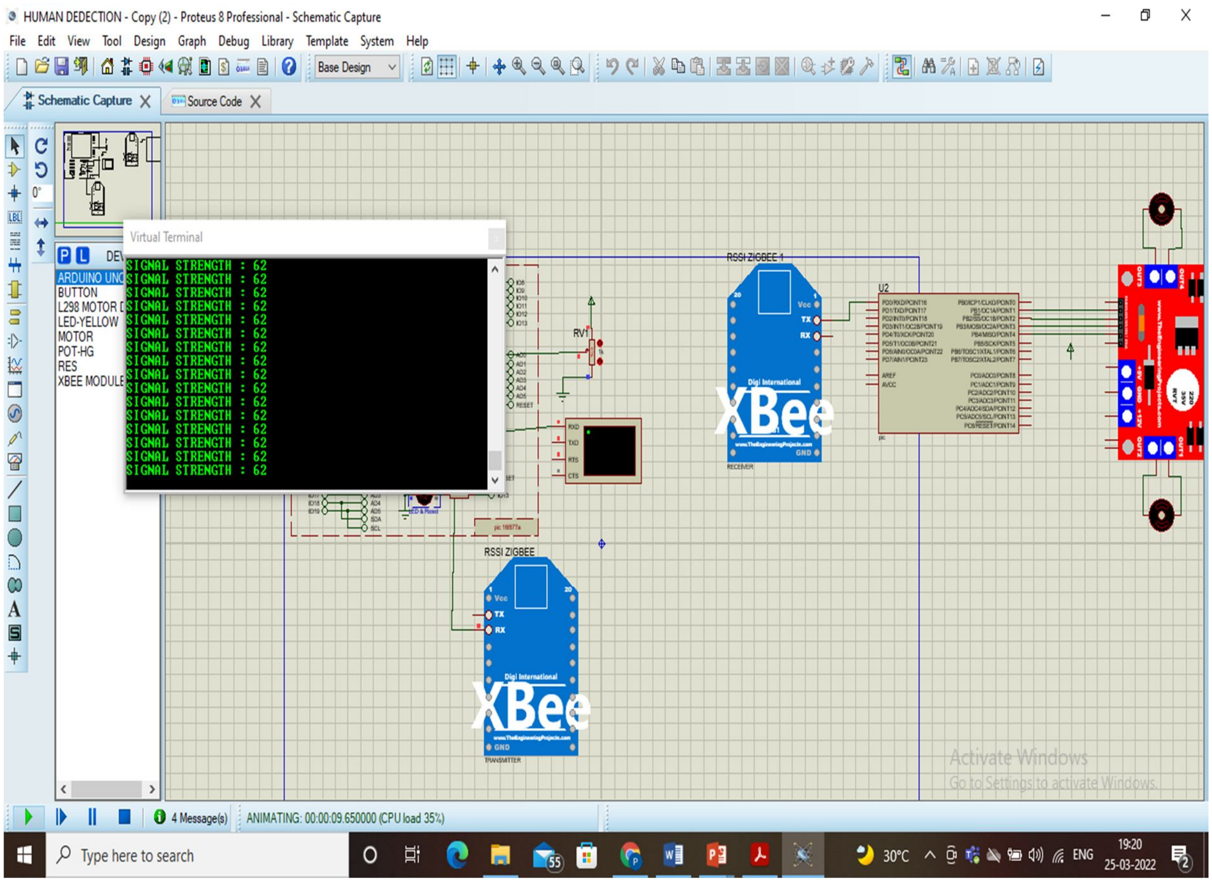

Figure 5: Simulation Output for Human Detection

E. Implementation

The boat detection and tracking process begins after the computer receives the RSSI values from the transmitter nodes. The main concept of how to detect and track human movements is described here. Generally, in the communication area between the transmitter and the receiver nodes, RSSI values received by the receiver node often fluctuate around their mean. On the other hand, when the boat is in the communication area, blocking the radio signal path, the measured RSSI will significantly fluctuate. Thus, the variations in the RSSI values can represent the presence and movement of the boat. By this understanding, we use a different level between a mean RSSI value determined during no boat movement and a measured RSSI value collected during the test to compare with a predefined threshold (i.e., an appropriate RSSI variation level, which can indicate the boat movement) for detecting the boat. Detection results from all communication pairs are determined simultaneously. Here, the process of the boat detection and tracking is explained. During no movement in the communication area, the receiver node is assigned to collect the RSSI values from each transmitter node with a predefined number of samples. The RSSI is measured and collected using a simple and effective communication protocol. Indication intrusion and package defeat in the networks can be decreased by managing the sending and receiving sequences of packets that are transferred across nodes. In addition, the network's signaling overhead and the system's power consumption are reduced. We create an autonomous boat identification and tracking approach that uses low-complexity processing to accurately recognize and track boat movement.

The individuality of this proposed method is that it determines the actual zone in which the boat is currently present by considering an acceptable threshold and the level of RSSI fluctuation measured in each zone. A simple and efficient communication protocol is developed for measuring and collecting the RSSI. By controlling the sending and receiving sequences of packets that are exchanged among nodes, the signal interference and the packet loss in the network can be reduced. Also, the signaling overhead generated in the network and the power consumption of the system are minimized. We develop an autonomous boat detection and tracking method that can accurately detect and track the boat and consume low complexity processing.

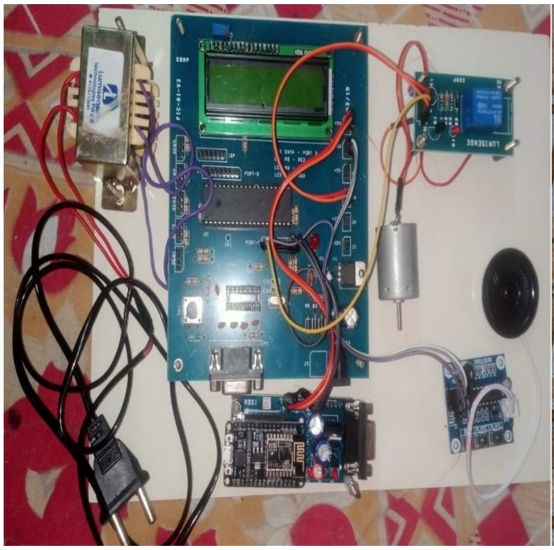

Figure 6: Transmitter Side

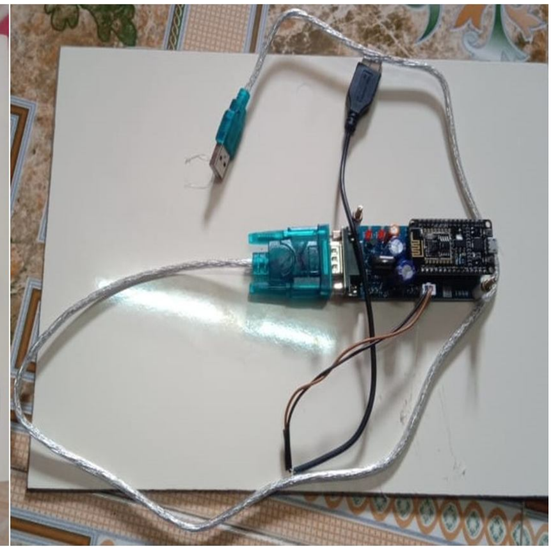

Figure 6: Receiver Side

F. Hardware Setup Input And Output

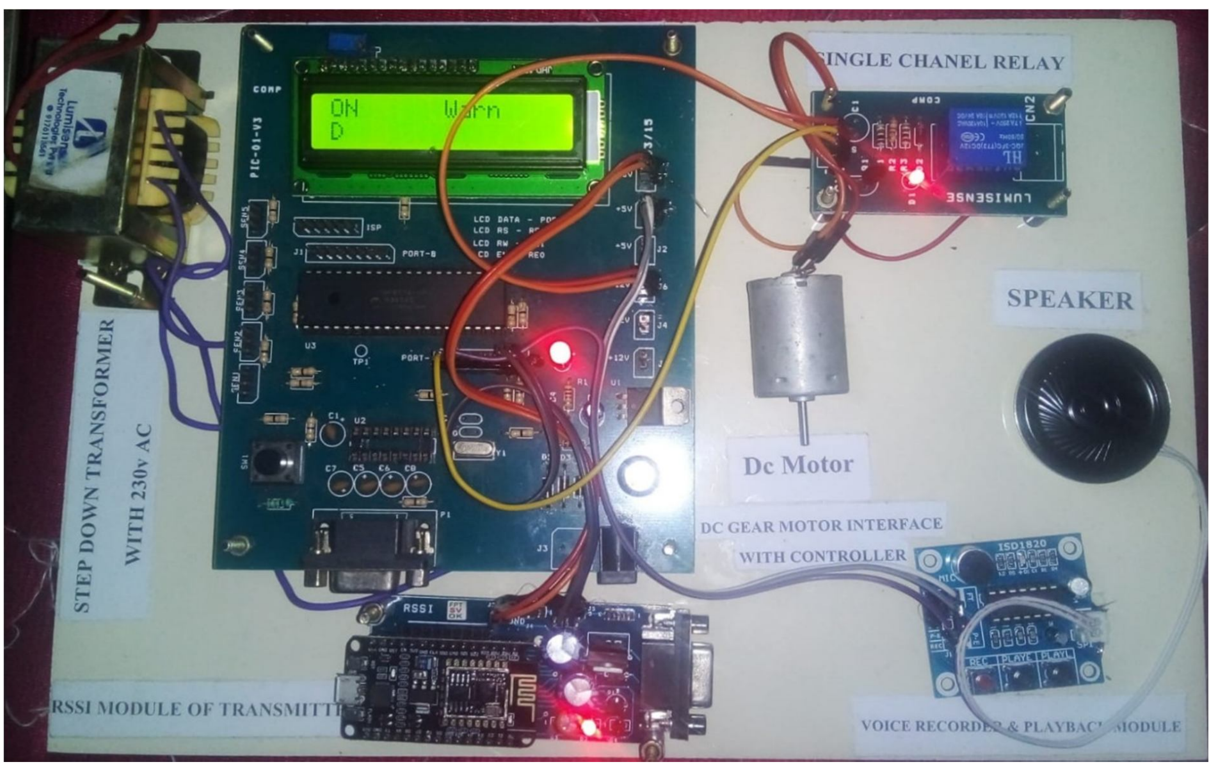

Figure 8: Transmitter Side Output

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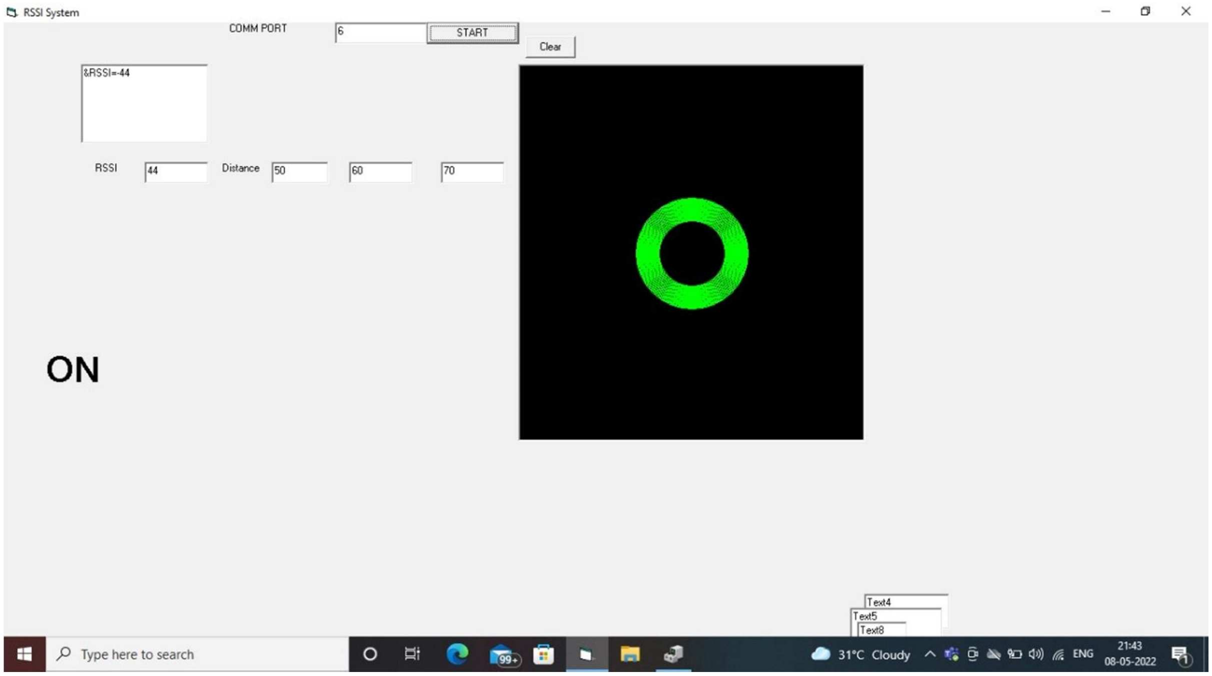

Figure 8: Receiver Side Input

II. RESULT AND DISCUSSION

The results obtained are discussed below:
The proteus software is used for obtaining the simulation for the boat detection. The schematic representation is shown in simulation diagram which shows the connection of transformer, motor driver, LCD, potentiometer with the microcontroller.

POT VALUE (ohms)	SIGNAL STRENGTH (db)
1000	102
900	92
700	71
500	51
400	41

Table 1 Simulation Output Value Readings

The above table shows the values of signal strength with respect to potentiometer. These values are obtained by varying the values of potentiometer.

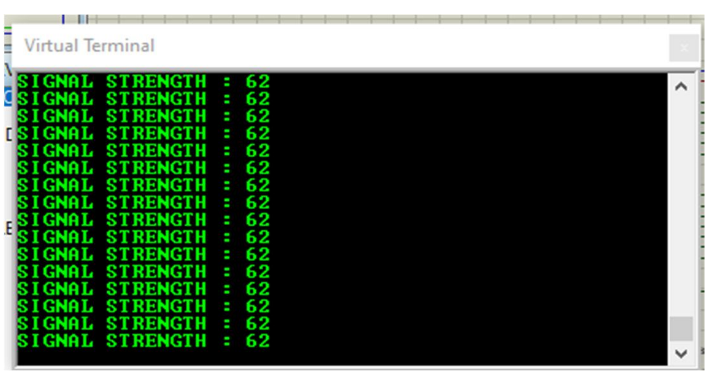

Figure 6: Output of Minimum Signal Strength

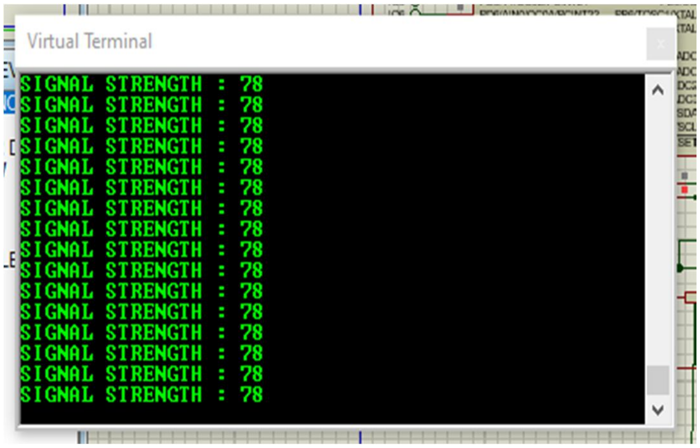

Figure 7: Output of Maximum Signal Strength

DISTANCE D1 (MINIMUM)	DISTANCE D2 (MEDIAN)	DISTANCE D3 (MAXIMUM)
50	60	70

Table 2 Hardware Input Value Readings

RSSI VALUE	ALARM (ON/OFF)	MOTOR (ON/OFF)
50	OFF	ON
55	OFF	ON
60	ON	ON
62	ON	ON
70	ON	OFF

Table 3 Hardware Output Value Readings

A power supply unit (or PSU) converts mains AC to low voltage regulated DC power for the internal components of a controller. A power supply is used to reduce the mains electricity at 240 volts AC down to something more useable, say 12 volts DC. There are two types of power supply, linear and switch mode

The microcontroller of the board has a circuit inside called an analog-to-digital converter or ADC that reads this changing voltage and converts it to a number between 0 and 1023. When the shaft is turned all the way in one direction, there are 0 volts going to the pin, and the input value is 0. When the shaft is turned all the way in the opposite direction, there are 5 volts going to the pin and the input value is 1023. In between, analog Read () returns a number between 0 and 1023 that is proportional to the amount of voltage being applied to the pin.

III. CONCLUSION

Boat Position estimation is an important goal for realizing services that offer safety and security, especially during emergency situations and greater energy efficiency, even in small areas. Our proposal combines a simple method with a new signal processing procedure that uses the received signal strength indicator (RSSI) in a wireless sensor network for estimating boat movement. This method is simple and has the benefit of running on existing devices and existing wireless sensor networks.

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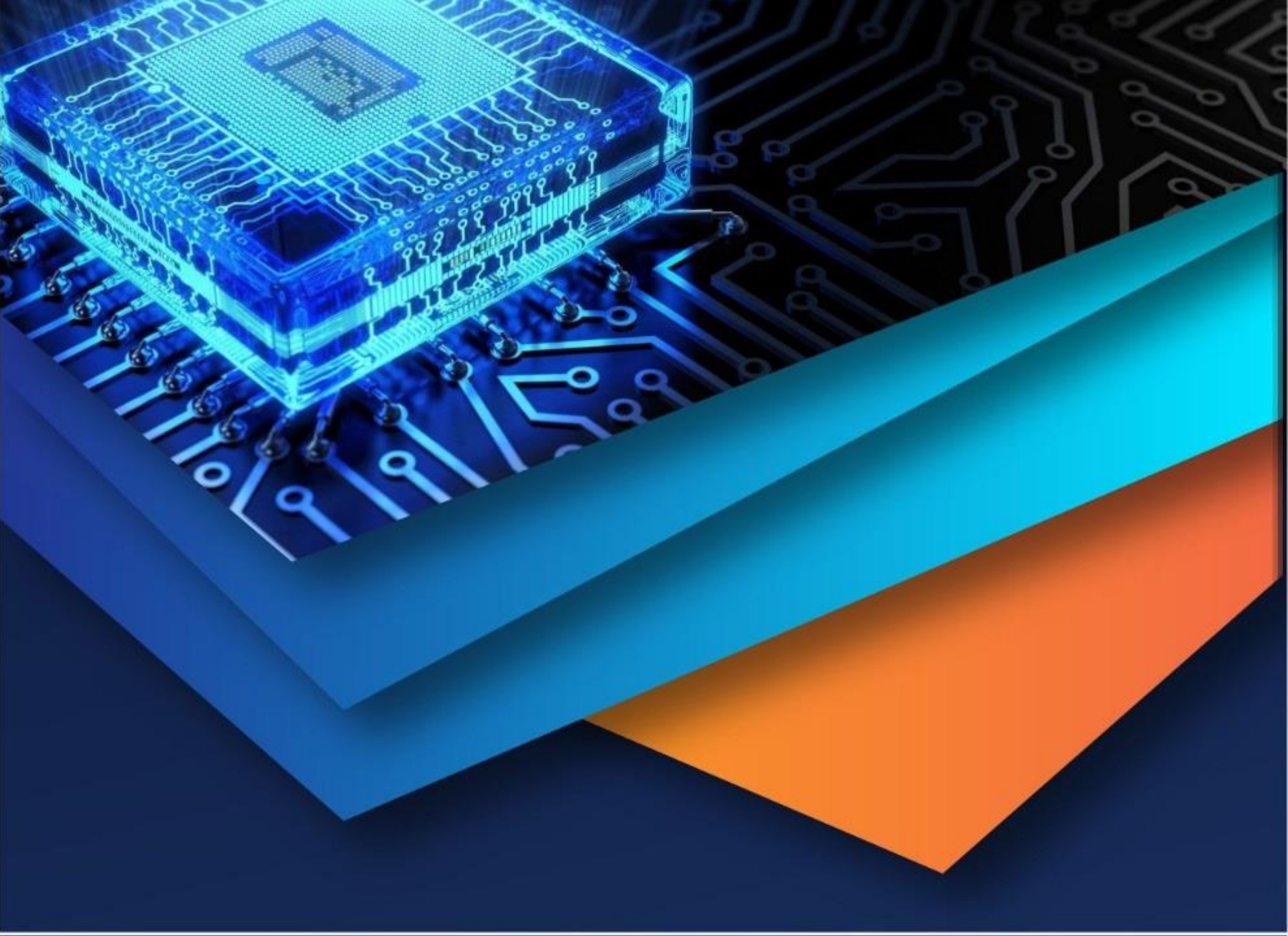

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