2024 3rd International Conference on Advancement in Electrical and Electronic Engineering (ICAEEE 2024), 25-27 April, 2024, Gazipur, Bangladesh

A Comprehensive Approach to Preventing Naval Accidents through Modern Signalling and Tracking

Md Abu Ismail Siddique
Electronics & Telecommunication Engineering
Rajshahi University of Engineering & Technology
Rajshahi, Bangladesh
Email: saif101303@gmail.com

Electrical & Computer Engineering
Rajshahi University of Engineering & Technology
Rajshahi, Bangladesh
Email: oj.ruet@gmail.com

Dr. Md. Samiul Habib
Electrical & Electronics Engineering
Rajshahi University of Engineering & Technology
Rajshahi, Bangladesh
Email: samiul.engieee@gmail.com

Dr. Md. Samiul Habib
Electrical & Electronics Engineering
Rajshahi University of Engineering & Technology
Rajshahi, Bangladesh
Email: samiul.engieee@gmail.com

Dr. Md. Samiul Habib
Electrical & Electronics Engineering
Rajshahi University of Engineering & Technology
Rajshahi, Bangladesh
Email: samiul.engieee@gmail.com

Dr. Md. Samiul Habib
Electrical & Electronics Engineering
Rajshahi University of Engineering & Technology
Rajshahi, Bangladesh
Email: samiul.engieee@gmail.com

***Abstract*—Maritime safety remains a critical concern in the prevention of boat and naval accidents. This paper outlines a comprehensive strategy to improve marine safety by integrating contemporary tracking and signaling technology. By utilizing cutting-edge technologies, the suggested approach improves situational awareness for both boats and naval vessels by supplying real-time information. Our method builds a strong system that can recognize and reduce any threats by combining state-of-the-art tracking technology with cutting-edge signaling strategies. The system utilizes navigation patterns, vessel locations, and environmental information to prevent accidents before they happen. IoT technology is used to monitor the real-time data anywhere in the naval path and all the sensor parameters can be visualized in the web interface. Presenting a comprehensive approach that incorporates contemporary signaling and tracking technology, this study adds to the continuing conversation on maritime safety by providing a viable means of reducing the dangers connected with boat and naval mishaps in the ever-changing marine environments of today.**

***Index Terms*—Naval Accidents, Tracking, Internet of Things (IoT), GPS, GSM, Nodemcu.**

I. Introduction

For a country's development, it is essential to ensure a safe traveling system. As Bangladesh is a riverine country, so one of our major traveling routes is a river. Boat transportation has significantly improved in recent years but it's still a very risky way of transportation. Boat accidents can be devastating, and it's important to take precautions to ensure the safety of passengers. The main reasons behind the accidents are overloading the boat, making the boat unstable when traveling at high speeds; machinery failure resulting in fire and explosion; and collusion with other boats or objects in heavy rain or foggy places. Unexpected weather changes like heavy rain, high winds, and rough waters that reduce visibility make navigation difficult and cause boats to capsize. During the period from 2005 to 2015, the percentage of those reasons were collisions (60.3%) whereas the vast majority, specifically 92%, of collisions occur as a result of direct contact with other vessels, unexpected weather (8.7%), and overloading (6.1%) [1]. From 1981 to 2015, the collision was 42.7%, the overloading was 24.7% and the inclement weather was 23.6%. Also are many reasons, they are the fire and explosion (6.17%), and bottom damage (2.83%) [2] Proper communication with the Coast Guard authority and proper awareness about the surroundings is also a reason for accidents to occur. These accidents can result in injuries, loss of life, and trauma for individuals involved. Prioritizing safety measures helps mitigate these risks and ensures the well-being of those working on or traveling. In case of oil spills or chemical releases, it can have severe consequences for the marine environment. Several works have been done to prevent naval accidents by integrating the Internet of Things (IoT) into the system [3]. This IoT refers to anything that can connect to the internet and collect and share data [4]. This enables them to collect and exchange data over the Internet. So we capitalized on this aspect of IoT and suggest disarming a device that monitors the location and crucial parameters in real-time.

In this paper, we demonstrate the solution to naval accidents using frontier technology, this system helps prevent accidents

979-8-3503-8828-2/24/$31.00 ©2024 IEEE

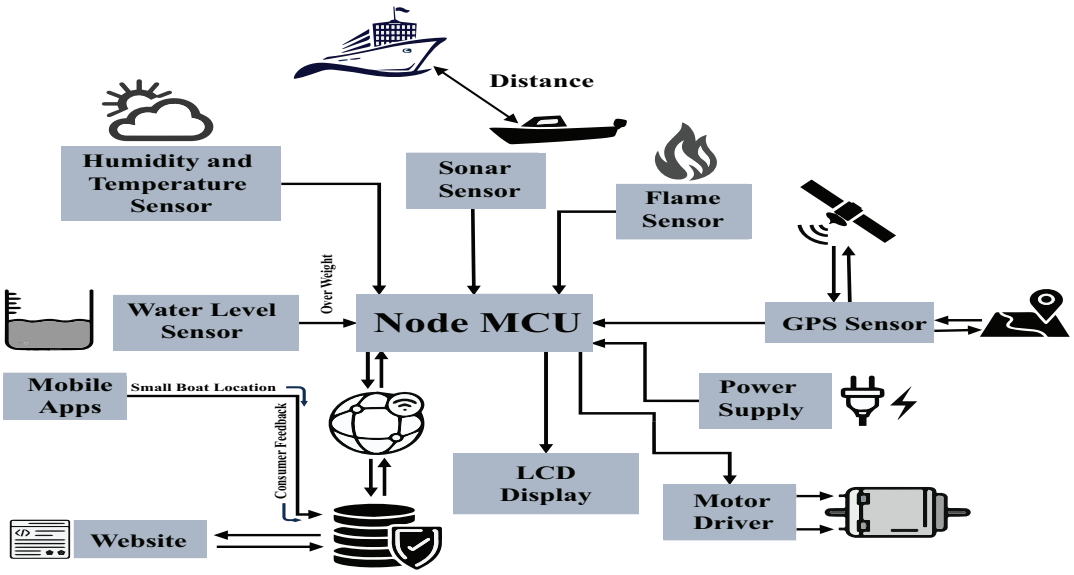

Fig. 1. Functional block diagram of the proposed prototype.

by identifying potential risks early. Authorities from the Coast Guard are able to manage and minimize maritime incidents because they can respond quickly to newly emerging threats.

II. Literature Review

The causes of maritime accidents in Bangladesh have been discussed in several papers. There have been few papers regarding the prevention of marine accidents but none give a compact solution where that deals with almost all major reasons for naval accidents. A study by FMJM Shamrat et al. [5] proposed a solution to address vessel overloading issues by implementing a system where, if the vessel is overloaded, it will stop and notify the Coast Guard of its current location. This is a valuable safety measure for preventing accidents but this system failed to prevent the problems of hostile weather, sand bed collisions with other vehicles, etc. Some of these major factors were covered by S.V.S.N.Murthy et al. [6], [7] where sensors like ultrasonic sensors and moisture sensors were used to prevent collisions and hostile weather problems. But other still major factors as the collisions of the ships with the small boats, the sand bed problem, and last but not least the pirate attack on small boats. Similarly some other studies like Suraj Gahalyan1 et al. [8] proposed a system that was based on the safety measures of the ferry system [9]. However the majority of the safety measures have not been implemented, nor has a mapping system. In the proposed system, Our proposed website called Dishari website always provides the data of a sand bed to the ship's driver authority so that the sand bed problem can be reduced. Our proposed mobile application called the

The Dishari app (for the small boat interface) provides the data of the boats continuously to the Coast Guard authority which helps to prevent the pirate attack problem. The proposed system Dishari, is an IoT and web-based system that offers users an advanced and more convenient All-In-One ferry system. Based on the information that the GPS receiver module receives, the system offers a mapping system. This map shows the nearby boats and ferries, helping to plan the boat's route. Additionally, this mapping system indicates recent bars and sediment in the river, assisting the sailor in avoiding it.

III. Proposed System

Figure 1 shows the functional block diagram of the proposed device. By turning on the device all the components get power from the battery which is the external power source of our proposed system. NodeMCU and Arduino connect and exchange data through digital pins with serial communication. GPS and GSM modules which give location and connect through the internet they got powered by Arduino. When GPS got power it started to connect with the satellite track the current location and send that location coordinates via the GSM module, sending a message meant as an alert to a predetermined phone number. The Arduino has a connection with an LCD that displays danger messages and location coordinates [10]. As soon as the Wi-Fi module, NodeMCU got power it connected with the server and started to exchange data through the IoT platform ThingSpeak.The IoT platform uses GPS to constantly monitor the location and feed the server. From the cloud storage, one can easily fetch, share, or analyze the location of the victim. Our proposed website and mobile app are used to track the locations associated with messages that have been received. The GSM module is in charge of sending messages that inform the user's location. In this process, authorities can easily detect the location of the victim.

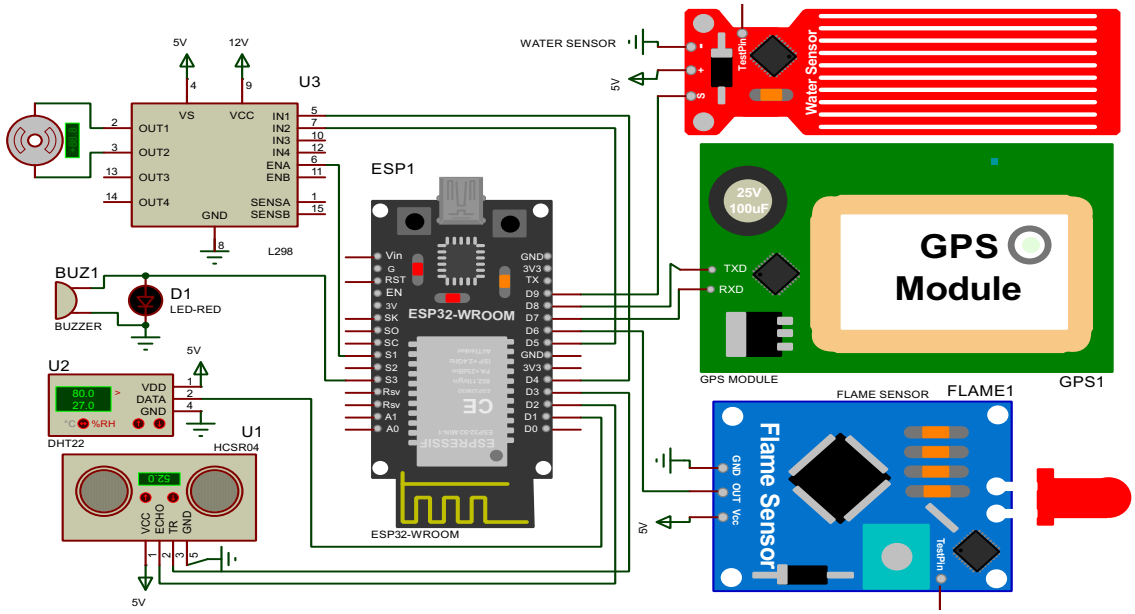

Fig. 2. Functional block diagram of the proposed prototype.

IV. Details Regarding the Proposed System's Specifications

The suggested system has a user interface, a controlling mechanism, and web compatibility.

A. Implementation

Within the Node MCU ESP-32 device, the integration of a Wi-Fi module empowers seamless transmission of data collected by various sensors to the central server. The implemented sensors include a water level detector, flame sensor, GPS module, sonar sensor, and temperature and humidity sensor. The water sensor is connected to pin D4 of the ESP32, while the TXD and RXD pins of the GPS module are linked to D8 and D7, respectively. The flame sensor is affixed to pin D6. The L298 motor driver is interfaced with the ESP32, facilitating the operation of a 5V motor as an illustrative representation of a boat engine. In the event that sensor readings collectively indicate imminent danger, the motor or engine is promptly deactivated.

Furthermore, the temperature sensor is integrated into pin D1, and the sonar sensor's echo and trigger components are correspondingly connected to pins D2 and D3. To provide visual and audible alerts, a buzzer and LED are attached to pin S3. Consequently, the system generates a buzzing sound and illuminates a red light, signaling the presence of danger. These alerts are relayed from the main server, utilizing the sensor data. All data gathered by the sensors is relayed to the main server, with the

prototype utilizing the Internet of Things (IoT) platform, ThingSpeak, for data transmission The disseminated data is made available to small boat applications, the primary website, and the passenger mobile app. This comprehensive dataset serves as a basis for real-time monitoring, allowing the Coast Guard authority to receive alerts if the vessel encounters any issues. The GPS module contributes to the server's awareness of the boats' locations, enhancing overall safety and operational efficiency.

TABLE I
Battery Parameters

Sl. No.	Item	Specification
01	Battery Type	18650 Lithium-ion
02	Battery Voltage	3.7V per cell
03	Battery Capacity	7800mAh
04	Charging Time	1.5h-2h
05	Approx. Battery Weight	30 gm

B. Hardware Description

Different types of sensors are used in our proposed prototype shown in Fig. 2 The digital pins on the NodeMCU are used to connect the GPS and GSM modules, enabling data interchange and interaction between them. The operating voltage of the GPS module is 2.7V - 3.6V. The water level operates less than 20mA current with a detection area of 40mmx16mm, this analog-type device generates analog output signals based on water pressure. The Sonar Sensor (HC-SR04) automatically sends eight 40 kHz signals and detects whether there is a pulse signal back. Here NodeMCU acts as a controller that makes decisions by gathering various signals from various sensors and modules and responding in accordance with the modules. In Table 1 our proposed model battery performance is described.

C. Control Mechanism

All the sensor collects the data and stores it on the local computer of the ship. These data will be analyzed and alert if there is any danger. These data are also sent to our server

through the Internet. In our server, these data will be analyzed more deeply and show all information on our website.

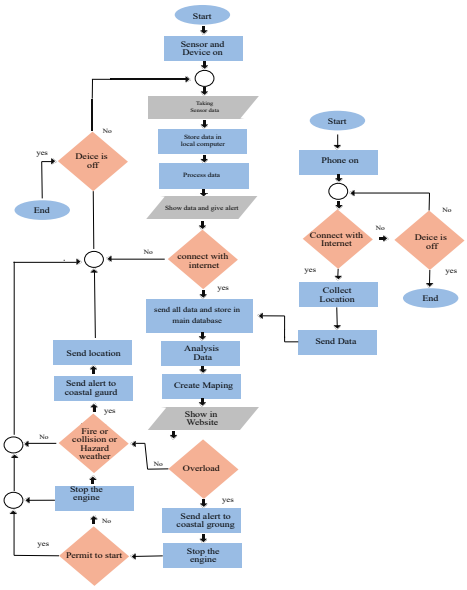

Fig. 3. A Visualization of The Prototypes of Working Flow Chart.

Also, a map will be generated using the GPS location of different ships and boats. If any other ship or unwanted substance is detected in a certain zone then the alert will be given to the sailor from the local computer as well as the Coast Guard authority from our server by our website. Before leaving the ship from the ship wharf, if the water level sensor detects the overweight of this ship, then the engine will be stopped. This engine only starts if the overweight problem is solved or the Coast Guard authority gives permission. If other sensors (like flame sensor, and temperature sensor) value show critical value then the alert system of the ship will be activated and the Coast Guard authority will be notified through our website. When a small boat sailor logs into our apps, the location of this boat will be collected and stored in our database. This location is also updated on our map.

D. Mobile App Interface

There will be two segments for the mobile app. Both the interfaces of the app are discussed :

1) The First Segment:: This segment will be dedicated to the small boat's authority who can't afford the Naval Accident Preventing Design. This app will be used to locate the small boat and after locating all the small boats the location data will be updated on the website and an alert message will be sent to the captain or master of the ships or launches. This segment of the app is focused on two main features of the total Naval Accident Preventing system.

1) "I am in Danger" option is provided to alert the Coast Guard authority immediately if any danger has occurred to the boat as seen in Fig.4(e)
2) The Location of the boat is fed to the main website spontaneously. It is shown in the Fig.4(f)

2) The Second Segment:: This segment is specially designed for the customers of the launch or ship who will travel in the boat. All the data on the boat, such as weather analysis, fuel amount, overweight, etc can be seen via this app. If the boat is in danger the screen will show " This boat is not safe to travel" (shown in Fig.5(e)). The first page will be the login page (showed in Fig.5(a)), following that a user has to give his/her NID number and phone number to login to their respective account (shown in Fig.5(b)). The NID number is compulsory because a feature of the complain box (shown in Fig.5(i)) was added to the app, to prevent the same complaint done by a user. A user can select their respective boat by QR code (shown in Fig.5(c)) that will be provided to their ticket even at the entrance of the boat. They can also manually select the name of the boat. (shown in Fig.5(d)) In the menu option, the user can provide their personal as shown in Fig.5 (k). The features that are added to this segment of the app are the hazardous Weather Checking option and Over weighting check option. Engine Temperature, Fire Alert, complaint Box, Location of the Boat (shown in the Fig.5) (g)).

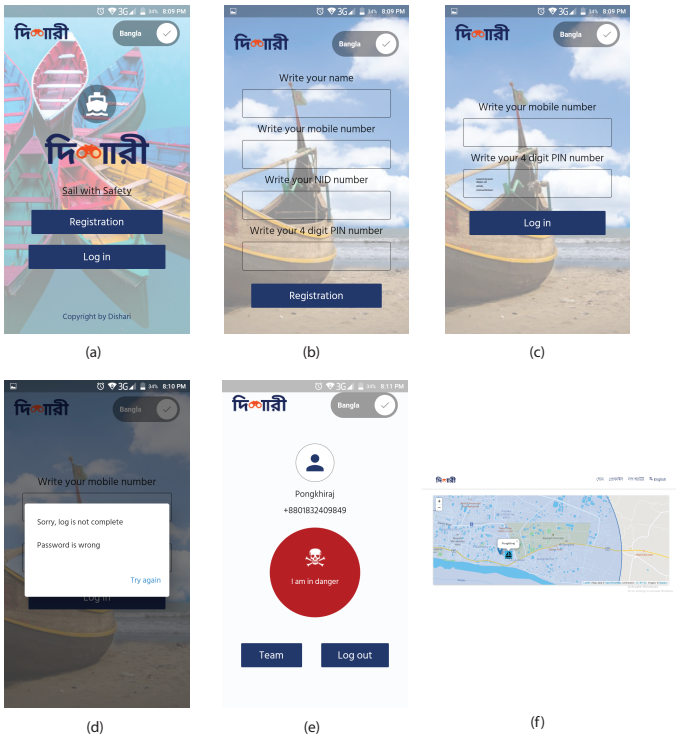

Fig. 4. Mobile app interface (a) First Page (b) Registration Page (c) Login page (d) Wrong credentials page (e) Small boat danger feature page (f) Location of a small boat which will be fed to the website.

They can also see their journey details, ticket no, room no other details regarding the boat. The complaint box page will require NID card verification. If the NID no is wrong Red cross will be shown in the screen Fig.5) (h).

E. Website

Our website was divided into two main parts. One part is for the sailor and ship owner and another part is for our

admin panel. Users in the sailor and ship owner section can access real-time data about their vessel position, speed, course, and whether there are any other boats in front of them. An interactive map offers where they also see the other vessel's location. Meanwhile, the admin panel section will be able to view and know all the boat's location and other information. Besides, the website will indicate if there is an overload problem, if there is a possibility of collusion, and if there is a fire.

Fig. 5. Mobile app interface (a) First Page (b) Registration Page (c) Login page (d) Wrong credentials page (e) Small boat danger feature page (f) Location of a small boat which will be fed to the website.

In Fig. 6(a), this is the front page before login. On the vessel registration page (Fig. 6(c)), for registering a vessel, need to enter some information like Vessel Name, Vessel ID, Owner Name, Phone No, etc. After a sailor login, they will be able to access a map interface, represented as Fig. 6(i). This map is likely a visual representation displaying relevant information such as navigation routes, points of interest, vessel speed, or real-time vessel positions. It serves

as a graphical tool to assist sailors in navigating and understanding their surroundings. The map shown in Fig-6(j) will be viable when an admin login using their user-id and password. In this map, all the boats' locations will be visible, and also can access all the information of all vessels. There was a feedback section where passengers could provide their feedback for any vessel. All the feedback will be checked to ensure there is no false feedback.

V. Experimental Analysis

In the proposed system, efforts are made to prevent maritime accidents and prioritize an alert system for accident prevention. The primary and main reasons for maritime accidents have been considered in the development of our alert system. Both the Coast Guard Authority and onboard sailors will monitor the ship's location and conditions in our proposed system. Through a mobile app, small boats and passengers on ships can obtain real-time information about the vessel's location and conditions.

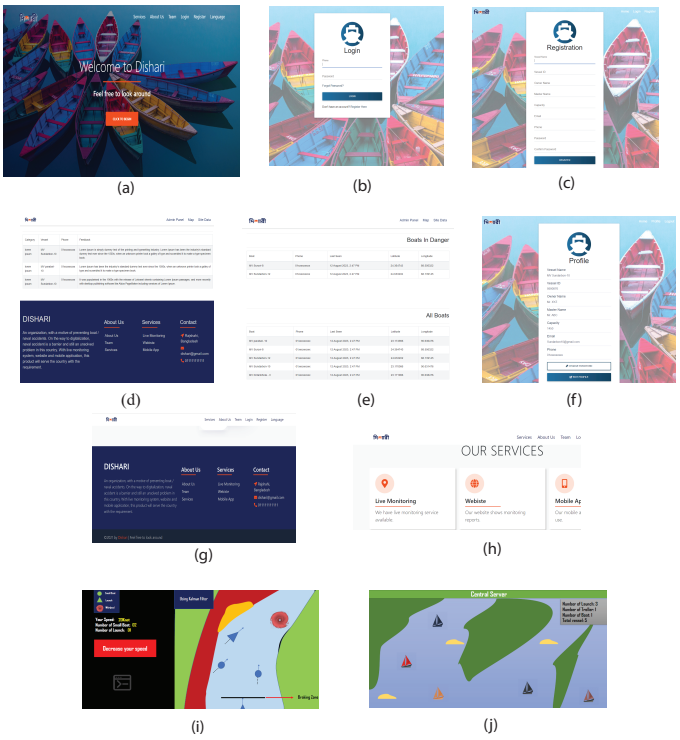

Fig. 6. Website interface (a) Front Page (b) Login page (c) Vessel Registration Page (d) Feedback (e) Vessel Information (f) Vessel Profile (g) Footer (h) Services, (i) Map for Individual Vessel, (j) Central Map.

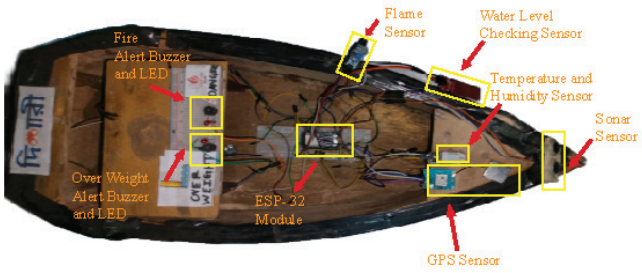

Fig. 7. Functional Prototype for Proposed System.

In our proposed system, data analysis will be conducted through proprietary

software and the mobile app. Our proposal provides automated control mechanisms implanted in Fig. 7 which makes it different from other existing systems.

VI. Discussion

The proposed system ensures passenger safety through proper connection and communication with the mariner and Coast Guard authority. The device scans the

boat's surroundings and provides the sailor with an appropriate route. Furthermore, the device can also solve the

overweight issue by sending data about how much weight the boat can support and immediately sending an SOS signal to a nearby boat and the Coast Guard authorities in the event of an engine failure or an internal fire. The Dishari app is beneficial to both small and large boats as the small ones can send their location and also can see their surroundings using the app. But in this instance, having an internet connection is necessary; even without one, there won't be any issues because ESP32 will be conducting our offline feature, which will update the server's data automatically as soon as it obtains an internet connection.

VII. Conclusion

In summary, this study presents a complete approach that integrates contemporary signaling and tracking technology to improve maritime safety and prevent boat and naval mishaps. The system's efficacy stems from its capacity to evaluate navigation patterns, vessel positions, and environmental data instantaneously, thereby averting accidents before they transpire. Internet of Things (IoT) technology is used to enable continuous real-time data monitoring along the naval course. A user-friendly web interface is used to show all sensor metrics. This research will open the door to solving the major naval accident problem to the next level.

References

[1] M. Uddin and Z. I. Awal, "An insight into the maritime accident characteristics in bangladesh," vol. 1919, p. 020011, 12 2017.

[2] S. Rahman, "An analysis of passenger vessel accidents in bangladesh," *Procedia Engineering*, vol. 194, pp. 284–290, 2017. 10th International Conference on Marine Technology, MARTEC 2016.

[3] M. Plaza-Hernández, A. B. Gil-González, S. Rodríguez-González, J. Prieto-Tejedor, and J. M. Corchado-Rodríguez, "Integration of iot technologies in the maritime industry," in *Distributed Computing and Artificial Intelligence, Special Sessions, 17th International Conference*, pp. 107–115, Springer, 2021.

[4] S. Madakam, V. Lake, V. Lake, V. Lake, *et al.*, "Internet of things (iot): A literature review," *Journal of Computer and Communications*, vol. 3, no. 05, p. 164, 2015.

[5] F. M. J. M. Shamrat, Z. Tasnim, N. I. Nobel, and M. R. Ahmed, "An automated embedded detection and alarm system for preventing accidents of passengers vessel due to overweight," in *Proceedings of the 4th International Conference on Big Data and Internet of Things*, BDIoT '19, (New York, NY, USA), Association for Computing Machinery, 2020.

[6] Svsn, Murthy and Satyanarayana, and Srinivas, Ch , "Location tracking and warning system of a ship using arduino," pp. 1786–1790, 04 2021.

[7] J. Vargas, S. Alsweiss, O. Toker, R. Razdan, and J. Santos, "An overview of autonomous vehicles sensors and their vulnerability to weather conditions," *Sensors*, vol. 21, no. 16, p. 5397, 2021.

[8] S. Gahalyan and S. Palanidoss, "Iot based smart ferry system," *Journal of Physics: Conference Series*, vol. 2115, p. 012015, 11 2021.

[9] R. H. Della, T.-C. Lirn, and K.-C. Shang, "The study of safety behavior in ferry transport," *Safety science*, vol. 131, p. 104912, 2020.

[10] N. N. San Hlaing, M. Naing, and S. San Naing, "Gps and gsm based vehicle tracking system," *International Journal of Trend in Scientific Research and Development (IJTSRD)*, vol. 3, no. 4, pp. 271–275, 2019.