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IoT based Fisherman Border Alert System

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Abstract: *Fishermen in Tamil Nadu, particularly those from impoverished communities, often unknowingly cross international maritime boundaries due to a lack of awareness and technical resources, leading to arrests and severe legal consequences. This situation has caused significant hardships for these fishermen and their families, who rely on fishing as their primary source of income. To solve this problem, we propose the development of a Border Alert System that uses GPS technology to track the real-time location of fishing vessels. The Proposed system will provide both audio and visual alerts when a fisherman is nearing the international maritime boundary, helping them stay within Indian waters and avoid accidentally crossing into foreign territory. Designed to be affordable, easy to use, and durable, the system will be accessible to fishermen even in remote coastal areas. This solution aims to prevent border violations, ensuring the safety and livelihoods of fishermen while reducing the legal and economic challenges they face. By offering a simple and effective way to remain within legal boundaries, the system will contribute to the well-being of coastal communities and promote stability for their families.*

Keywords: Fishermen

I. INTRODUCTION

The **Global Positioning System (GPS)**, also known as **Navstar GPS**, is a widely recognized technology that provides precise geo-location and timing information to GPS receivers in all weather conditions, anywhere on or near Earth. GPS works by triangulating the signals from at least four satellites, ensuring an unobstructed line of sight. This system is versatile and applicable in a wide range of sectors, including mapping, navigation, and emergency response. In maritime contexts, GPS technology is crucial for navigation, ensuring safe movement of vessels in vast and often dangerous bodies of water. One particular group that benefits greatly from GPS technology is **fishermen**, who work in remote and hazardous areas. Fishermen, especially those in coastal regions, often face challenges when navigating near national borders, as they may accidentally cross into foreign waters and face legal consequences. This issue is common in regions where boundaries are difficult to identify, and such mistakes can lead to arrests or other legal problems.

The primary motivation behind this project is to address the real-world problems faced by fishermen who risk crossing maritime borders unintentionally. These fishermen, while fishing for their livelihood, may unknowingly enter restricted or foreign waters, which can result in severe legal repercussions. This issue is particularly evident in areas where the maritime borders between countries are not clearly demarcated. To solve this problem, this project proposes a **GPS-based safety device** for fishermen. The device aims to **alert fishermen when they approach maritime borders,** ensuring that they can turn back in time and avoid crossing into restricted areas. This project integrates a **GPS module** and a **Wi-Fi module** to create a system that continuously monitors the movement of fishing vessels.

II. RELATED WORK

Various studies have explored the development of navigation and border alert systems aimed at ensuring the safety of fishermen who inadvertently cross international maritime boundaries. One of the key contributions to this area is by Krishnamurthy [1], who proposed a low-cost embedded sea navigation and security system tailored for fishermen. This system integrates basic navigation tools with security features to help fishermen avoid crossing international waters. Similarly, Krishnamoorthy et al. [2] designed a border alert system using Received Signal Strength Indicator (RSSI) to inform fishermen about their proximity to international borders. Their system focused on providing an emergency contact feature, ensuring that fishermen can quickly reach authorities in case of any border-related incidents. Ulagamuthalvi et al. [3] developed an IoT-based nautical tracing system for fishermen, which combine real-time

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tracking with communication technology to alert fishermen when they approach international boundaries. This system emphasizes the use of IoT devices to ensure efficient monitoring and communication. Another notable study by the International Journal of Students Research in Technology & Management [4] proposed a border alert system using GPS technology, which functions as an early warning mechanism for fishermen when they approach maritime boundaries. The GPS-based approach was also explored by Dinesh Kumar et al. [5], who integrated an Android-based alert system to provide real-time notifications to fishermen regarding boundary violations. In line with these advancements, Suresh Kumar and Sharath Kumar [6] focused on designing a low-cost maritime boundary identification device using GPS technology, ensuring that such systems remain affordable and accessible for fishermen in rural coastal areas. Isaac [7] introduced an advanced border alert system utilizing GPS and intelligent engine control units, enhancing the system's capability to provide accurate and timely alerts. Lastly, Karthikeyan et al. [8] explored broader approaches to protecting fishermen on Indian maritime boundaries, emphasizing the integration of various technologies to safeguard the fishing community. These studies demonstrate the ongoing efforts to develop cost-effective and reliable solutions to prevent fishermen from inadvertently crossing maritime boundaries. While previous work has focused on different technologies and methods, the consistent goal remains the same: ensuring the safety and livelihood of fishermen by keeping them within national waters and preventing legal complications arising from accidental border violations.

III. PROPOSED SYSTEM

The proposed system aims to enhance the safety of fishermen by using GPS technology to monitor their proximity to international maritime borders, thereby preventing accidental border crossings. Designed to work globally, it is applicable not only for the India-Sri Lanka maritime boundary but for any international sea boundary. The system incorporates a GPS receiver that continuously receives signals from satellites to determine the current position of the fishing boat. The boat's position is compared with predefined boundary coordinates stored in the memory of a microcontroller. These coordinates represent the maritime borders, with a "border layer" defined at a safe distance (a few nautical miles) from the actual boundary to serve as a warning zone.

The system operates in stages, activating different warning mechanisms as the boat approaches the border. When the boat nears the first predefined location, a warning buzzer is triggered, and the LCD display shows the exact distance to the border. Additionally, the boat’s speed is reduced by 50%, allowing the fisherman time to correct their course. If the fisherman ignores the initial warning and moves closer, the LCD updates with the new distance, and the boat’s motor is further slowed down before being stopped completely to prevent further movement toward the boundary. If the fisherman continues past this point, the motor is fully stopped, and the boat’s exact location is sent to the navy control room for verification. Authorities can then assess the situation to determine if the border has been violated. To restart the boat, a randomly generated key is required, ensuring that only authorized personnel can resume the journey. The system also sends the boat’s location to the fisherman’s family via GSM, notifying them of the situation and ensuring their awareness.

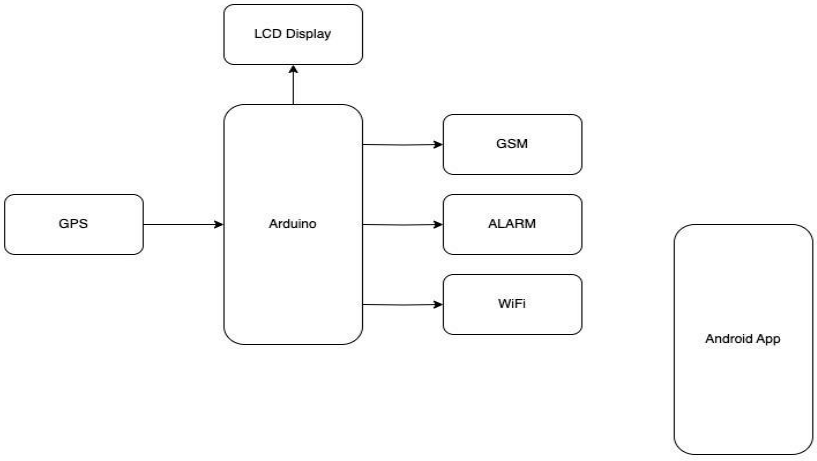

Figure 1 Block Diagram of Proposed System

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Figure 1 represents the block diagram of the proposed border alert system. At its core, the system is controlled by an Arduino microcontroller, which acts as the central processing unit and integrates various components to ensure real-time monitoring and progressive warnings. The GPS module provides the boat's current location, which the Arduino compares with predefined boundary coordinates. If the boat approaches the warning zones, the Arduino triggers an alarm system, providing audible alerts to the fisherman. The LCD display shows critical information, such as the boat's distance from the boundary. The GSM module sends the boat's location to designated recipients, such as family members or maritime authorities, in case of a potential border crossing. A WiFi module facilitates additional connectivity, potentially linking the system to an Android app for remote monitoring and control. This app enables family members or authorities to track the boat's location and receive real-time notifications. The system progressively warns and stops the boat from crossing international borders by reducing its speed or halting the motor altogether, ensuring safety, communication, and real-time monitoring. This comprehensive approach enhances the safety of fishermen near international maritime boundaries, preventing inadvertent border crossings while maintaining effective communication with relevant stakeholders and their families

IV. RESULTS AND DISCUSSION

The implementation of the border alert system for fishermen using the specified hardware and software demonstrates the practical feasibility of real-time monitoring, location tracking, and safety measures. Below is a detailed breakdown of the results and observations:

Our experiment setup includes

a. HARDWARE USED

i. Arduino Uno
ii. LCD Display
iii. GPS
iv. GSM
v. IOT(WIFI)
vi. Alarm

b. SOFTWARE USED

i. Arduino IDE
ii. Android Studio

1. **GPS-based Location Tracking**:
   - The system accurately receives and processes the GPS coordinates of the boat. The real-time latitude and longitude are displayed on the LCD, ensuring visibility to the fishermen.
   - The GPS module delivers a reliable accuracy of 2 meters, meeting industry standards for navigation and boundary detection.
2. **Border Violation Detection**:
   - The system effectively detects when the boat crosses the predefined boundary and triggers an alarm to notify the fishermen immediately.
   - The LCD provides visual alerts, such as "BORDER CROSSED," ensuring the user is promptly informed.
3. **Communication with Authorities and Family**:
   - The GSM module successfully sends SMS alerts containing the boat's location and status to predefined phone numbers.
   - The integration with IoT enables location updates to be sent to a centralized server for monitoring by naval authorities.
4. **Safety Mechanisms**:
   - The alarm effectively alerts fishermen when the border is crossed, providing an audible notification in addition to the visual alert.
   - The system continuously sends updates to the server, ensuring real-time monitoring and tracking.

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5. **System Reliability**:
    - The GSM module initializes correctly and sends messages reliably during operation.

The periodic updates to the server work seamlessly, maintaining a steady connection and allowing for continuous tracking

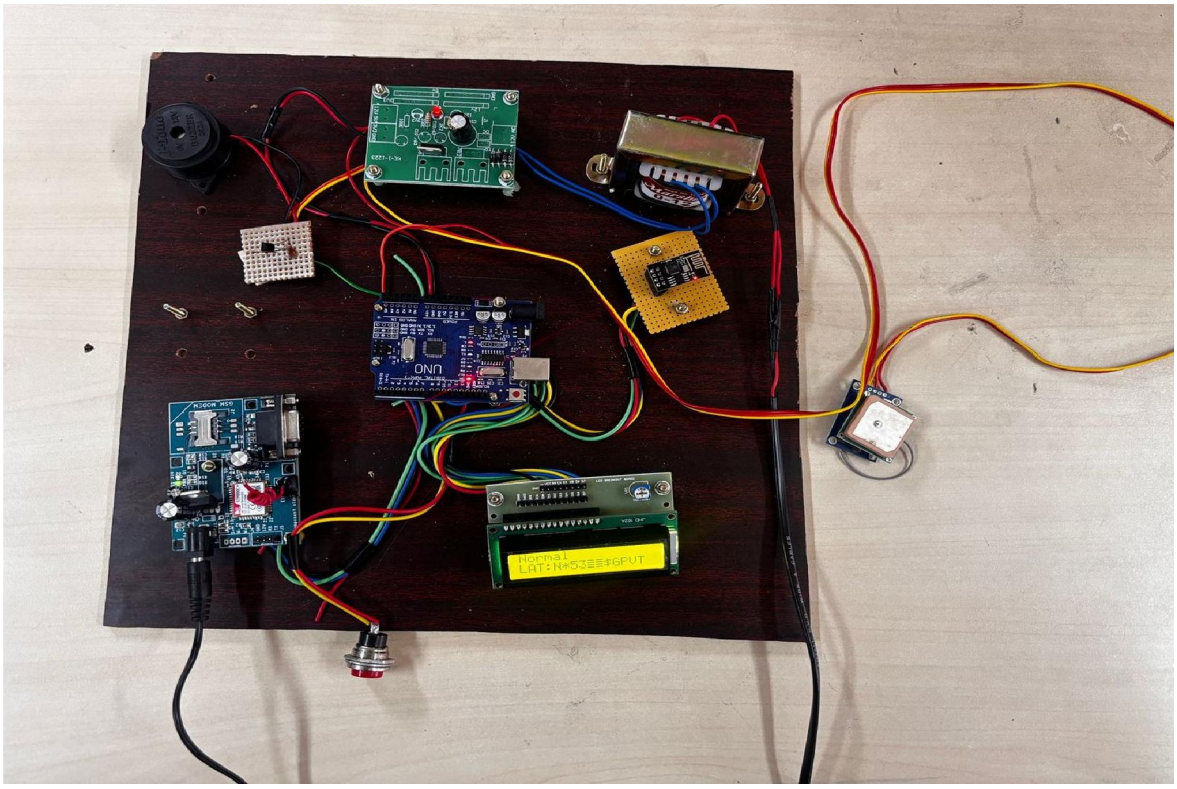

Figure 2. Hardware Implementation

The system achieves its intended objectives of enhancing fishermen's safety, preventing accidental border crossings, and enabling real-time monitoring by authorities. However, the following aspects were observed:

1. **Hardware Performance**:
    - The Arduino Uno provides sufficient computational capability for handling GPS data and managing communication modules (GSM and Wi-Fi).
    - The LCD offers clear visibility of data, although it has a limited character display capacity. A larger display could improve usability.
    - The alarm is loud enough to be heard in normal conditions, but additional waterproofing may be necessary for marine environments.
2. **Software Capabilities**:
    - The Arduino IDE simplifies coding and debugging, making it suitable for implementing the program logic.
    - Android Studio can be utilized for developing a companion app to enhance user interaction, allowing family members or authorities to monitor the boat's location via a mobile interface.
3. **System Limitations**:

The GSM module is dependent on network availability, which may be inconsistent in remote maritime regions

- The current system does not control the boat's speed or movement automatically, which could be considered for future enhancements.
- The IoT integration is basic, and adding more advanced features like geofencing and real-time data visualization on a cloud dashboard would improve system usability.

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4. **Recommendations for Future Improvements**:
   - **Advanced Navigation Features**: Integrate geofencing to dynamically adapt to changing maritime boundaries or special zones.
   - **Enhanced Notifications**: Include email or app-based notifications in addition to SMS for better reliability.
   - **Environmental Adaptability**: Test and optimize hardware components for harsh marine conditions, such as high humidity and salinity.
   - **Automatic Speed Control**: Extend the system to control the boat's engine speed automatically as it approaches the boundary.

V. CONCLUSION

The proposed Fishermen Border Security Alert System using the Internet of Things (IoT) is a comprehensive embedded solution integrating data acquisition, processing, actuator control, and cloud-based centralized monitoring with an industry-standard accuracy of 2 meters. The system actively tracks the boat's location, uploads data to the cloud for real-time monitoring, alerts fishermen upon nearing the border, and automatically reduces the boat's speed by 50% via the engine control unit to prevent boundary violations. A centralized data hub, accessible to naval forces, enhances monitoring and accountability, enabling justice if fishermen are apprehended within the nation's territorial waters. Future advancements include integrating Artificial Intelligence (AI) for predictive analysis, 5G connectivity for faster data transmission, and advanced marine sensors for real-time environmental data. Additional features, such as a multilingual mobile app for navigation and notifications, geofencing technology for dynamic boundaries, and blockchain for secure, tamper-proof data, can further enhance the system. Solar-powered hardware could improve sustainability, making the system suitable for long-term use in remote marine environments, thereby elevating safety, functionality, and efficiency in maritime border management

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