AN AI AND ML BASED GIS APP FOR ENHANCED MONITORING AND SAFETY OF DEEP SEA FISHERMAN

Ms.Pappathi.K[1], Dhanusha.M[2], Sabura Beevi.J[3], Santhiya.B[4], Srima.R[5]

[1]Assistant Professor, [2]Final year(CSE), [3,4,5]student
[1]B.Tech, M.E.,
Computer Science of Engineering,
K.S.K College of Engineering and Technology,
Kumbakonam, India.

Abstract: This Ideation endeavors to address the pressing need for advanced technology to track deep-sea fishermen and their locations, thereby enhancing safety measures in maritime activities. The proposed solution involves the development of an Artificial Intelligence/Machine Learning (Al/ML) based Geographic Information System (GIS) app tailored for detecting fishermen's locations during deep-sea fishing expeditions. This application aims to achieve robust accuracy in identifying and tracking deep-sea fishermen. Key features of the app include real-time data integration, GIS visualization, and an alert system to notify users of potential fishing activities. This technology not only facilitates effective monitoring but also contributes to maritime safety by providing timely information for search and rescue operations with a focus on user-friendliness, the app incorporates a seamless interface, allowing users to interact with GIS maps and interpret detected fishing zones. Furthermore, the project emphasizes scalability, ensuring adaptability to future advancements and the evolving needs of the maritime industry. By bridging the gap in tracking deep-sea fishermen, this Al/ML- based GIS app aspires to revolutionize maritime safety practices, offering a versatile tool for fisheries management, marine conservation, and emergency response. The project embodies a commitment to technological innovation for the betterment of maritime activities and the safeguarding of the lives of deep-sea fisherman.

I. INTRODUCTION

Smart phones are increasingly the most common type of mobile phone used throughout the world, offering users the ability to browse the internet and access mobile applications. Smart phones are also often equipped with high definition digital cameras, accelerometer, gyroscopes, and GPS. They can, therefore, facilitate the collection and dissemination of data, often through purpose designed applications (apps). As a result, numerous apps have been developed for use in wild capture fisheries. These apps have been designed for a number of purposes including for data collection, providing information to fishers, being linked to value chains and post-harvest practices and for uses linked to employment, legislation and safety. These apps are used across the world from large commercialized fisheries to small scale fisheries. In the latter, apps have the potential to bridge a technology gap, possibly replicating the functions of multiple pieces of hardware such as are used on larger vessels.

The potential for the use of smart phones in fisheries as a data acquisition tool, in addition to educational and outreach purposes, has been recognized for a number of years. More general use of such technology in fisheries can be traced back to the early twenty-first century as smart phones became smaller and cheaper, while apps that were suitable for use in fisheries were concurrently developed during this period. A proliferation of apps for use in sport and recreational fishing is evident with anglers taking advantage of smart phone technology and location services to access information ranging from how to tie knots to the best baits for different target species, find nearby fishing locations and their weather and water conditions, keep track of personal catches and share these with other anglers.

II.NEED OF THE STUDY

The need for an AI and ML-based GIS app for enhanced safety of deep-sea fishermen is driven by the inherent dangers of maritime occupations, including unpredictable weather, navigational hazards, and limited real-time communication. Deep-sea fishermen are particularly vulnerable to adverse conditions that can lead to accidents, loss of life, and economic hardships. By leveraging artificial intelligence and machine learning, combined with geographic information systems (GIS), the proposed app can provide real-time predictive analytics, hazard mapping, and automated alerts. These features aim to enhance situational awareness, optimize route planning, and ensure timely responses to emergencies, ultimately improving the safety and efficiency of deep-sea fishing operations.

2.1 High-Risk Environment

Deep sea fishing is one of the most dangerous occupations in the world. Fishermen face numerous hazards including severe weather conditions, equipment malfunctions, and the risk of drowning. An AI and ML-based safety system can mitigate these risks by providing real-time monitoring and predictive analysis.

2.2Accident and Fatality Reduction

Statistics show a high rate of accidents and fatalities among deep sea fishermen. Implementing advanced safety systems powered by AI can significantly reduce these incidents by predicting dangerous situations and alerting the crew in advance.

2.3 Weather Prediction and Analysis

Weather at sea can change rapidly, and traditional forecasting methods may not always be precise. AI models can process vast amounts of meteorological data to provide accurate and timely weather predictions, helping fishermen avoid dangerous conditions.

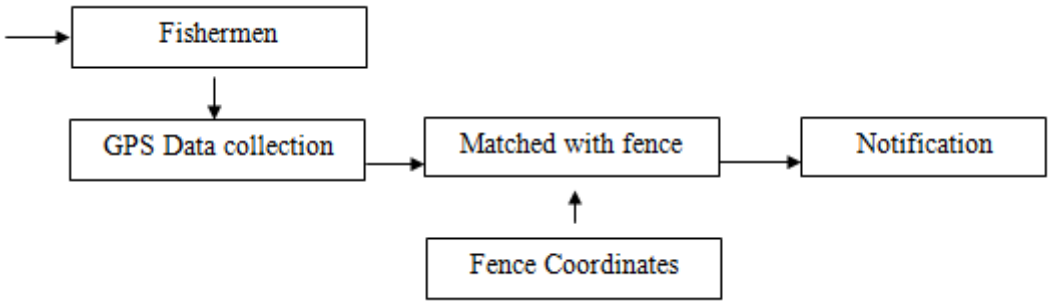

Fig 2.1 Weather analysis

III.RESEARCH METHODOLOGY

The methodology section outline the plan and method that how the study is conducted. This includes universe of the study, sample of the study, Data and Sources of Data, study's variables and analytical framework. The details are as follows;

3.1 Heuristic Detector and task scheduler

Deep sea fishing is one of the most dangerous occupations in the world. Fishermen face numerous hazards including severe weather conditions, equipment malfunctions, and the risk of drowning. An AI and ML-based safety system can mitigate these risks by providing real-time monitoring and predictive analysis.Deep-sea fishing ranks among the most perilous professions globally due to the constant exposure to severe weather conditions, the potential for equipment malfunctions, and the ever-present risk of drowning. Fishermen often venture far from shore, where rapid weather changes and high seas can turn routine trips into life-threatening situations. The isolation and lack of immediate support amplify the dangers, making timely and accurate information critical for survival. Current safety measures, while helpful, often fall short of providing the comprehensive real-time data and predictive insights needed to effectively mitigate these risks.An AI and ML-based safety system can revolutionize the safety protocols for deep-sea fishing by integrating advanced technologies to enhance real-time monitoring and predictive analysis. Such a system can process vast amounts of data from multiple sources, including weather forecasts, ocean currents, and equipment status, to predict potential hazards and provide actionable insights. With the ability to send automated alerts about impending storms, mechanical failures, or hazardous navigation zones, fishermen can make informed decisions quickly, reducing the risk of accidents.

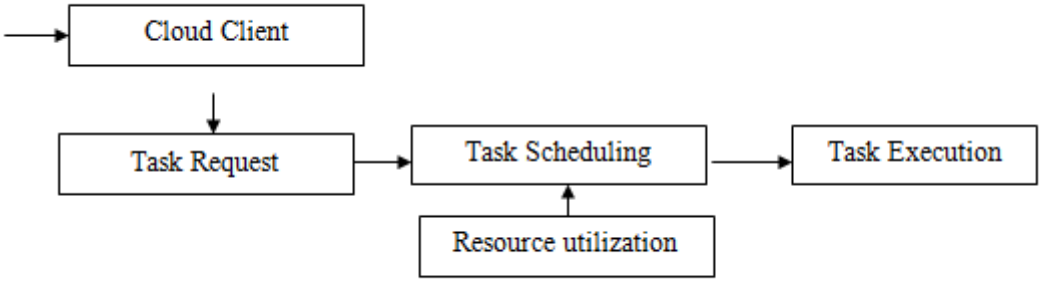

Fig 3.1 Heuristics detector and Task Scheduler architecture

3.2 Accident and Fatality Reduction

Statistics show a high rate of accidents and fatalities among deep sea fishermen. Implementing advanced safety systems powered by AI can significantly reduce these incidents by predicting dangerous situations and alerting the crew in advance.Statistics consistently reveal a high rate of accidents and fatalities among deep-sea fishermen, underscoring the urgent need for enhanced safety measures. Implementing advanced safety systems powered by AI can significantly mitigate these risks by leveraging predictive analytics to foresee dangerous situations before they occur. By analyzing real-time data from weather patterns, oceanographic conditions, and equipment sensors, AI can identify potential hazards such as severe storms, high waves, and equipment malfunctions. These systems can then alert the crew well in advance, allowing them to take proactive measures to avoid danger. This predictive capability not only enhances the safety of the fishermen but also ensures more secure and efficient fishing operations, ultimately aiming to reduce the alarming accident and fatality rates in this high-risk profession.

3.3 Weather Prediction and Analysis

Weather at sea can change rapidly, and traditional forecasting methods may not always be precise. AI models can process vast amounts of meteorological data to provide accurate and timely weather predictions, helping fishermen avoid dangerous conditions. Weather at sea can change rapidly and unpredictably, rendering traditional forecasting methods insufficiently precise for ensuring the safety of deep-sea fishermen. AI models, however, can revolutionize weather prediction by processing vast amounts of meteorological data from diverse sources, including satellite imagery, ocean buoys, and atmospheric sensors. These models use machine learning algorithms to identify patterns and generate highly accurate, real-time forecasts. By providing fishermen with timely and precise weather predictions, AI can help them avoid hazardous conditions such as sudden storms, high winds, and rough seas. This advanced capability not only enhances safety by enabling more informed decision-making but also improves operational efficiency by allowing fishermen to plan their activities around favorable weather windows.

3.4 Equipment Monitoring and Maintenance

AI can be used to monitor the health and performance of fishing equipment. Machine learning algorithms can predict when equipment is likely to fail, allowing for proactive maintenance and reducing the risk of accidents caused by equipment malfunction.AI has the potential to revolutionize the maintenance and safety protocols of deep-sea fishing equipment by providing continuous health and performance monitoring. Machine learning algorithms can analyze data from sensors embedded in fishing gear and machinery, tracking variables such as wear and tear, usage patterns, and operational efficiency. By detecting subtle signs of degradation or abnormal performance, these algorithms can predict when equipment is likely to fail, often well before any visible signs of malfunction appear. This predictive maintenance capability allows fishermen to address potential issues proactively, scheduling repairs or replacements during periods of low activity rather than dealing with unexpected breakdowns at sea.

The benefits of AI-driven equipment monitoring extend beyond safety to include operational efficiency and cost savings. By reducing the incidence of sudden equipment failures, fishermen can avoid dangerous situations that could lead to accidents or fatalities. Furthermore, this proactive approach minimizes downtime and enhances the reliability of fishing operations, leading to more consistent and productive outings. The ability to maintain equipment in optimal condition also extends its lifespan, reducing long-term costs associated with frequent replacements and emergency

repairs. Overall, the integration of AI and machine learning into equipment maintenance represents a significant advancement in the pursuit of safer, more efficient, and economically sustainable deep-sea fishing practices.

3.5 Rescue and Emergency Response

In the event of an emergency, AI can facilitate faster and more efficient rescue operations. By analyzing location data and environmental conditions, AI systems can guide rescue teams to the precise location of distressed vessels more effectively.In the event of an emergency at sea, AI can play a crucial role in facilitating faster and more efficient rescue operations by leveraging its ability to analyze real-time location data and environmental conditions. When a distress signal is received, AI systems can quickly process the vessel's GPS coordinates, weather patterns, ocean currents, and other relevant factors to provide an accurate and up-to-date situational overview. This comprehensive analysis enables AI to generate precise coordinates and optimal routes for rescue teams, significantly reducing the time required to locate and reach distressed vessels. Additionally, AI can continuously update rescue teams with real-time information about changing conditions, ensuring that they are well-prepared to navigate any challenges. By enhancing the speed and accuracy of emergency responses, AI not only increases the chances of successful rescues but also improves the overall safety and security of deep-sea fishing operations.

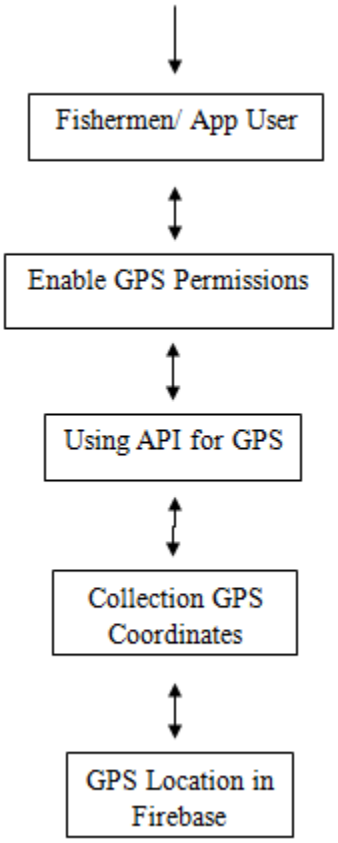

Fig 3.2 Rescue and Emergency response

3.6 Cost-Effectiveness

Investing in AI and ML technologies can be cost-effective in the long run. By preventing accidents and reducing downtime due to equipment failure, the overall operational efficiency and productivity of fishing operations can be improved, leading to better economic outcomes.Investing in AI and ML technologies for deep-sea fishing operations can prove to be cost-effective in the long run, offering significant economic benefits through enhanced safety and efficiency. By preventing accidents and reducing downtime associated with equipment failures, these advanced technologies help maintain a consistent and productive fishing schedule. Predictive maintenance powered by machine learning ensures that equipment is serviced and replaced before critical failures occur, thus avoiding costly emergency repairs and potential loss of catch. Additionally, real-time monitoring and predictive analytics improve decision-making and route planning, enabling fishermen to avoid hazardous conditions and optimize their efforts. This increased operational efficiency not only boosts productivity but also minimizes fuel consumption and resource wastage, further

contributing to cost savings. Over time, the reduction in accidents and downtime, combined with optimized operations, leads to better economic outcomes, justifying the initial investment in AI and ML technologies and ensuring a sustainable and profitable fishing industry.

3.7 Enhanced Decision-Making

AI systems can assist fishermen in making informed decisions by providing insights based on data analysis. This includes optimal fishing locations, timing, and methods, which can improve catch efficiency while maintaining safety standards.AI systems can significantly aid fishermen in making informed decisions by analyzing vast amounts of data to provide actionable insights. By processing information from various sources such as oceanographic data, weather conditions, historical catch records, and real-time sensor inputs, AI can identify optimal fishing locations, timing, and methods. These insights enable fishermen to target areas with higher fish concentrations, thereby improving catch efficiency while minimizing time and fuel expenditure. Additionally, AI can recommend the safest and most effective fishing techniques based on current conditions, ensuring that safety standards are upheld. This data-driven approach not only enhances productivity but also promotes sustainable fishing practices by reducing overfishing and preserving marine ecosystems. Ultimately, AI empowers fishermen with the knowledge to make strategic decisions that balance profitability with safety and environmental responsibility.

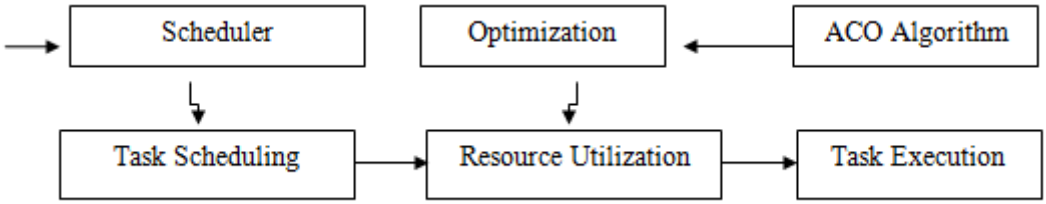

Fig 3.3 Enhanced Decision-making architecture

3.8 Compliance with Regulations

Many countries have stringent regulations regarding the safety and operations of fishing vessels. An AI-based safety system can ensure compliance with these regulations by continuously monitoring conditions and operations, thus avoiding legal issues and potential fines.In many countries, fishing regulations are stringent, aimed at safeguarding both the marine environment and the safety of fishermen. An AI-based safety system presents a powerful tool to ensure compliance with these regulations by providing continuous monitoring of vessel conditions and operations. By analyzing data from onboard sensors, weather forecasts, and navigational charts, AI can detect deviations from safety protocols or regulatory requirements in real time. This proactive approach not only helps prevent accidents and injuries but also avoids legal issues and potential fines associated with non-compliance. By maintaining adherence to regulations, fishing vessels can operate within the bounds of the law, promoting sustainable fishing practices and safeguarding the well-being of both fishermen and marine ecosystems. Thus, AI-based safety systems serve as invaluable assets in ensuring regulatory compliance while enhancing overall operational efficiency and sustainability in the fishing industry.

3.9 Data-Driven Insights

The integration of AI in deep sea fishing can provide valuable data-driven insights that can be used for research and development. This information can help in further improving safety measures and developing new technologies to support the fishing industry.The integration of AI into deep-sea fishing operations generates a wealth of valuable data that extends beyond immediate safety concerns, offering a treasure trove of insights for research and development. By analyzing this data, researchers can gain a deeper understanding of oceanic ecosystems, fish behavior, and environmental factors affecting fishing activities. These insights can inform the development of innovative technologies and strategies to improve safety measures, enhance sustainability, and optimize resource utilization in the fishing industry.

Furthermore, the application of AI in deep-sea fishing research and development fosters collaboration among scientists, engineers, and fishermen. By sharing data and insights, stakeholders can collectively work towards addressing complex challenges facing the fishing industry, such as climate change impacts, overfishing, and habitat destruction. This collaborative approach facilitates the rapid advancement of technology and knowledge, leading to continuous improvements in safety, efficiency, and environmental stewardship within the deep-sea fishing sector.

3.10 Sustainability

AI can contribute to sustainable fishing practices by ensuring that fishing activities do not overexploit marine resources. By analyzing fish population data and migration patterns, AI systems can help fishermen adhere to sustainable fishing practices, thereby protecting marine ecosystems. AI holds tremendous potential to promote sustainable fishing practices by monitoring and managing fish populations to prevent overexploitation of marine resources. Through sophisticated data analysis, AI systems can track fish population dynamics, migration patterns, and habitat preferences. By leveraging this information, fishermen can make informed decisions about where and when to fish, ensuring that their activities remain within sustainable limits and do not exceed the capacity of the marine ecosystem to replenish itself.

AI can aid in the implementation of adaptive management strategies by continuously monitoring environmental conditions and adjusting fishing practices accordingly. For example, AI can provide real-time updates on changes in ocean temperature, salinity, and currents, which can affect fish behavior and distribution. By adapting fishing efforts in response to these environmental changes, fishermen can minimize their impact on vulnerable fish populations and reduce the risk of overfishing.

Additionally, AI-driven tools can facilitate the implementation of fisheries management policies and regulations aimed at promoting sustainability. By analyzing compliance data and monitoring fishing activities, AI systems can help authorities enforce quotas, size limits, and seasonal closures to prevent overfishing and protect endangered species.

Ultimately, by harnessing the power of AI to promote sustainable fishing practices, we can safeguard marine ecosystems, preserve biodiversity, and ensure the long-term viability of the fishing industry for future generations.

3.11 System Architecture

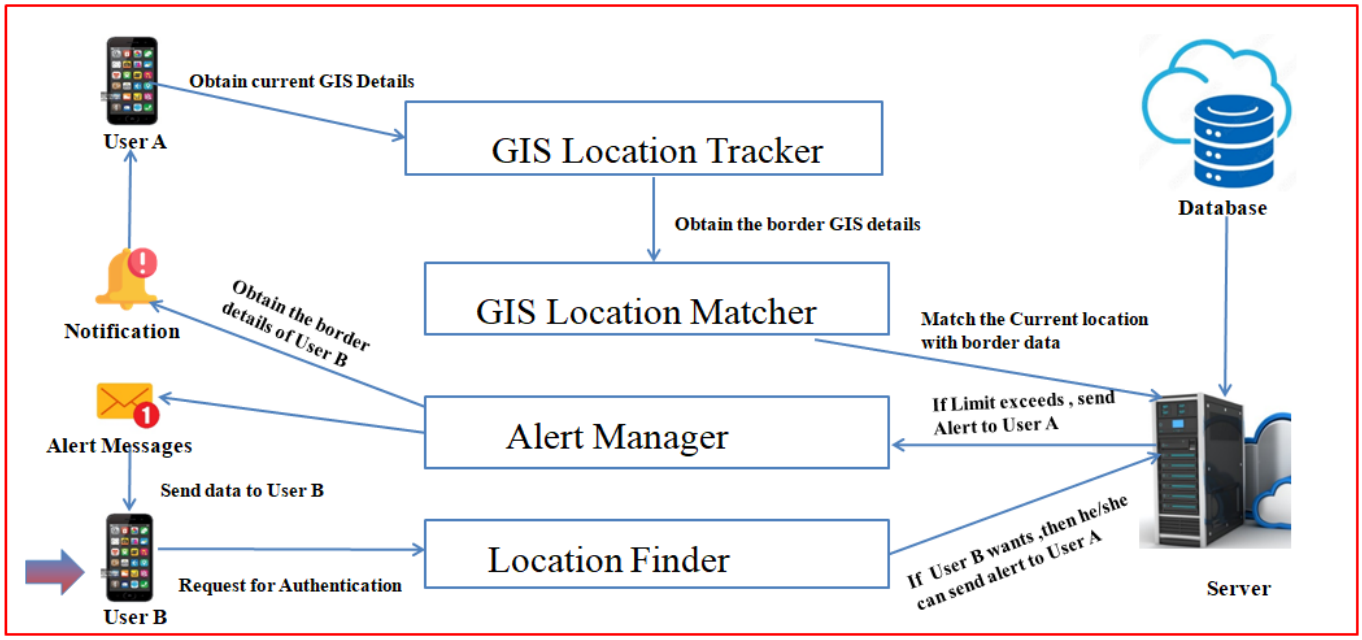

Fig 3.1 Architecture diagram

IV. RESULTS AND DISCUSSION

4.1 Results of Descriptive Statics of Study Variables

This research work shows that smart phone applications have a place in commercial wild-capture fisheries to meet a number of uses from GIS data collection to improving safety at sea for fishers, as well as being used in supply chains and marketing. This application directly related to fishing activity generally had greater uptake compared to apps offering other functionality, such as non-mandatory reporting. While larger commercial vessels may have the space and infrastructure for numerous pieces of hardware that can be used to inform their fishing practices, this is not always the case for smaller vessels, and smart phone apps can potentially replicate the functionality of some of this hardware. There is still a place for smart phone apps for use by fishers operating on these larger vessels and apps have been specifically

designed for use in these fisheries, including catch sharing and reporting applications. In many instances co-design has been recognized as being important to ensure apps meet the demands of the final users. Ease of use and low data requirements are key considerations to encourage uptake of mobile applications in fisheries. While numerous apps are currently available across fisheries around the world there is potential for continued development in this field. Already, apps that were originally developed for one specific fishery are being extended to more universal applications.

4.2 Smartphone App Utility

Smartphone applications serve multiple roles in commercial wild-capture fisheries, from GIS data collection to enhancing sea safety for fishers, supply chain management, and marketing.Smartphone applications play a multifaceted role in commercial wild-capture fisheries, serving as versatile tools for various aspects of the industry. From facilitating GIS data collection for mapping fishing grounds to enhancing sea safety for fishermen through real-time weather updates and emergency alerts, these apps are indispensable for operational efficiency and crew safety. Additionally, they contribute to supply chain management by enabling real-time tracking of catches, ensuring traceability, and optimizing logistics. Moreover, Smartphone apps empower fishermen with marketing tools, allowing them to showcase their products, connect with buyers, and access market information, thereby enhancing market access and profitability. Overall, these applications serve as comprehensive solutions that streamline operations, improve safety standards, and enhance market competitiveness in commercial wild-capture fisheries.

4.3 Adoption and Functionality

Apps directly related to fishing activities see higher adoption rates compared to those offering additional, non-mandatory functionalities such as reporting.Apps directly related to fishing activities tend to experience higher adoption rates compared to those offering additional, non-mandatory functionalities such as reporting. Fishermen prioritize apps that directly assist them in their core tasks, such as finding fish, tracking weather conditions, or managing gear, as these functionalities directly contribute to their productivity and success at sea. While reporting features may be important for regulatory compliance and data collection, they are often perceived as secondary or optional by users. Therefore, app developers should prioritize the development of features that directly address the immediate needs and priorities of fishermen to ensure higher adoption rates and user engagement.

4.4 Hardware Limitations

Larger commercial vessels may accommodate various hardware tools to aid fishing practices, but smaller vessels often lack space and infrastructure, making multifunctional Smartphone apps particularly beneficial.For smaller vessels where space and infrastructure are limited, multifunctional Smartphone apps emerge as invaluable tools to aid fishing practices. Unlike larger commercial vessels equipped with various hardware tools, smaller boats face constraints in accommodating bulky equipment or sophisticated technology. In such settings, Smartphone apps serve as versatile and compact alternatives, consolidating multiple functionalities into a single device that fishermen already carry onboard. These apps can offer a wide range of features, from navigation assistance and weather forecasting to fish finding and gear management, all accessible through a user-friendly interface on a Smartphone or tablet. By leveraging the capabilities of modern mobile devices, fishermen on smaller vessels can overcome space limitations and access essential tools to enhance their productivity, safety, and efficiency at sea. Additionally, the affordability and accessibility of Smartphone apps make them particularly well-suited for smaller-scale operations, democratizing access to advanced technology and leveling the playing field for fishermen operating in resource-constrained environments.

4.5 Versatility for Larger Vessels

Even on larger vessels, Smartphone apps have a place, with specific designs catering to tasks such as catch sharing and reporting.Even aboard larger vessels, Smartphone apps play a vital role, offering specialized designs tailored to streamline tasks like catch sharing and reporting. These apps provide fishermen with convenient and efficient tools to record and share catch data in real-time, facilitating communication and collaboration among crew members and stakeholders. By leveraging Smartphone technology, fishermen can capture important information such as species, quantity, and location of catches with ease, eliminating the need for manual paperwork and reducing administrative burden. Furthermore, these apps often integrate with centralized databases or fisheries management systems, ensuring that catch data is accurately recorded and reported for regulatory compliance and resource management purposes. In essence, Smartphone apps designed for catch sharing and reporting not only enhance efficiency and accuracy but also contribute to the sustainability and transparency of fishing practices on larger vessels.

4.6 Co-Design Importance

Involving end-users in the design process (co-design) is crucial to ensure the apps meet their specific needs.Involving end-users in the design process, commonly referred to as co-design, is paramount to the success and effectiveness of any application, particularly in complex domains such as deep-sea fishing safety. By actively engaging fishermen, vessel operators, and other stakeholders throughout the design and development phases, developers can gain valuable insights into the unique challenges, preferences, and requirements of the end-users. This collaborative approach allows for the creation of solutions that are tailored to the specific needs of the target audience, ensuring that the final product addresses real-world issues and integrates seamlessly into existing workflows. Moreover, involving end-users fosters a sense of ownership and buy-in, leading to greater acceptance and adoption of the app once deployed. Overall, co-design not only enhances the usability and functionality of the application but also strengthens relationships between developers and end-users, resulting in more effective and impactful solutions.

4.7 Key Considerations for Uptake

Ease of use and minimal data requirements are essential to encourage widespread adoption of mobile applications among fishers.For mobile applications aimed at fishers, prioritizing ease of use and minimizing data requirements are paramount to encouraging widespread adoption and maximizing utility. Given the often challenging and dynamic working environments of fishermen, where attention is divided between navigation, fishing operations, and safety protocols, simplicity and efficiency in app usability are crucial. Interfaces should be intuitive, requiring minimal training or technical expertise to navigate effectively, ensuring that fishermen can access critical information and functionalities without distraction or frustration. Additionally, reducing data requirements helps overcome potential barriers related to limited connectivity or expensive data plans, ensuring that the app remains accessible and functional even in remote offshore locations. By prioritizing ease of use and minimizing data requirements, mobile applications can effectively serve as valuable tools for fishermen, empowering them with the insights and resources needed to enhance safety, productivity, and sustainability in their operations.

4.8 Continued Development

While many apps are currently available globally, there is significant potential for further development and expansion, with apps initially created for specific fisheries being adapted for more universal use.While numerous fishing-related apps exist globally, there remains substantial potential for further development and expansion, particularly in the realm of adapting existing apps for broader, more universal use. Many apps are initially designed to address the specific needs and challenges of particular fisheries or regions, offering tailored solutions to local stakeholders. However, by leveraging the core functionalities and insights from these specialized apps, developers can create more generalized versions that cater to a wider audience of fishermen worldwide. This adaptation process involves streamlining features, optimizing usability, and ensuring compatibility with a diverse range of fishing practices and environments. By repurposing and refining existing solutions, developers can capitalize on valuable insights and lessons learned, accelerating the pace of innovation and expanding access to essential tools and resources for fishermen across different regions and sectors. Ultimately, this approach fosters collaboration, knowledge sharing, and the continuous improvement of fishing-related apps to better serve the needs of the global fishing community.

4.9 RESULTS AND OUTCOMES

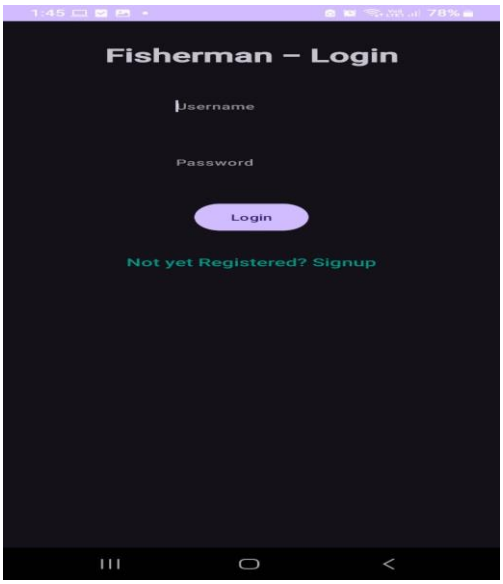

Fig 4.1 Login activity page

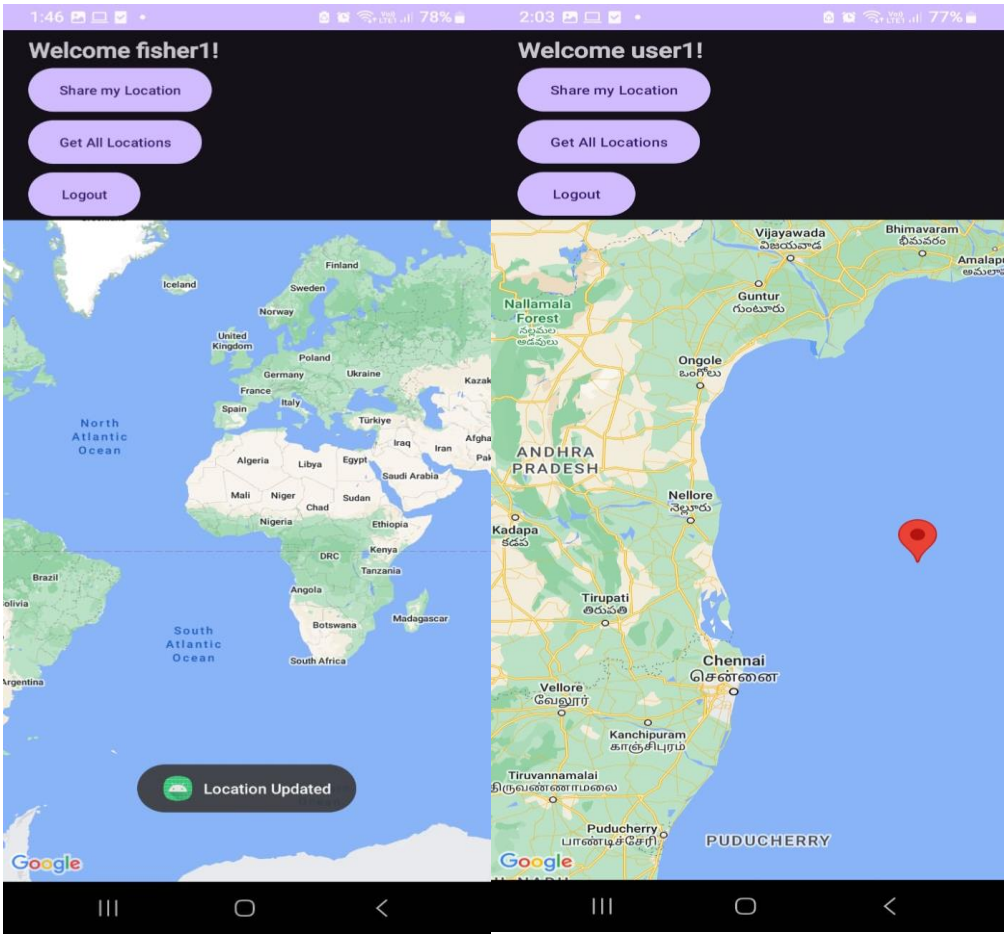

Fig 4.2 Get User Location

V. ACKNOWLEDGMENT

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