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Fishermen Rescue System with LoRa Module

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Abstract:- Many lives are in danger at sea in the events of an unforeseen storm, cyclones, and other natural disasters. One of the major difficulties faced by the rescue team in such an event is the difficulty to locate the personnel in danger. Our project aims at solving this issue by incorporating a chip that helps fishermen in sending distress signals to the shore while in danger. The signal will contain the location of the person. Repeaters are meant to be placed at buoys that helps in transmitting the signal from the source to the destination. Our project includes the study and selection of hardware devices and network specifications. The specifications of potential hardware, network topology and routing protocols are collected and studied. This is compared with each other and the most optimum hardware components and network specifications are selected. The selection of these components were made based on their power consumption, range, data rates etc. Selection of network properties were made based on their efficiency, reliability and economic factors.

Keywords:- *LoRaWAN, Lora Module, Marine Disaster Management.*

I. INTRODUCTION

Fishing and other related activities are one of the major source of income and livelihood for a large section of society in a coastal state like Kerala. Currently, there are no affordable mechanisms that can help track the location of these people when at risk. We propose a system that can help address this situation. A module is included in the life jackets of these fishermen that can transmit their real-time location coordinates.

The system that we are proposing is a low cost, high energy efficient system that can be used and accessed by all. A button is provided, which when pressed, sends the distress signal. The location is tracked using a GPS Module present in the life jackets, which is transmitted to the shore by a Radio Transmitting module. The data packets are routed to the destination using a routing mechanism, and once received, these data packets can be used to retrieve the location of the people at danger.

These components were chosen based on their power consumption, range, and data rates, among other factors. The properties of networks were chosen based on their efficiency, dependability, and cost.

II. RELATED WORKS

A. Existing Systems

Existing systems for locating stranded fishermen in sea and include distress signals sent from boats when they sink. However, these systems are inefficient because they are costly, and can only be installed on bigger boats due to its high power consumption. Also these systems only allow identification of location of the sunken boat, and not the fishermen. So there are virtually no efficient systems to locate fishermen who get stranded while going out on sea on smaller boats and canoes.

B. Vessel Tracking Systems

Automatic Identification System is a vessel tracking system that uses Global Positioning System and serves as transmission and receiving points using VHF radio channels. It acts as a transmitting and receiving interface between ships and coast guards.

Ship Loc is another vessel tracking system that can be set up in vessels which gives readings regarding location and position of the ship. It can also monitor air and wave pressure of the oceanic area through which the ship is coursing through.

Emergency position-indicating radio beacon (EPIRB) is a satellite based system that uses 406 MHz position indicating radio beacons as part of Global Maritime Distress and Safety System.

NAVTEX is an automated satellite based system for instantly distributing maritime safety information which includes weather forecasts, navigational warnings and weather warn- ings, search and rescue notices and similar information to ships. The frequency of transmission of these system is 518 KHz. This can be used to inform the location of a sinking boat to other nearby boats for search and rescue.

Long-range identification and tracking is an international system in which ships report their position to administration at least four times a day. These reports can be automated. Long-range identification and tracking uses communication service providers, application service providers, Long-range identification and tracking data distribution plan and Long- range identification and tracking data exchange.

C. Disadvantages of existing systems

There are many disadvantages for vessel tracking systems. These systems can only identify the location of ships in which the apparatus is installed in, and not the stranded fishermen. So this is not convenient for smaller boats due to size and cost constraints. Smaller boats like canoes do not have the necessary space and prerequisites for these systems. So a much simpler alternative is required. Also, there are several con- straints that reduces the efficiency of these systems like their limit of distance and constraints of satellite transmission. Most of these systems are inefficient with long range transmissions and satellite communication and GPS communication may not be effective in adverse weather conditions.

III. BACKGROUND

The proposed system consists of three main components

- Gateway: LoRa module with ESP32 Microcontroller on land to connect to network.
- Repeaters: LoRa module with ESP32 implemented on buoys, connected in a mesh topology.
- Endpoints: LoRa module and NEO-6M GPS module with ESP32 implemented on lifejacket worn by fisher- men.

A. LoRa Technology

LoRa technology is a wireless protocol that is specifically developed for long-range connection and low-power com- munication. Long Range Radio (LoRa) is a technology that is mostly used in the Internet of Things (IoT) and M2M networks. Multi-tenant or public networks will be able to connect a number of apps running on the same network using this technology. The open Lora WAN protocol and LoRa Technology allow smart IoT applications that address some of the world 's most challenging issues, including natural resource conservation, pollution control, disaster avoidance, energy management, infrastructure efficiency, and more.

Fig. 1: LoRa Module

B. ESP32 Microcontroller

The ESP32 is a highly adaptable System On a Chip (SoC) that may be used as a general-purpose microcontroller with a wide range of peripherals, including WiFi and Bluetooth wireless capabilities. Espressif has already pre-loaded the low- level device drivers, wireless protocol stacks for WiFi b, g, n, Bluetooth, and BLE, as well as FreeRTOS as the basic OS, so adopting this module rather than creating from scratch has a number of advantages.

A bootloader has also been loaded to make downloading user programs reasonably simple.

C. NEO 6M GPS Module

The u-blox NEO-6M GPS engine is used in the GPS mod- ules. The NEO-6M has a type number of NEO-6M-0-001 and a ROM/FLASH version of ROM 7.0.3. (PCN reference UBX- TN-11047-1). For serial connection, the NEO-6M module has one adjustable UART port, however the default UART (TTL) baud rate is 9,600. The GPS antenna will be different from the usual whip antennas used for linear polarised communications since the GPS signal is right-hand circular-polarized (RHCP). The patch antenna is the most common antenna type. Patch antennas are flat antennas with a ceramic and metal body set on a metal base plate. They're frequently cast in a house. When using the patch antenna, it should be oriented parallel to the geographic horizon. The antenna must have full view of the sky, ensuring a direct line of sight with as many visible satellites as possible.

D. Mesh Networks

A mesh network (or simply meshnet) is a local net- work topology in which infrastructure nodes connect to as many other nodes as feasible directly, dynamically, and non-hierarchically as possible, and collaborate to efficiently route data from/to clients. Because there is no reliance on a single node, every node can participate in the information relay. Mesh networks may self-organize and arrange themselves in real time, reducing installation time. The ability to self-configure allows for dynamic burden distribution, especially in the case that a few nodes fail. This leads to increased fault tolerance and lower maintenance expenses. Mesh networks can use either a flooding or a routing strategy to relay messages. The message is routed along a path by hopping from node to node until it reaches its destination with routing. The network must allow for ongoing connections and rearrange itself around damaged links using self-healing algorithms like Shortest Path Bridging to ensure that all of its paths are available. When a node fails or a connection becomes unreliable, self-healing allows a routing- based network to continue to function. As a result, the network is usually quite dependable, as there are generally several paths between a source and a destination.

Fig. 2: ESP32 Microcontroller

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Fig. 3: NEO 6M GPS Module

E. Flutter

Flutter is an open source software development kit. It can be used to create android application required for the interface of the project. Flutter applications are written in Dart language. The reason for choosing flutter is because it has reduced code development time. Since Dart compiles into native code, it contributes to faster application start up times and less performance issues. Also it can be used to develop applications for different operating systems.

F. Arduino IDE

The Arduino Integrated Development Environment is an IDE that can be used to code ESP32 microcontroller. It is a text editor that can be used to write code and upload the code to a board. It is inexpensive, open source and operating system independent. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User- written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

G. Firebase Realtime Database

The Firebase Realtime Database is a cloud-hosted NoSQL database that lets you store and sync data between your users in realtime. This allows to view the location of the stranded fishermen in real time. A real time database was selected because they are traditional databases that use an extension to give the additional power to yield reliable responses. They use timing constraints that represent a certain range of values for which the data are valid. This range is called temporal validity. A conventional database cannot work under these circumstances because the inconsistencies between the real world objects and the data that represents them are too severe for simple modifications. An effective system needs to be able to handle time-sensitive queries, return only temporally valid data, and support priority scheduling. To enter the data in the records, often a sensor or an input device monitors the state of the physical system and updates the database with new information to reflect the physical system more accurately.

H. Comparative Study

A comparative study of different components required was done due to the availability of components of different makes and properties. The study was based on different parameters like efficiency, range and cost.

a) Selection of LoRa Module
Many radio frequency transceivers are available in the market like LoRa module,NB-IoT module, Zigbee module and Sigfox module. Through the study, it was found that
- LoRa module has a lower power consumption compared to the NB-IoT module.
- LoRa module has a longer range than Zigbee module.
- LoRa module has a better downlink rate than Sigfox module.

b) Selection of ESP32 Microcontroller
Through the comparative study, it was found that
- ESP32 Microcontrollers have lower power consumption compared to Arduino microcontrollers.
- ESP32 offers WiFi support.
- ESP32 has higher clock speed.

c) Selection of GPS module
NEO-6M GPS module was selected because
- It consists of an external antenna and a built-in EEPROM.
- It is compatible with ESP32 Microcontroller.

IV. IMPLEMENTATION

A. Hardware Design

The LoRa module and NEO 6M GPS will be connected to the ESP32 microcontroller. NEO 6M GPS module takes the location of stranded fishermen when a button is pressed, and then these coordinates will be transmitted by the LoRa module. This entire system will be encased in a waterproof case. This case will be attached on to the life jacket worn by fishermen.

A LoRa module connected to the ESP32 microcontroller is enclosed in a similar case which will be implemented on buoys floating on the sea surface. These make up the network used for routing the packets.

Finally, a LoRa module connected to an ESP32 microcon- troller is implemented on land as the gateway, which receives the data packets and send them to the server which can then be used to display real time locations on an interface.

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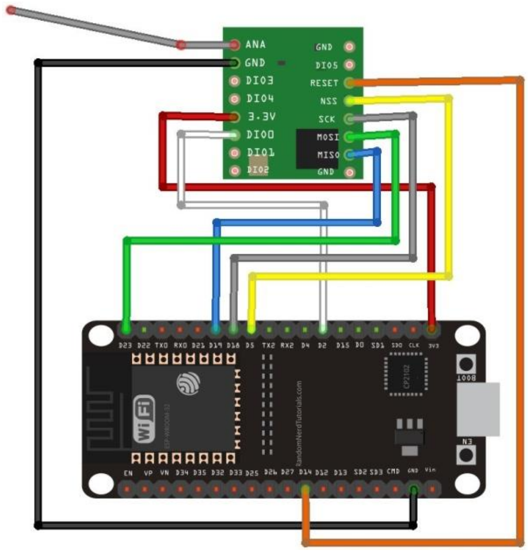


Fig. 5: Circuit diagram of receiver

B. Network Routing

A flooding approach is used to send packets between nodes. In this approach, whenever a node receives a data packet, it sends the packet to all other nodes other than itself.

The flooding mechanism is

- Simple to set up and implement.
- Extremely robust. Even if a malfunction occurs in the network, the packets find a way to reach the destination.
- All nodes are visited. There is no chance for any node to be left out

C. Implementation

For the sender node, the LoRa module and GPS module is connected to the ESP32 microcontroller. A trigger switch is also connected. When the switch is pressed, the GPS module takes the location and writes it into the LoRa packet. The packet is then sent by the LoRa module.

For the repeater nodes, the LoRa module is connected to ESP32 microcontroller. The packet sent by the sender node is received and then retransmitted. This is repeated until the packet reaches the node situated on land.

The gateway node is implemented similar to the repeater node, the LoRa module is connected to an ESP32 microcon- troller. The routed packet is received by the node which is then sent to the server for displaying in a user interface in real time.

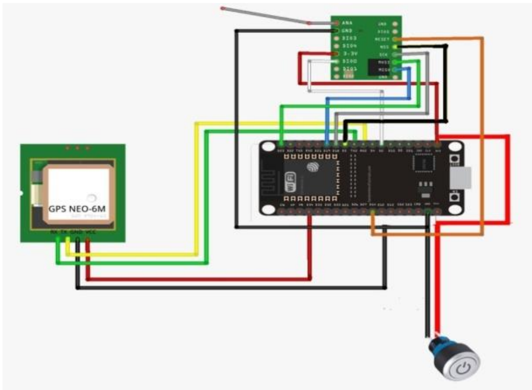
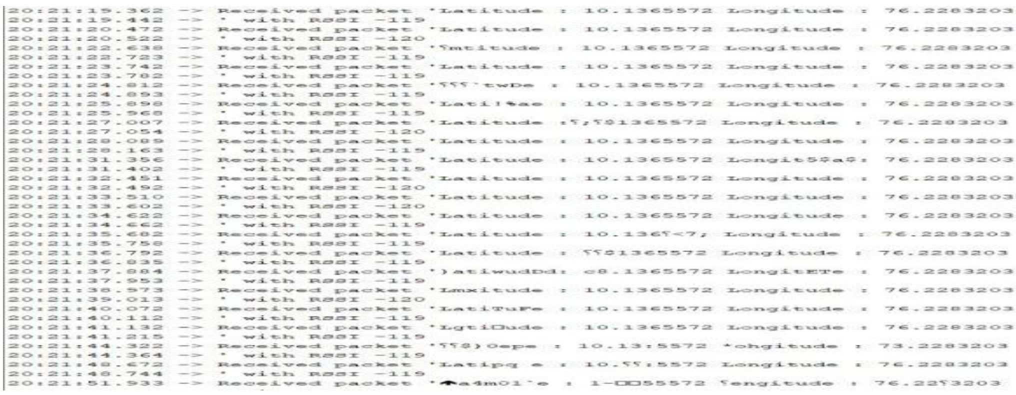


Fig. 4: Circuit diagram of sender

V. RESULT

A. Packet Transmission Output - 2 Node

- Sender node ID: 0x1, Intermediate node ID: 0x2, Re- ceiver node ID: 0xFF



```
20:21:15.362 -> Received packet 'Latitude : 10.1365572 Longitude : 76.2283203
20:21:15.442 -> ' with RSSI -119
20:21:20.472 -> Received packet 'Latitude : 10.1365572 Longitude : 76.2283203
20:21:20.522 -> ' with RSSI -120
20:21:22.638 -> Received packet '?mtitude : 10.1365572 Longitude : 76.2283203
20:21:22.723 -> ' with RSSI -119
20:21:23.742 -> Received packet 'Latitude : 10.1365572 Longitude : 76.2283203
20:21:23.782 -> ' with RSSI -119
20:21:24.812 -> Received packet '???`twDe : 10.1365572 Longitude : 76.2283203
20:21:24.893 -> ' with RSSI -119
20:21:25.898 -> Received packet 'Lati!%ae : 10.1365572 Longitude : 76.2283203
20:21:25.968 -> ' with RSSI -119
20:21:27.007 -> Received packet 'Latitude :?;?$1365572 Longitude : 76.2283203
20:21:27.054 -> ' with RSSI -120
20:21:28.089 -> Received packet 'Latitude : 10.1365572 Longitude : 76.2283203
20:21:28.163 -> ' with RSSI -119
20:21:31.356 -> Received packet 'Latitude : 10.1365572 Longit5?a?: 76.2283203
20:21:31.402 -> ' with RSSI -119
20:21:32.451 -> Received packet 'Latitude : 10.1365572 Longitude : 76.2283203
20:21:32.492 -> ' with RSSI -120
20:21:33.510 -> Received packet 'Latitude : 10.1365572 Longitude : 76.2283203
20:21:33.602 -> ' with RSSI -120
20:21:34.622 -> Received packet 'Latitude : 10.1365572 Longitude : 76.2283203
20:21:34.662 -> ' with RSSI -119
20:21:35.682 -> Received packet 'Latitude : 10.136?<7; Longitude : 76.2283203
20:21:35.758 -> ' with RSSI -119
20:21:36.792 -> Received packet 'Latitude : ??$1365572 Longitude : 76.2283203
20:21:36.835 -> ' with RSSI -119
20:21:37.884 -> Received packet ')atiwudDd: c8.1365572 LongitETe : 76.2283203
20:21:37.953 -> ' with RSSI -119
20:21:38.573 -> Received packet 'Lmxitude : 10.1365572 Longitude : 76.2283203
20:21:39.013 -> ' with RSSI -120
20:21:40.072 -> Received packet 'LatiTuFe : 10.1365572 Longitude : 76.2283203
20:21:40.112 -> ' with RSSI -119
20:21:41.132 -> Received packet 'Lgti□ude : 10.1365572 Longitude : 76.2283203
20:21:41.215 -> ' with RSSI -119
20:21:44.322 -> Received packet '??$)Oepe : 10.13:5572 *ohgitude : 73.2283203
20:21:44.364 -> ' with RSSI -119
20:21:48.672 -> Received packet 'Latipq e : 10.??:5572 Longitude : 76.2283203
20:21:48.744 -> ' with RSSI -119
20:21:51.933 -> Received packet '↑a4m01`e : 1-□□55572 ?engitude : 76.22?3203
```

Fig. 6: Packet Transmission Output - 2 Node

- Path shows the path travelled by the packet
- 1-2: routed through intermediate node
- 1: intermediate node failed - routed directly to receiver

B. Packet Transmission Output - 3 Node

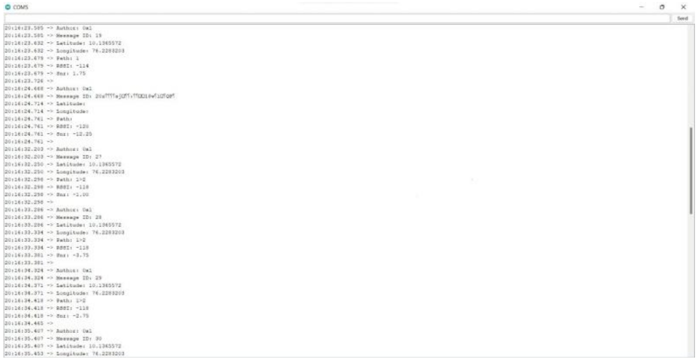


Fig. 7: Packet Transmission Output - 3 Node

- Sender node ID: 0x1, Intermediate node ID: 0x2, Receiver node ID: 0xFF
- Path shows the path travelled by the packet
- 1-2: routed through intermediate node
- 1: intermediate node failed - routed directly to receiver

C. Output Analysis

- The demonstration of the proposed system with a sender, receiver and an intermediate node was successful.
- Packet was created at the sender enclosing the coordinates, routed through the intermediate node, and received at the receiver
- Packet loss experienced was minimal
- GPS could be accessed when demonstrated outside build- ings and under direct view of the sky
- Transmission range obtained : 8-10 m approx.

VI. FUTURE RESEARCH

A major disadvantage of using flooding approach for routing is that it can decrease the efficiency of the network with more number of nodes. Optimization of the network routing process should be done to avoid compromise on efficiency and speed of packet transmission. Also, a graphical user interface that enables users to easily view the location of the stranded fishermen could be developed for a better user experience and faster response time.

VII. CONCLUSION

The proposed system that aids in rescuing fishermen stranded in ocean during adverse climatic conditions is designed using components like LoRa module, ESP32 micro-controllers, GPS modules which enables access of location coordinates and transmission of the same. For routing data packets to the gateway we plan to make use of mesh network- ing topology and distance vector routing. The aim is to develop a low cost, efficient system that can be easily implemented. Since no existing system is available that satisfies all of these requirements, this proposed system will prove to be highly useful in tracking and saving stranded fishermen.

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