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Design of Emergency Position Reporting System for Disasters Using Amateur Radio and Automatic Packet Reporting System (APRS) as a Mobile Station Operator for Educational Purposes

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ABSTRACT

The emergency position reporting system is proposed for disasters using amateur radio and Automatic Packet Reporting System (APRS) as mobile station operators for unexpected natural disasters after the Internet and mobile communication system infrastructure are destroyed surrounding the disaster areas. In this work, the objectives are to report and receive position information on emergency use with Amateur Radio and APRS as a Mobile Station Operator. The location tracking systems are used with amateur radio devices and implemented with APRS in the act of position reports. The position information is received from the smartphone's Global Positioning System (GPS) using the offline mode to the APRS via Bluetooth network that is connected to transceivers. The transceiver used the dual-band Yagi antenna 145 Mhz/435 Mhz called Mobile Station Operator (MSO) as the APRS client using callsign. The MSO collected the location data sent to the Response Station Operator (RSO) that combined with APRS, transceivers, and antenna. The server system allowed data location information monitoring using a valid passcode from a licensed amateur radio operator and used strictly by the servers to validate the connection to the server application.

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1. INTRODUCTION

Nowadays, the Internet is a more important role in everything with the Internet, called the Internet of Things (IoT) (Luckyardi *et al*., 2022; Anh, 2022; Thapwiroch *et al*., 2021; Jebur, 2023; Pantjawati *et al*., 2020). Everything for data access on smartphones required Internet access to be enabled and disabled Internet meant disabled data access. Unexpected natural disasters are happened someday all the landline or mobile communication system infrastructures are fully destroyed surrounding the disaster area and any type of data in electronic devices are surely not accessed. During disaster attacks about 5% of respondents reported receiving information from cellular phones, and computers nearly 30% reported using the media. Many ways to report and receive alert information in social media (Facebook, Twitter, Instagram, and Google Crisis Response tool, etc.) This feature allowed users who are located within a position or distance of a natural disaster's occurrence, to log in and tell friends if they are safe and check their safety situation also provides information for both emergency responders and those in need of assistance. Mobile apps, Cell Phones, and Landline telephones, all of these are great if the Internet is still available to access these electronic devices, but what is going on when the Internet is down? A set of items can be used without power, electricity, cords, and WiFi Access-Satellite Phones (Satphones), Two-Way radios (Walkie Talkie), Citizens Band Radio (CB Radio), and Amateur Radio (HAM Radio) is the way to use for Emergency responsible (see https://www.adjustersinternational.com/newsroom/top-10-communication-methods-in-a-disaster-setting/).

In an early October 2020 report from the National Committee for Disaster Management (NCDM) floods affect over 240,000 people in 71 districts of 19 of the country's 25 provinces and autonomous regions. At least 20 people have lost their lives. The Early Warning System 1294 (EWS1294) (see http://ews1294.com/en/home/) installed 34 sites to warn people of natural hazards occurring in Cambodia. When an event such as flooding is detected or predicted, a voice recording is sent to the mobile phones of registered users in the areas at risk. EWS1294 works frequently with smartphone devices and internet access to receive warning information from the Provincial Centers for Disaster Management (PCDM) (see http://www.ncdm.gov.kh/) to people via their mobile phones and take appropriate action to protect themselves. During floods, landline phones and mobile phone repeaters, even internet access can be interrupted by heavy flooding/storm areas (see https://floodlist.com/tag/cambodia) or due to power outages and damaged cell sites (El Khaled & Mcheick, 2019). The cellular connection system and internet access failed to occur to EWS1294 deactivating warning messages and voice not able to reach people via their cellular phone. In these situations, the people need to recover and activate their suitable connection to contact the authority for help or other responsible operator stations to inform them that they were alive and needed help.

Recently, a lot of HAMs have been focusing on modern system techniques to add to their operation more easily using Automatic Packet Reporting System (APRS). APRS as shown in **Figure 1**, which was designed by Bob Bruniga (callsign: WB4APR), is a packet communication protocol for exchanging real-time tactical information to everyone in a shared RF environment and APRS is also used for tracking systems. In this research, an emergency position reporting system for disasters using amateur radio and APRS as a mobile station operator proposes to build the Amateur grounding system (ground-space-ground) with APRS Amateur transceivers.

Figure 1. Automatic packet reporting system.

In this work, the objectives are to report and receive position information on emergency use with Amateur Radio and APRS as a Mobile Station Operator. The APRS is the most important role to becomes the GPS when connecting to a TTL/RS-232 (jumper selectable)-it can act as an APRS Tracker, and it can read sensors and becomes a weather station (WX) without the need for a computer.

The full system is worked with low power consumption, a simple homemade Yagi Dual Band with 3-element and 6-element Yagi-Uda antenna with frequency rang 29.4815 MHz/145.900 MHz for uplink and 435.350 MHz/435.690 MHz for downlink suitable used for any type of Amateur Radio Devices. The transceivers are 7 watts and 100 watts power with Dual Band VHF/UHF mode are used for The Mobile Station Operator (MSO) and Response Station Operator (RSO). MSO could report the GPS location automatically via the smartphone in offline mode that shared data GPS through APRS to the RSO from the ground-to-ground station. The data location reporting displayed in the RSO's monitor is used strictly by the APRS-IS servers to validate the connection to the server application or accessed through the website findu or aprs.fi (see https://aprs.fi/).

Amateur operators mostly call Ham, a group of emergency operators who is a response to Ham Radio in disaster activities. Recently, Cambodia doesn't have more local Ham operators for any disaster help. The Ham Radio operator has required the user to be an Amateur Radio license operator holder from FCC; thus, giving authenticity to the information that is regulated across the airwaves. In the experiment, XU7AKM/XU7AMO are used for local callsign in Cambodia and KE0SOY/KE0RAS are used for international callsign.

2. METHOD

This study showed the design of an emergency position reporting system for disasters using APRS as a mobile station operator for educational purposes. This study explained step by step in designing the process.

3. RESULTS AND DISCUSSION

3.1. Mobile and Response Station Design

The emergency position report is proposed for Amateur grounding operators during unexpected natural disasters. APRS is the main device that is used for generating data information. This system was designed in two parts, MSO and RSO as illustrated in **Figure 2**. The MSO site is designed for the mobile ground station to access all report data and message information to RSO. The GPS in MSO was for getting data location from the GPS Satellites connected to APRS via the smartphone, it can act as a position reporter and BT TNC. RSO responds to the position and data information from MSO accessed to the server and displays data information to devices that are connected to internet access.

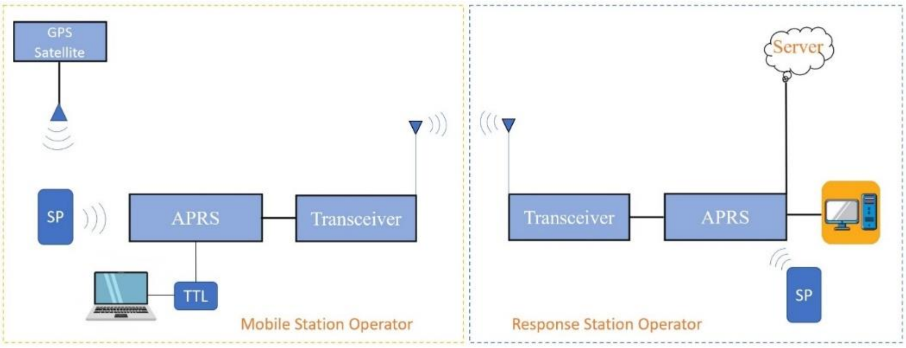

Figure 2. MSO and RSO system diagram.

3.2. System Setup and Configuration

APRS software was installed and configured in the PC to register for MSCOMM32.OCX, TABCTL32.OCX, mswinsock.OCX is extracted to the file in the folder of OCX Files then copy these files to the Window folder in directory file (C:) system32 with the SysWOW64 folder. Run command prompt (cmd) and type regsvr32 TABCTL32.OCX then enters until the success message is alerted. Before configuration of the APRS 51TNC, the PC is connected to the network system via LAN or Wireless as illustrated in **Figure 3**. Install the APRS 51TNC in the PC until the APRS network interface as shown in **Figure 4** appeared with the IP Addressing verified the network status between PC and APRS after register callsign.

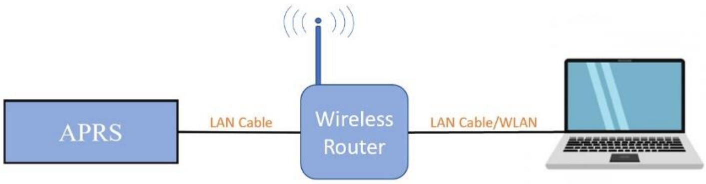

Figure 3. APRS network configuration.

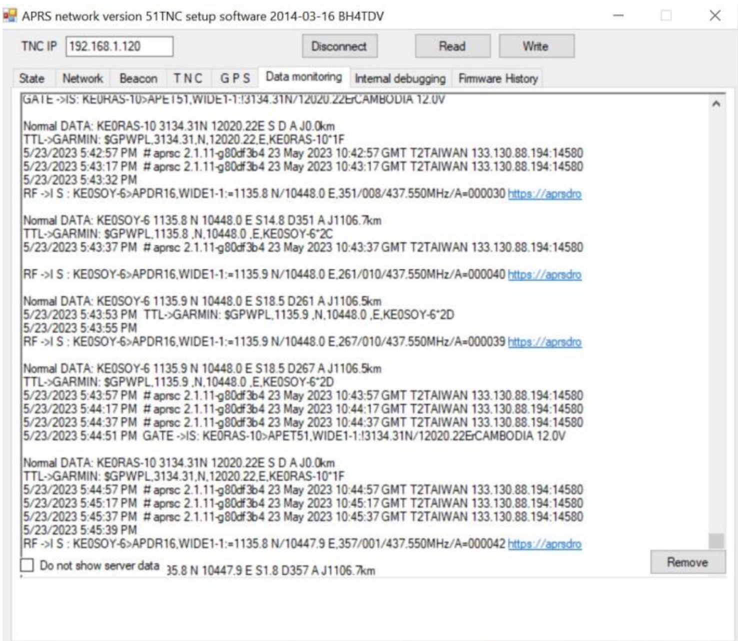

Figure 4. APRS 51TNC network interface.

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The important aspect is the APRS GPS tracker. APRS becomes the GPS when connecting to a TTL/RS-232 (jumper selectable)-it can act as an APRS Tracker as shown in **Figure 5**. Normally, the APRS is the act of a GPS tracker when the TTL/RS-232 port is connected to the external GPS module. In this experiment, APRS used the GPS tracker to share its GPS status with the Smartphone via Bluetooth network.

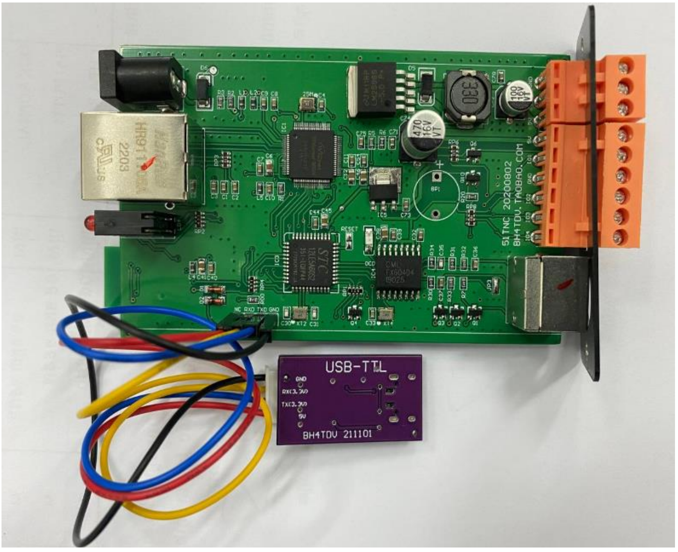

Figure 5. Connecting between APRS and TTL.

The APRS was configured as same as the MSO that connected from the transceiver with the Yagi Uda antenna to APRR. This system can share location data collected from the MOS is the act of a GPS tracker in the Smartphone via an internet connection to show the location map in web browser aprs.fi or findu and APRSdroid is an application on Smartphone for Amateur Radio operators. It allowed position reporting to other RSO for receiving information from nearby amateur radio station operators and exchanging the messages with APRSIS application as server/client on the PC as shown in **Figure 6**.

Figure 6. APRSIS application interface.

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3.3. Experimental Steps

The experimental tasks are conducted in six steps in order of an experiment Diagram as illustrated in **Figure 7**. The MSO diagram is for sending position and the RSO diagram is for receiving position display on the APRSIS32 application.

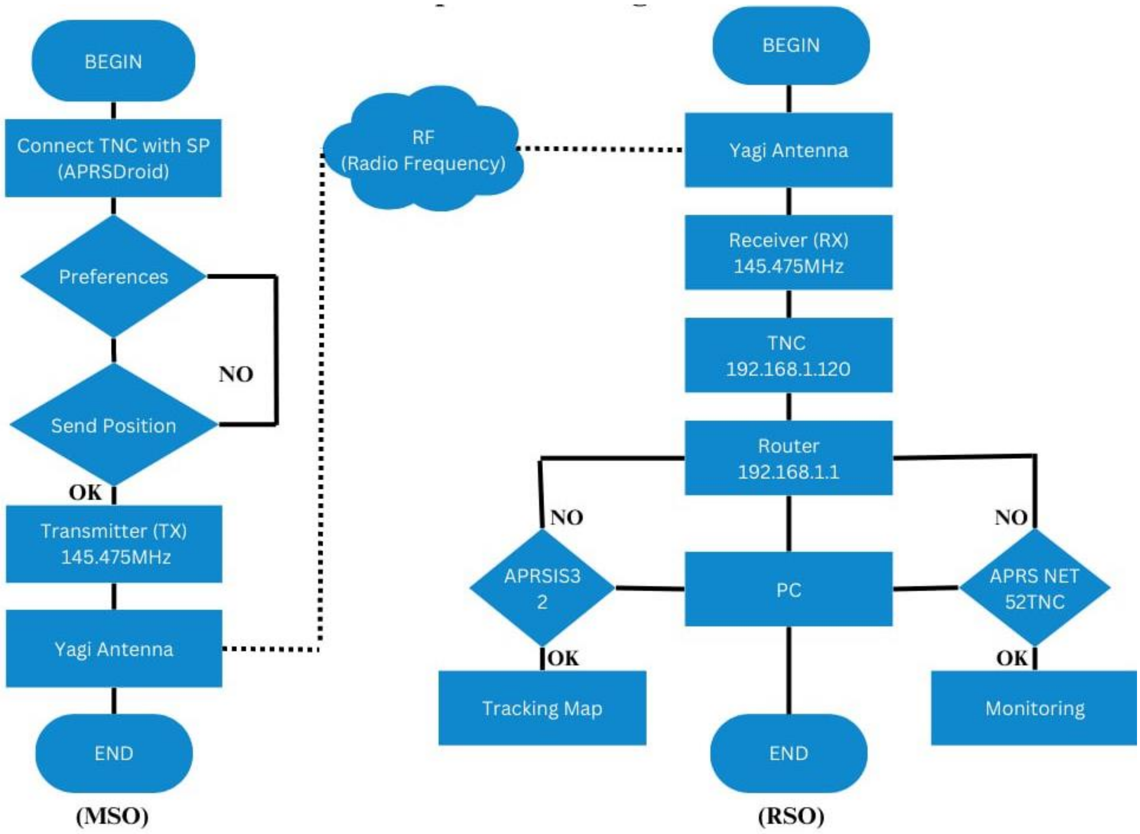

Figure 7. Experiment diagram.

The steps used in this design are the following:

(i) ***Step One: Connecting APRS as TNC on MSO.*** APRS became the TNC (Terminal Network Control) when connected to an Android app (APRSDroid or others) via Bluetooth, it becomes a BT TNC.

(ii) ***Step Two: Sending Position from the smartphone on MSO.*** Using ARPSDroip software in the Smartphone to generate GPS data from smartphones to Transceivers. The transceivers are selected frequency range 145.475Mhz.

(iii) ***Step Three: Installing Yagi Antennas.*** Homemade Yagi Uda dual ban antenna is designed with 3-element and 6-element Yagi-Uda antenna with a frequency range of 29.4815 MHz/145.900 MHz for MSO and RSO.

(iv) ***Step Four: Connecting the ARPS network with the PC.*** The APRS for RSO became the iGat (Internet Gateway) when connected to the network via RJ45 port. The router is beware of any duplicated IP address. APRS needs a unique global IP address to access the internet and to be ready for an iGat.

(v) ***Step Five: Showing Tracking Position on Map.*** The data position of the MSO is at a different location around 5-7 km away from the RSO where a standby system in Telecom Lab/NPIC is to make sure that both sides are still available and connected as well as sent position data through the air.

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(vi) ***Step Six: Monitoring Position Display on RSO.*** Data positions sent from MSO and plotted on the RSO are monitored for tracking maps in the APRS-IS server application system to display the position information on the RSO side. The MSO side is using the ID callsign KE0RAS and RSO's ID callsign KE0SOY as shown in **Figure 8**.

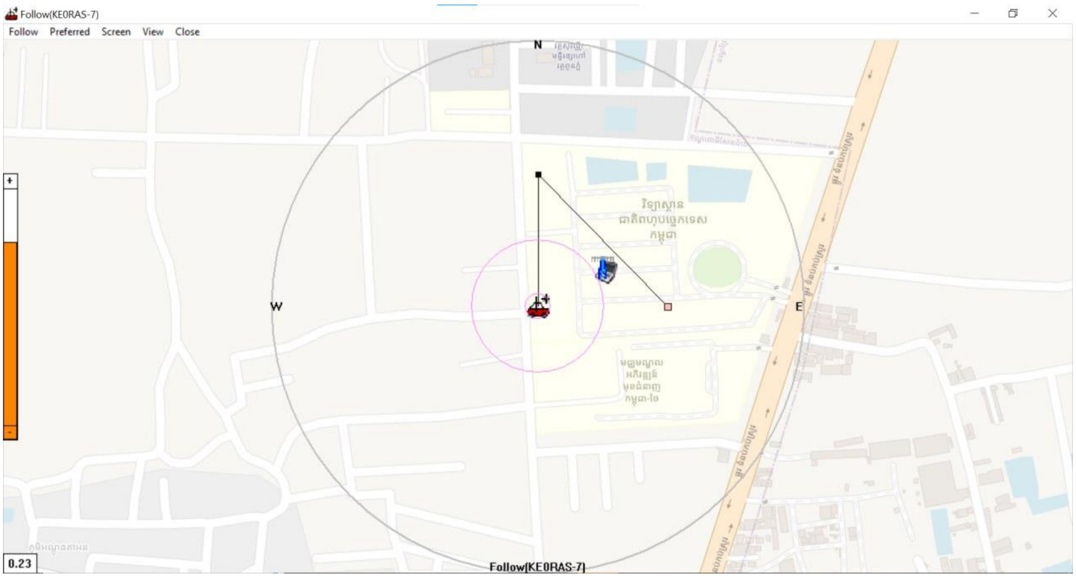

Figure 8. Data position information.

4. CONCLUSION

The research focuses on the way to send data position information during a disaster that interrupted the Internet connection. This system worked between smartphone's GPS and Amateur Radio devices are implemented with APRS for emergency position reporting. According to the experimental tasks above, the result from the experiment is generated the GPS data positions from a smartphone in the offline mode assuming no internet access to the smartphone. Different places of the MSO are precisely plotted on the APRS-IS map of the RSO side. Father more, when using APRSDroid on the smartphone, it is also tracked position and displayed in the aprs.fi web application.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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