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MCTE 4344
SECTION 1
REMOTE SENSING AND TELEMETRY

PROJECT

Telemetry For AIS Using 443 MHz + RockBLOCK Iridium

LECTURER: ASSOC. PROF. DR. ZULKIFLI BIN ZAINAL ABIDIN
GROUP: 1

NO	NAME	MATRIC NO
1	AMIRUL AMIN BIN HASBULLAH	1813595
2	AHMAD FIRDAUS BIN GHAZALI	1814113

EXECUTIVE SUMMARY

Problem statement

Ships at sea have difficulty identifying other ships when they are not visible for example on stormy nights, in arcs or radar blind shadows or at long distances. For heavy ships or vessels that weight thousands of tonnes that require several kilometer of breaking distance and change of heading direction, unprecedented accident can happen if the location of other vessels and ocean structures are not known.

Proposed solution

- Garmin GPS 19x HVS as the main poitional data acquisition

  The GPS 19x HVS consists of an antenna and an integrated receiver. The GPS 19x HVS tracks many satellites simultaneously, with quick time-to-time fixes, precise navigation updates from once per second to ten times per second, and low battery consumption. The GPS 19x HVS also allows users to use the Russian GLONASS satellite system at the same time. The GPS 19x HVS is built to survive harsh operating circumstances and is waterproof to IEC 60529 IPX7, which means it can withstand 30 minutes of immersion in 1 metre of water.

- SV651 443MHz remote telemetry for local area data transmission

  The SV651 is an industrial-grade, highly integrated RF transceiver module that uses Silicon Labs' high-performance Si4432 and an industrial microcontroller. 232 is selected as the equivalent of SV651-232. The SV651 has a high sensitivity and output power of 500mW, allowing for a long RF range and dependable RF transmission. The SV651 has 40 frequency channels and a customizable Net ID to prevent interference.

- RockBLOCK Mk2 Iridium 9602 satellite communication for global data transmission

  The RockBLOCK Mk2 allows users to send and receive brief messages from anywhere on the planet with a clear view of the sky, outside of the reach of WiFi and GSM networks. An Iridium 9602 satellite modem is at the heart of RockBLOCK. Iridium is the only satellite network that permits data to be transmitted from any location on Earth; other networks do not have coverage in other marine or land locations. Iridium has 66 satellites in orbit around the Earth, providing coverage 24 hours a day, seven days a week, anywhere on the planet. No other satellite network can claim to cover the entire globe. Messages transmitted by Iridium arrive in the user's inbox in seconds, either via e-mail or directly to the user's web service.

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DESIGN PROBLEM AND OBJECTIVES

Design problem

- Difficulty to solve problems of different logic levels Arduino TTL to RS232 to read the GPS data (GPS output a 0-3.3 CMOS logic level).
- It is very possible that a satellite may have had an unobstructed view of the RockBLOCK, returned a 5 bar signal and then disappeared behind an obstruction or even the horizon itself.

Objectives

- To transmit the position of a ship using GPS to base at regular intervals via RockBLOCK Iridium & SV651 for a distance below 3km and RockBLOCK Iridium for a distance above 3km.
- To receive the transmitted GPS data by using Iridium cloud monitoring and local ground control station (GC).

Design constraints

- Garmin GPS 19x HVS
  - The accuracy with GLONASS turned on was never better than 10 metres (33 feet).
- SV651 443MHz remote telemetry
  - The module can only be configured by the specified PC software or customer's own device with the communication protocol. If the customer wants to configure the module with their own device, they need to contact the corresponding sales engineer for communication protocol.

- RockBLOCK Mk2 Iridium 9602 satellite communication
    - Satellite communication does not work unless it is placed outside with a clear view of the sky.

DETAILED DESIGN DOCUMENTATION

1. Overall Mechanical Design

The completed system can be separated into two main system which are data acquisition system (DAQ) which in this case is the remote sensing part of the system and the second part is the data transmission of the acquired data which is the telemetry part of the system. In this system, the main DAQ part of this system is measured or acquired from the Garmin maritime GPS module with the NMEA interface. The GPS is capable of interfacing with NMEA compliance protocol and also capable to produce serial communication by interfacing it with RS232 format serial. The sent data is then translated into TTL(transistor-transistor logic) format to make it possible for interfacing with microcontroller module (Arduino MEGA) using the serial communication (RX1 ⇄ TX1). The GPS data is then displayed on the arduino serial monitor for confirmation of received data and then transmitted to both RockBlock Iridium module and SV651 transceiver module using the other serial port on the Arduino Mega (RX2 ⇄ TX2 and RX3 ⇄ TX3). The data is then received on both end of the transceiver on the web monitoring cloud services of Iridium Rockblock and the TX port of the other SV651 module respectively. A minimum number of 3 pair of serial communication port of microcontroller is required in order for the system to function as one complete remote sensing system with satellite and RF telemetry and since Arduino MEGA is by default, capable of handling of 3 pair of serial communication through the designated serial port, it is suited to be used in the development of this AIS system.

2. Garmin GPS 19x HVS

The Garmin GPS that we used act as the main sensor for this project by providing the raw string data of the local geolocation of the system. After passing the raw NMEA format data to the microcontroller through the serial port, we need to callibrate the data by providing the offset value so that the precise location coordinate that we took from Google Map services matches with the longitude and the latitude data provided by the GPS. From our experimentation, we found that the offset of the data provided by the Garmin GPS to be -0.0938545 latitude and -0.2970166 longitude which translate to -10km in vertical and -32km in horizontal displacement. Only after calibrating this value into the Arduino coding we can then proceed to transmit the geolocation data.

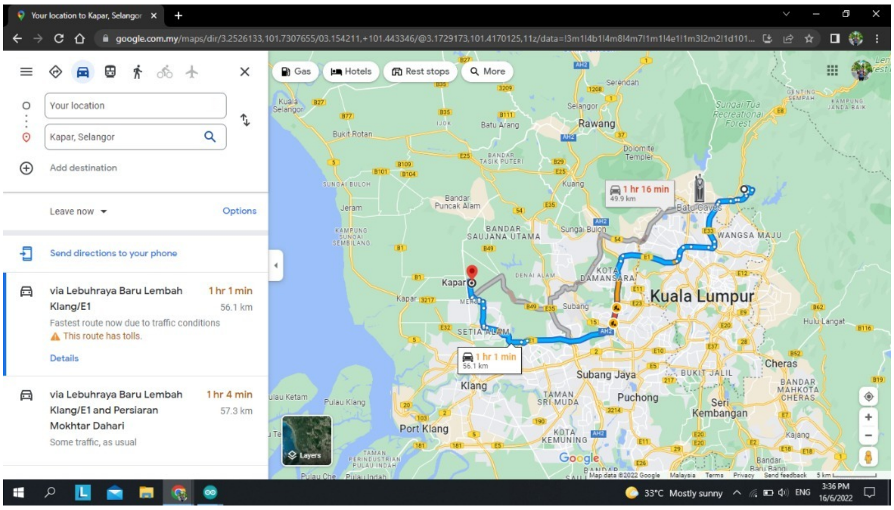

Figure above shows the approximate coordinate output given by the Garmin GPS (with 33.5 km off set radius)

3. RockBLOCK Mk2

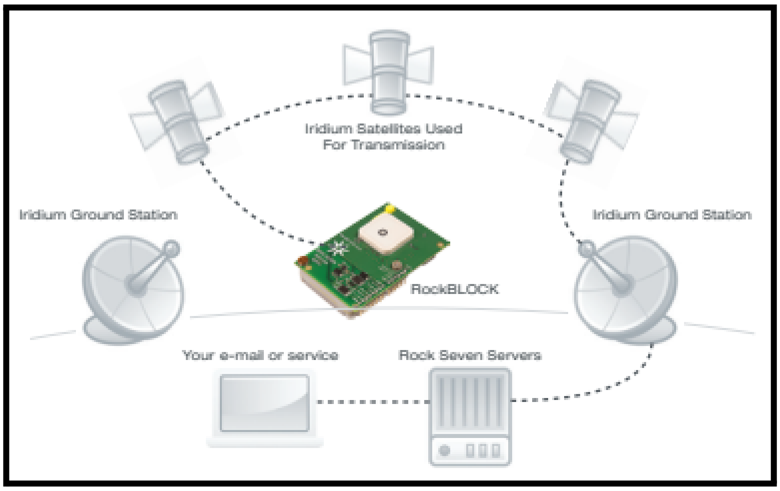

Figure: RockBLOCK working mechanism

The corrected data from the GPS is then transmitted to the subscribed Iridium Satellite Services that are capable for two way communication. In this project however, we are only using the module to satellite communication for sending data to the satellite and from the satellite we only receive checksum information to makesure a successful transmission which is displayed on the serial monitor of the arduino. The data from the satellite is then transferred to the Iridium cloud services which stores it and broadcast it to the user web panel of the iridium web interface. With proper API, the data gathered from the satellite can be broadcasted to the other AIS monitoring website so that the location of the vessel is known globally and can be monitored live via the internet.

4. SV651

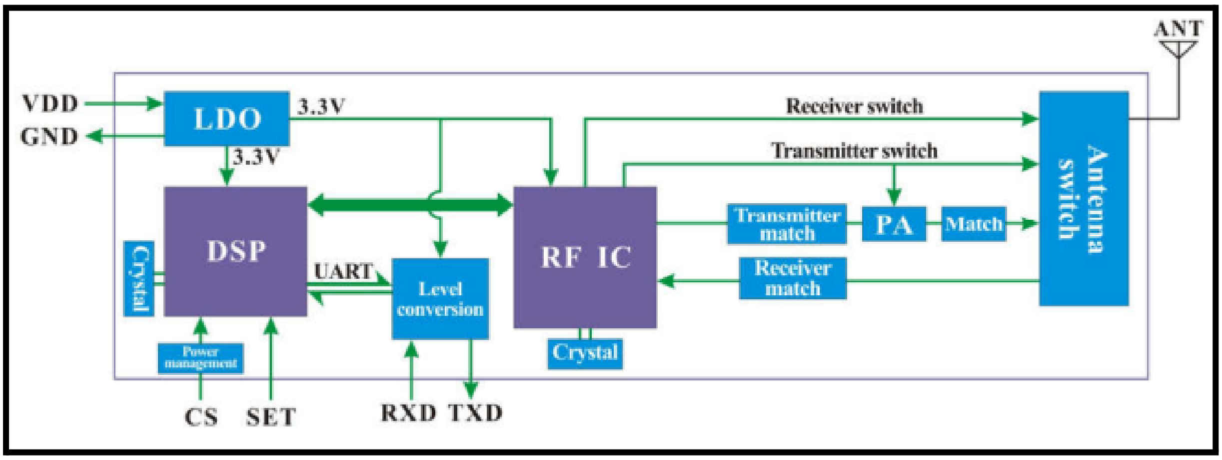

Figure: SV651 block diagram

For the local wireless area network (WLAN) transmission, we used the SV651 433MHz transceiver module that capable of communicating in distinct 40 channel to makesure no data interference happens. This module capable of transmitting data up to 3km radius in a low-interference environment and it is suitable to be used in an open line-of-sight surroundings such as on the ocean surface. With baudrate up to 100kbps, it is more than enough for us to broadcast the AIS string data for the surrounding area to have awareness of our ship's presence on the water.

DISCUSSION AND SAFETY

The findings show that raw GPS data may be gathered and subsequently corrected using cell tower triangulation and local atomic clock time. The list of data from GPS includes latitude, longitude, GPS quality, direction, number of satellites, accuracy, altitude from sea level, height of antenna and geoidal saperation. The data is then converted into AIS data. The data consists of MMSI ship date, navigation status, Rate of Turn (ROT), ship speed, ship position (Longitude and Latitude), Course Over Ground COG), True Heading (HDG), Time Stamp, RAIM flags, and Radio status. The AIS (NMEA message) data can be decoded into ship data using the AISDecoder programme. AISDecoder feeds AIS words over UDP, making it simple to interact with other AIS software like LabVIEW, which listens for incoming UDP AIS data.

"See and be seen" is a cardinal safety rule that all pilots obey. A ship's pilot may rapidly view and identify any vessel transmitting an AIS signal in their local vicinity using AIS. Even in deep fog or at night, this information is visible. The safety alerts are usually transmitted in text format and are aimed at one or more stations. They are only sent when necessary.

CONCLUSION AND FURTHER WORKS

AIS was created as a way to track real-time vessel movements in order to improve navigational security and safety through traffic awareness. This technology can also be used in a variety of other ways. Companies and government agencies will continue to employ AIS data in novel and creative ways, as demonstrated by the examples in this study.

The rise of autonomous vessels will bring AIS front and centre, and it will almost likely have an impact on its evolution as vessel operators need AIS capabilities as a crucial component of their onboard C&C systems. Hopefully, the advent of a new, more accurate, and secure AIS will have implications beyond the world of ships and shipping. One of them could be a cleaner environment, as real-time AIS vessel tracking will contribute significantly to the overall decarbonisation effort.

Real-time AIS should help in the fight against illicit fishing by making it simpler to recognise vessels engaged in manoeuvers that suggest fishing in regions where they shouldn't be. This will aid poorer countries that rely on fishing but lack the resources to safeguard and patrol their waterways, as well as the struggle to manage fish stocks sustainably. As more organisations and corporations figure out how to use the new data, other applications will undoubtedly emerge.