A shipping fleet control system

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Abstract: - This paper presents a low cost system developed for finding ships by GPS, as well as its localization in a map. Circuitry has been developed from marketed devices and an application has been programmed that allows the easy administration of the own fleet. In this way, you have a modular system designed, in which technological updates can be easily carried out.

Key-Words: - GPS, protocols, shipping communications.

1 Introduction

This paper describes a maritime crafts localization system from a central base station. It allows knowing the position and controlling a fleet of ships through the use of the Global Positioning System (GPS) [1].

The base station (figure 1) has a personal computer, a modem and a transmitter-receiver. Software has been developed to automatically control this tool in a convenient way.

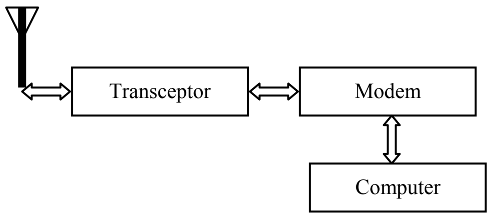

Fig. 1. Base station block diagram

Each ship is equipped with a GPS, a microcontroller, a modem, a PTT (Push To Talk) circuit and a transmitter-receiver (figure 2).

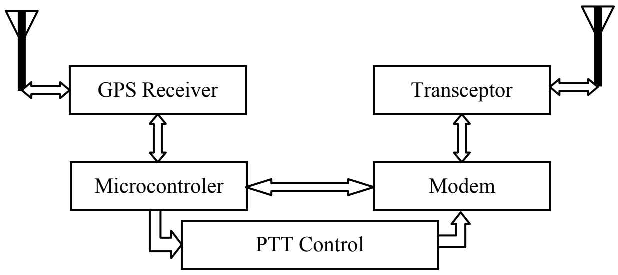

Fig.2. Ship equipment block diagram.

The main problem of the shipowners is to know every moment the ships position, in order to improve the service provided, and also to know inmediatelly moment any incidence that can arise during the course of the normal activity of the fleet.

The system allows the knowledge of the speed and shows the position of each ship at the base station. It draws a signaling icon over an electronic world map. For this purpose, we use a communication system capable of transmitting information whitout human intervention.

This communication is organized as follows: first we describe the purposed location system performance. Then we explain the different properties of the devices and protocols in both the base station and the ship. Finally we expose the laboratory test that we have realized in order to verificate the adecuate performance of each module.

2 Radiolocation system

Based on the aforementioned constraints, a system with a base station and a mobile station at each ship has been developed. The general block diagram has been drawn in figures 1 and 2.

The basic operation of the system is described below:

The computer at base station uses the developed software to request the position data of each ship. This requesting is studied by the radio trasmitter, using as computer-transmitter interface the modem. Each ship receives a coded information incoming, so that such information is not been processing by the rest. GPS gets the information that is going to be sent to the receiver. After that, it is processed by the microcontroller through the modem. The microcontroller produces the information to be transmited towards the base station. Moreover the microcontroller generates an activation signal of the radio station PTT button.

The signal emmited by each ship reaches the radio receptor of the base station which, through the modem, arrives at the computer. An icon on a world map is then plotted and a file with the data about the transmitter ship is saved.

3 Base station modelling

Following the block diagram of figure 1, the main characteristics of the utilized equipment are given below.

The computer in use is one personal computer, with a Pentium IV processor, 256 MB RAM memory, 60 GB hard disk and a 64 MB graphics card. The operating system to use will be Windows 98 or higher version.

The computer-modem communication is carried out by means of a RS-232 serial port, connected to an adapting levels card whose electric diagram is shown in figure 3. This one transforms the out/in levels of the computer in an in/out TTL signal, using for it a integrated circuit MAX232 [2].

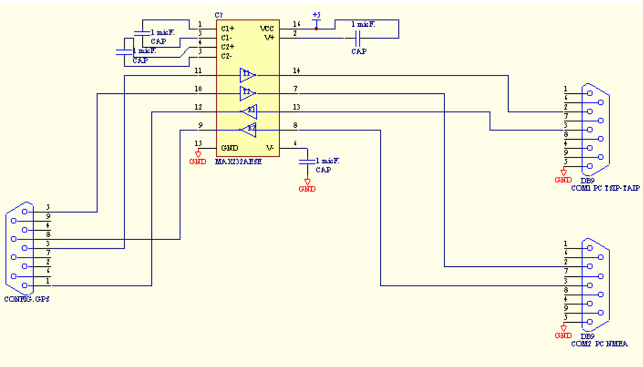

Fig. 3. Adapting level circuit electric diagram.

The TTL signal is taken to a low speed modem that transforms it into a FSK (Frequency Shift Keying) signal to 1200 bps. Of course, in reception carries out the inverse conversion.

The modem generates a signal which arrives to the transceptor through the microphone input. The transmitter is a HF transceptor of marine band frequencies (1.6 to 27.5 MHz) that allows working in all the ways (J3E, H3E, R3E, J2B, F1B and A1A). This allows memorizing 160 channels, identified by number, characters or frequency [3]. The out power is of 150 W, and it has an NMEA (National Marine Electronics Association) 0183 interface [4]. The frequency band in reception is from 500 kHz to 29.9999 MHz, taking the FSK signal sent to the interface modem.

For the operation of the system we have developed an application, whose name is COMAR for being installed in the computer. The application has been written in a user friendly way. It has been developed in Microsoft VisualBasic 6.0 [5] in order to design a very friendly front-end.

The program has the following functions:

- Configuration. Through different screens you can configure the connection series (port to use, speed, number of data bits and stop, parity). The selected data are shown permanenetly in the screen.
- Connection. It allows opening the communications port selected with the desired characteristics.
- Database. It shows all the ships of the fleet. For accessing it you can select each ship you want to know the position. The system manager is the only person who can change the database information.
- Communication. Pressing an icon in which a ship is represented, a communication process begins with the ship. In such moment the PTT of the base station is connected in order to send the sailing request that identify each ship. The ship answer is a TAIP (Trimble ASCII Interface Protocol) message that is shown in a textbox at the file top.
- Correction of errors. The program incorporates a CRC error correction system for assuring that the received messaage is right.
- Data extration. This function reads the TAIP message, extracts and presents the position and the speed ship data and the UTC local time in the screen. Likewise it places an icon on the map at the ship position.
- Erase. This function allows, using the suitable icon, to eliminate all the icons of the ships and to guarantee that position updating takes place.

Instead of selecting a ship of the fleet in the database, all the existent ones are selected in the same one, so the program stores all the messages and, when it receives the request it proceeds with each one of them in the mentioned way.

Figure 4 shows the screen that a user can see at the base station.

4 Ship station modelling

In a similar way, following the block diagram shown in figure 2, the characteristics of the systems and devices used in the different ships are described next.

The used transceptor must have the same frequency and mode specifications as the one at the base station.

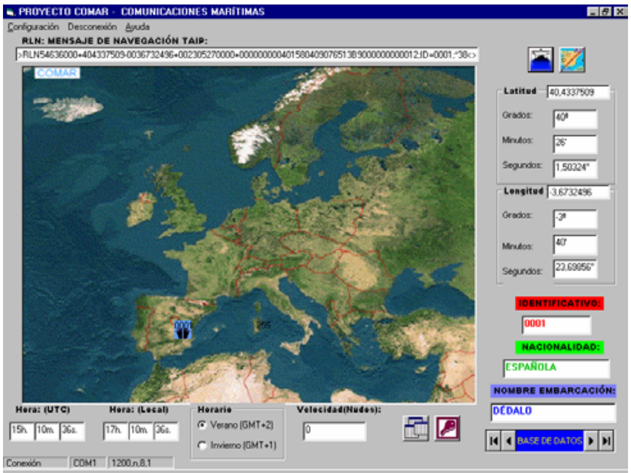

Fig. 4. COMAR file screen.

The GPS receiver is made of a group of software and hardware elements that allow determining the position, speed and the user local time, besides the additional requires parameters. Among their basic functions, the most important are: the identification and pursuit of the codes to each satellite, the determination of the distance, the decoding of the sailing signal data to obtain the ephemeris, the almanac, …, the aplication to correct for the clock and ionospherics, the determination of the position and speed, the validation of the obtained results, their storage in memory and presentation of information. In the figure 5 you can see the unit of the GPS receiver.

Fig. 5. Unit of Lassen SK II Trimble GPS receiver [7]

The receiver module is a miniaturied GPS receiver of frequency L1, code C/A (Coarse Adquisition), 8 channels, continuous pursuit and ability to switch to a differential mode that selects automatically the satellites to optimize the data precision. It has inputs and outputs of communication series with configurables levels TTL like TSIP (Trimble Standard Interface Protocol) [7] or TAIP [7] and NMEA.

Its main characteristics are: precision of position is 25 m. in static conditions and no diferential mode, precision of speed is 0.1 m/s. Their characteristics and operation limits are higher than the necessary ones for this application.

The connected antenna of this receiver allows for signal of -140 dB to 1575 MHz.

The TTL output signal of this receiver is sent to a C8051F226 microprocessor [8] of 8 bits, with a flash memory of 8Kx8, an internal RAM of 256 bytes and it has been programmed in assemble language [9].

The input signal comes from the first port of the GPS receiver and it provides a TTL output signal toward the low speed modem.

The transmission modem receives the incoming signal from the microprocessor and gives to the transmitter a FSK signal of 1200 bps by means of the input microphone. In reception, it picks up the modulated FSK signal of 1200 bps of the speaker and delivers a TTL signal to the first port of the GPS receiver.

The control circuit of the PTT receives from the microprocessor a fluctuating TTL signal and it generates a continuous TTL signal to the output activating a mechanism which simulates the performance of the PTT.

With the purpose of avoiding possible consistent sabotages to cause a shutdown, we have planned an autonomous feedign system which allows storing the GPS contents, so that when the feeding is reestablished all the data are sent again in the first connection that is carried out.

5 Test executed

After designing and implementing the different circuits we have performed laboratory test to verify the operation of each module.

In the base station we determined and measured the following signals:

- ·RS232 signal to the output of the computer serial port.
- ·The transmission and reception messages form to the serial port and adapter of levels output, respectively.
- ·TTL signal corresponding to the TAIP protocol to the adapter of levels output (figure 6).
- ·FSK signal to the modem output.
- ·HF signal to the transmitter output.

The test carried out in the ships equipment measured the following signals:

- ·Output signal of the GPS antenna.
- ·TTL signal corresponding to the TAIP protocol in the primary port output of the GPS receiver.

·The transmitting and receiving messages from at the endof the serial port of the GPS receiver and microprocessor outputs, respectively.

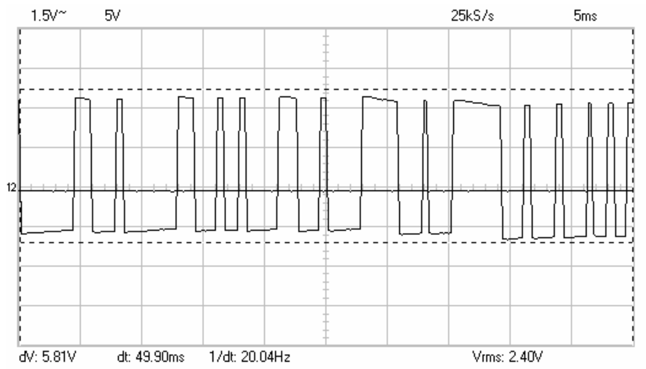

Fig. 6. TTL signal

·TTL signals at the modem input.
·Signal activation of the PTT circuit sent from the microprocessor.
·FSK signal at the modem output (figure 7).
·HF signal at the transmitter output.

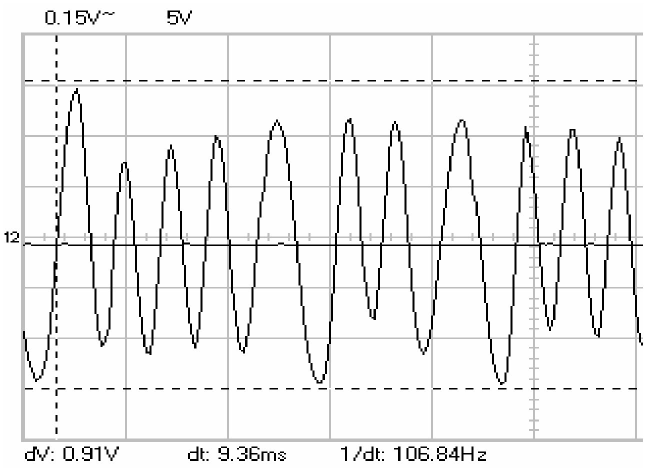

Fig. 7. FSK signal at the modem output.

A lot of operation test to the application COMAR were carried out and, lastly, we carried out differents global tests to the system, obtaining satisfactory results.

6 Conclusions

This paper describes the design and implementation of hardware and associated software to buid a system which allows the control of fleets. Although it has been oriented toward marine fleet, it could be applied lorry to etablished transport fleets.

The updating structure will allow the easy adaptation of the positioning system when a bigger satellite constellation numbrer will be ready.

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