Safety Measures for Large Passengers Ship Using RSSI

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Abstract- *System based on measuring the received signal strength indicator (RSSI) between smart lifejacket tags and one interrogator station mounted inside an unmanned aerial vehicle (UAV). Localization is based on weighted least mean squares (LMS) algorithm. Simulations that study the effect of the UAV search path on the localization accuracy are presented and it shows that the parallel tracks search path gives better localization results compared to other search paths. Measurements are carried out in a search area of 500 m x 350 m, where tags are localized with a mean error ofm. The measurement results show better localization accuracy compared to other RSSI based localization algorithms.*

Keywords- CSTR-PID-ZN-Fuzzy-MRAM-MATLAB.

I. INTRODUCTION

The development of a safe evacuation system of large passenger ships is a vital need for the maritime industry. Due to recent maritime disasters, a localization system that can be easily installed on both cruise ships and search and rescue (SAR) vessels is needed in order to locate simultaneously a larger number of passengers during emergencies. In the Lynceus2Market project , an innovative overboard localization system is developed. This system aims at improving the response time for people localization by SAR operations when several passengers go overboard a cruise ship. Some overboard localization solutions already exist in the market, but they either depend on GPS for passenger localization or on a Wi-Fi network around the cruise ship where location data are sent in regular bursts. The use of GPS is an expensive solution, and the use of a WiFi network requires the placement of several nodes around the cruise ship. The overboard localization system implemented here provides smart tags that can be easily integrated into lifejackets and localized using a UAV equipped with an interrogator station. 868 MHz Zigbee modules are used for measuring the RSSI between the smart tags and the UAV interrogator. Through implementing the weighted least mean squares algorithm presented in smart tags localization is performed and data is sent for SAR operations. The UAV can be launched from shore, a cruise ship or a SAR vessel.

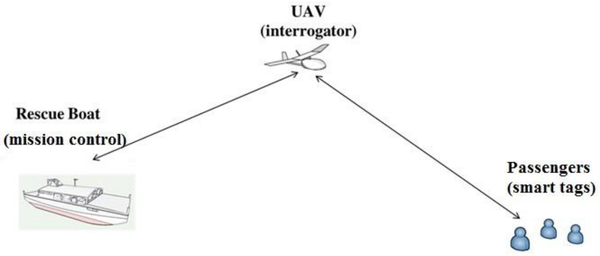


Fig. 1. Overboard localization system overview

Since errors in RSSI measurements increases with the increase of the distance between the tags and the interrogator node, several simulations are done to check the effect of the noise of the RSSI measurements on the localization accuracy. In addition, simulations for several search patterns are done to study how the UAV flight trajectory can affect the localization accuracy. The presented overboard localization system is integrated on board of a SAR vessel and tested in operational mode.

I.OVERBOARD LOCALIZATION SYSTEMOVERVIEW

An overview of the overboard system is shown in Fig. 1, where it is composed of:

A. Smart life jacket tags

These smart tags use ZigBee 868 MHz low power modules. These modules consume 1.7 uA in sleep mode and 22 mA in active mode. Using two AAA standard batteries allows these modules to operate for 20 continuous hours in active mode. A miniaturized PCB with size of 2.6 cm by 5 cm - compared to the one previously developed in [1] with size of5.3 cm by 7 cm- was designed and manufactured for easiness of integration inside Lynceus2Market lifejackets. The smart lifejacket tags are placed inside an IP67 waterproof package that was custom made for the Lynceus2Market components. A commercial 868 MHz antenna was chosen with small size (4.1 cm by 1.5 cm), so that it can be easily fitted inside the package. The antenna is placed on the side that faces outwards of the lifejacket in order to get clear line of sight to the UAV antenna. The tag activation mechanism is done through a water sensor, where the module only goes from sleep mode to active mode when the lifejacket and consequently the water sensor electrodes hit the water.

B. UAV integrated with interrogator PCBstack

The LNC3030 UAV prototype shown in Fig. 4 was specifically designed to be used with the Lynceus2Market overboard system. The interrogator PCB is equipped with STM32F microcontroller and ZigBee 868 MHz module. Through the STM32F microcontroller, the Zigbee module is programmed for passenger scanning, identification and RSSI measurement. The interrogator microcontroller is connected to a GPS card inorder to get the UAV positions at the times where RSSI measurements are done. The GPS card placement inside the UAV fuselage was don so that the GPS antenna always has clear sky view. Meanwhile, the interrogator antenna was placed in the bottom of the fuselage with no conducting material underneath in order to avoid signal attenuation and to ensure clear sea view. The interrogator PCB is connected through a universal asynchronous receiver transmitter (UART) interface to an on-board single board computer (SBC) that is also placed inside the UAV fuselage. The on-board SBC is used to process the RSSI and UAV coordinates data coming from the interrogator. The UAV is also equipped with an autopilot for carrying out programmed flight search missions. Shielding was done for all the wires inside the UAV in order to avoid interferences between the autopilot transceiver and the interrogator.

C. SAR vessel control unit

The SAR vessel is wirelessly connected to the UAV through a 5.8 GHz communication link with a transmission range of 10 km. This link is used for UAV mission control, where the search mission waypoints are programmed to the UAV autopilot before the flight and when needed can be altered during the flight. The 5.8 GHz link is also used for receiving the localization data calculated by the UAV on board SBC. The data can be visualized using Google Earth on the SAR vessel.

Fig. 2. Smart ZigBee tags placed in waterproof package

Fig. 3. Smart tags integrated in lifejackets pockets

Fig. 4. Interrogator PCB stack with GPS card

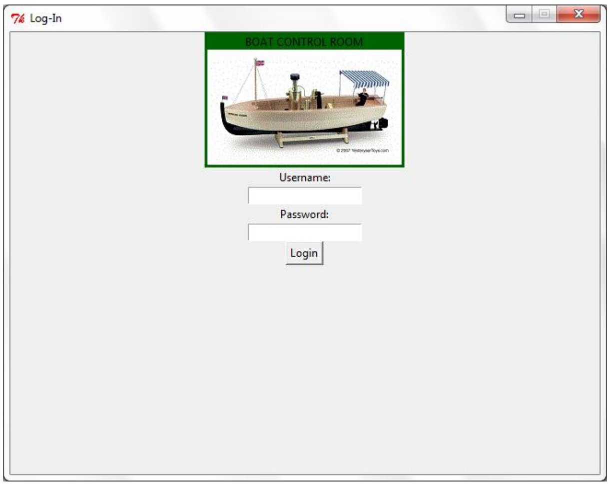
III. OVERBOARD SYSTEM OPERATION AND CALIBRATION

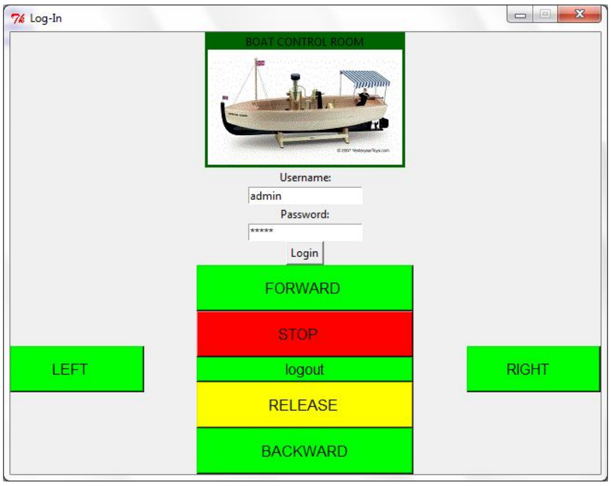
When the system is powered on, the SAR operator loads the mission to the UAV autopilot through the 5.8 GHz link. After launching, the interrogator scans for tags within its RF range as shown in Fig. 6. The data outputted from the interrogator to the on-board SBC is in the form of [TAGID, RSSI, UAV (Latitude, Longitude, Altitude)]. A real time localization application is developed to run on the on-board SBC. It creates an “n” RSSI samples container for each identified tag. The container when full keeps the strongest “n” RSSI samples and outputs a “.kml” file with all localizedtags. The“.kml” file is updated every scan cycle by the application, and it can be viewed on Google Earth Software, displaying a pin on the map with the tagID and its corresponding estimated latitude and longitude coordinates.

IV. SIMULATION AND MEASUREMENT RESULTS

It was found that the adopted flight search patterns are the parallel track search pattern and the expanding spiral search pattern. Simulations using different search patterns are done in order to verify the weighted LMS localization algorithm. After this ground measurement, another measurement was done in the sea where the system was installed on a search and rescue vessel. Ten tags were placed inside life jackets and thrown into seawater. All ten tags were localized within the designated search area. The localization results of the tags were constantly updated during the search mission, which helps track the tags if moved by the sea current.

V. SNAPSHOTS OF THE CONTROL ROOM WORKING





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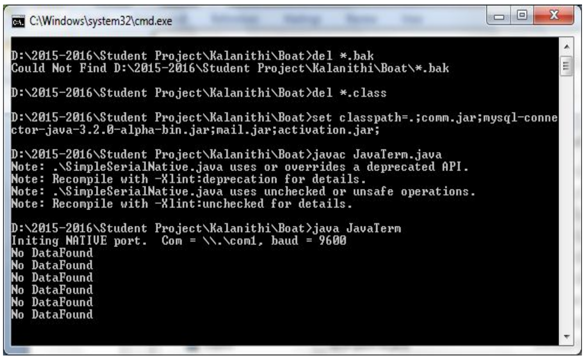

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Could Not Find D:\2015-2016\Student Project\Kalanithi\Boat\*.bak

D:\2015-2016\Student Project\Kalanithi\Boat>del *.class

D:\2015-2016\Student Project\Kalanithi\Boat>set classpath=.;comm.jar;mysql-conne
ctor-java-3.2.0-alpha-bin.jar;mail.jar;activation.jar;

D:\2015-2016\Student Project\Kalanithi\Boat>javac JavaTerm.java
Note: .\SimpleSerialNative.java uses or overrides a deprecated API.
Note: Recompile with -Xlint:deprecation for details.
Note: .\SimpleSerialNative.java uses unchecked or unsafe operations.
Note: Recompile with -Xlint:unchecked for details.

D:\2015-2016\Student Project\Kalanithi\Boat>java JavaTerm
Initing NATIVE port.  Com = \\.\com1, baud = 9600
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VI. CONCLUSION AND FUTUREWORK

In this work, an end-to-end overboard localization system was presented. System simulations that study the flight paths and the effect of noise on the localization accuracy showed that the parallel tracks search path when adopted gives lower localization errors. Measurements were done and compared to other RSSI localization methods, and it was shown that the weighted LMS algorithm used here gives a better FOMof20.95 dB. Future work will include large-scale measurements and system evaluation with 200 smart life jacket tags.

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