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Smoke Detection Alarm System in a Ship Using New Technologies and LoRa Wireless Communication Protocol

P.Vlaxospyros
Dept. of Industrial Design and Production Engineering
University of West Attica
Athens, Greece

D. Piromalis
Dept. of Shipping Trade & Transport
University of Aegean
Greece

M.Papoutsidakis
Dept. of Industrial Design and Production Engineering
University of West Attica
Athens, Greece
mipapou@uniwa.gr

***Abstract*— The rapid development of technology in the field of sensors and data transmission is also being immediately applied in the shipping industry, where companies are seeing the deployment of increasingly sophisticated parametric surveillance and security systems. New technologies are trying to "move" from wired transmission to the new age of wireless. It is desirable to gather information on the bridge in real time so that the respective officer and captain have a real and timely view of the status of the vessel in order to make the necessary decisions. The issue of early warning applies not only to ships in power but also to those in repair. Especially in this case, the first thing that happens is that the ship is manned with less staff which also means less surveillance on board, and secondly because of the various operations taking place inside it increases the risk of fire. In this work an inexpensive and reliable security system will be implemented and presented in which open source technology will collect the smoke sensor data and be sent to the receiver immediately and in real time which will control the alarm, in addition to being equipped with the ARDUINO GSM Shield 2 board which will also send a message from the operator to the competent authorities for assistance. Finally, the results of the implementation of the system on board will be presented as well as observations - conclusions.**

Keywords— Smoke sensor; ARDUINO; GSM Shield; LoRa; LoRaWAN

I. INTRODUCTION (*Heading 1*)

Alarm systems are an important part of our daily lives as they ensure the safety and integrity of an installation. Companies spend resources on being reliable and efficient. Alarm systems have the ability to detect movement, fire, smoke and anything else that is desirable and feasible. The term installation also means a ship and this is an industrial installation on which various machinery such as generators, pumps, etc. are installed, so there is a risk of fire resulting from either human error or mechanical failure. It is therefore imperative that there is an alarm system installed on board which alerts and alerts those responsible. The problem is that especially on older ships, either the alarm system is old enough and often fails or is missing. In the present thesis a cheap but reliable and effective smoke detection system will be built and installed on a small ship. This will be accomplished using open source technology in particular with the ARDUINO board, the Innoesys LoRa shield to achieve the wireless link, an ARDUINO GSM Shield 2 for alerting the sender via SMS text message as well as a number of detectors. Specifically the final product will consist of two parts. A receiver circuit that will be connected to the siren and the ARDUINO GSM Shield 2 as well as a transmitter circuit that will be wirelessly connected to the smoke detectors (ionisation detectors). The link between the transmitter and receiver will be wireless, and will be implemented by the LoRa technology using the corresponding shields.

II. BRIEF DESCRIPTION OF LORAWAN TECHNOLOGY AND THE LORAWAN PROTOCOL

LoRa technology was developed by Cycleo of Grenoble, France, and acquired by Semtech in 2012; the acronym stands for Long Range; the frequencies used are 433 MHz (ASIA), 868 MHz (EU) and 915 MHz (USA) freely available without license. LoRa technology consists of:

a) on the physical layer of the LoRa protocol

b) and at the Network layer from the LoRaWAN protocol.

To date wireless systems have used FSK modulation, LoRa protocol uses Chirp Spread Spectrum (CSS) modulation technology. This configuration was used in military and space applications so LoRa is the 1st low cost commercial application. Using the CSS configuration maintains the low-power feature as in the FSK configuration the spreading distance increases sharply. In addition to high propagation distances it exhibits resistance to interference (eg multipath effect). LoRaWAN is an LPWAN network protocol based on LoRa technology.

It defines the communication protocol and network architecture. It manages the communication frequencies, and the data transmission rate. It is designed to connect terminals to the Internet. A LoRaWAN network consists of:

a) End-Device: is a low-power device connected to various sensors and communicates with Gateway using LoRa.

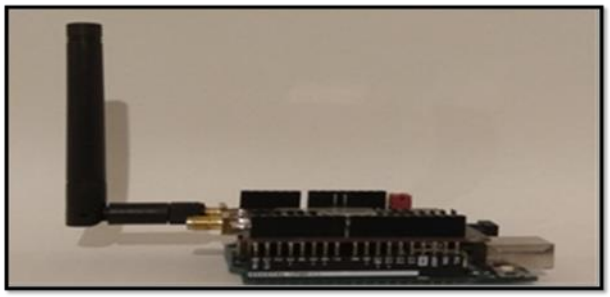

Fig. 1. *End-Device*

b) Gateway (LoRa Gateway): are intermediate devices that forward packets originating from the terminal devices to a Server. There may be multiple gateways to developing a LoRa system, where the same data packet can be received (and forwarded) from more than one gateway.

Fig. 2. *LoRa Gateway*

c) Server: is responsible for decoding the packets sent by the devices and for generating the packets sent back to the devices (in the case of two-way communication).

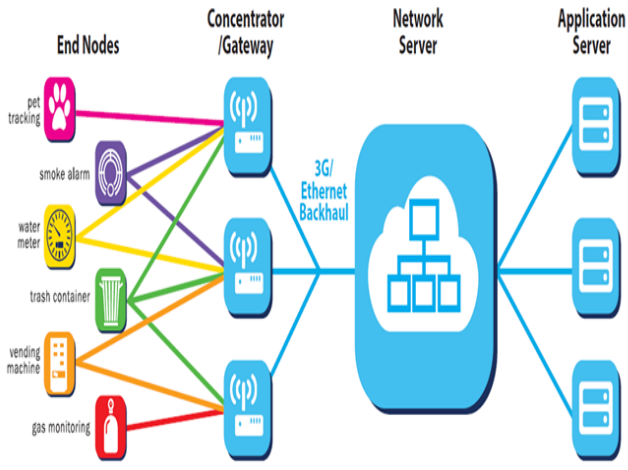

Fig. 3. *LoRa technology based network*

III. SYSTEM OPERATION

A. TRANSMISSION CIRCUIT

The transmitter circuit consists of Innoesys LoRa Shield mounted on the ARDUINO as well as the smoke detection sensor. The red LED is used as a communication indicator. When the program is loaded on the transmitter circuit, the smoke's sensor data is read. It follows that according to the logic of the program it is examined whether the values read by the sensor are greater or less than the threshold set therein and the corresponding letter is transmitted ('A': no smoke, 'B' no smoke) until one situation replaces the other.

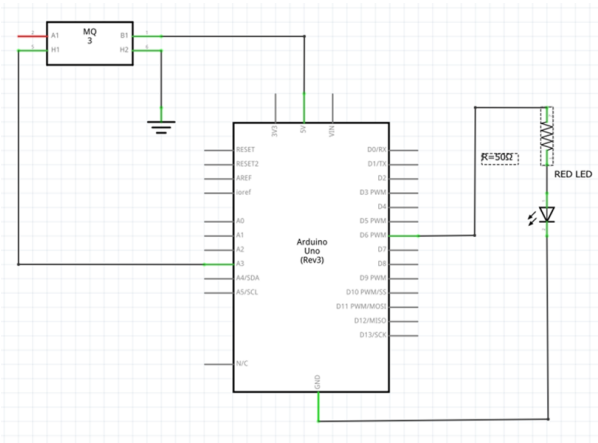

Fig. 4. *Transmission Circuit*

B. RECEIVER CIRCUIT

The receiver circuit consists of Innoesys LoRa Shield and ARDUINO GSM Shield 2 mounted on the ARDUINO in addition to the siren (BUZZER), hazard lights (red LED), safe mode (blue LED). and start - end message (yellow LED), and with a button (BUTTON). The green LED is used as a communication indicator. Starting the program is loaded into the receiver circuit and activates the continuous download of data from the transmitter. The receiver program receives the data (namely the letters 'A' or 'B'). As long as the letter "B" is received, the blue LED remains on and the siren is off. If it receives the letter 'A' and for as long as it is received, the siren (BUZZER) is switched on, the blue LED goes off and the red LED indicates smoke. In addition, after a confirmed smoke can also be sent SMS.

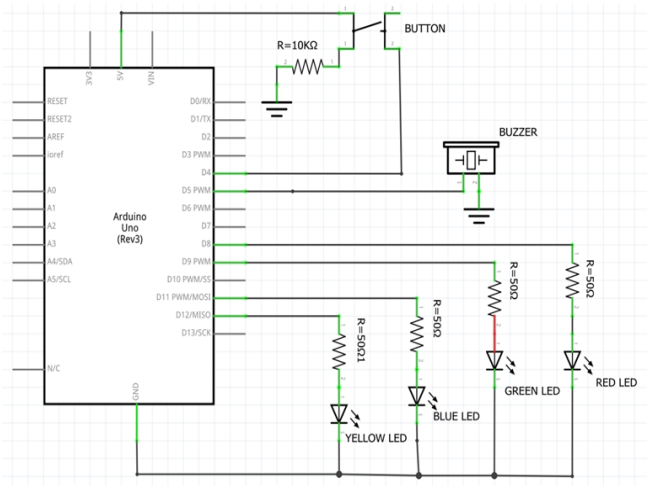

Fig. 5. *Receiver Circuit*

IV. CONCLUSIONS

In this thesis, after investigating and selecting the most appropriate and cost-effective development tools, as well as taking into account the environmental requirements of a small warship, the design, construction, implementation and operation of a development-based smoke detection alarm system were described. The cost of the alarm was low compared to similar alarm systems from companies. From the tests performed the system worked without the presence of any error. The use of LoRa technology to transmit data from the transmitter to the receiver and to this particular application has proven to be more effective than other technologies such as Wi-Fi and Bluetooth. The low cost of deployment and maintenance of the alarm coupled with the immediate response of the system makes it a reliable solution for the case of a small warship.

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