A Security and Surveillance Application of the Innovative Monitoring Underwater Buoy Systems (MUnBuS) on the Protected Marine Area (AMP) of Capo Gallo (PA-IT).

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Abstract— **The proposed low cost systems shows the results obtained in the implementation and testing on real security application to Protected Marine Area surface and submarine environment of a innovative Monitoring Underwater Buoy Systems (MUnBuS) for installation with IR-CCTV-Cam, ultrasonic dolphin warning system and Green Laser Perimeter Detection. This concerning innovative Monitoring Underwater Buoy Systems that can be remotely controlled from the ground, air, satellite and sea and from a Center of Supervision Telecontroller And Data Acquisition and Monitoring (Mobile-STADAM Center).**

The Buoy is hosts for the radio or satellite communication equipment, the downloading and telemetering data equipment and the photovoltaic power supply, board and underwater instrumentation. The underwater spheres, that is rendered in negative trim, is anchored on the seafloor that must be investigated and is equipped with submarine monitoring equipment and infrared CCTV cameras where the detect data and the image result are linked with the surface buoy through an ethernet cable to fiber optical. The STADAM Centre retransmit all data received in steaming online to the land or other analysis center. This complete system can be solved the typical logistic and technical AMP problems type: remote surveillance, ultrasonic dolphin warning system, and Laser Intrusion Perimeter Detection. The system is also applicable on lakes, river and ports monitoring, organic fish problems and biological submarine research. The underwater acoustics spheres with the environmental monitoring can also be useful with particular attention to submarine climate change impact indicators, surveillance of marine archaeological sites.

Keywords : Monitoring Buoy.

I. INTRODUCTION.

The Monitoring Underwater Buoy Systems (MUnBuS), also to function as a buoy monitoring and telemetry may analyze data from the bottom of the sea, lakes, rivers, dams simultaneously. The instrumentation used in the tests carried out have been used of the triaxial acceleration sensors coupled inclinometer triaxial sensors for the surface buoy. As for the underwater spheres was used a CCTV camera with lighting in the infrared spectrum, a ultrasonic dolphin warning, and Green Laser Perimeter Detection. As for the underwater buoy was used a camera with lighting in the infrared spectrum The umbilical cord has been fitted with a steel cable with a cable of electric power and an optical fiber for ethernet data communication.

The proposed buoy with the underwater spheres, can be seen in the figure 1 in 3D simulation, is a designed low cost prototype that maintaining communications with Centre of SupervisionTelecontroller And Data Acquisition and Monitoring (Mobile-STADAM Centre).

The complete systems is easily transportable with road transport and can be quickly arranged by the rivers of water such as lakes, rivers, canals, but also to be able to installed in marine environments with adverse weather and sea conditions for monitoring and supervision of: coastal and lacustrine environment, monitoring lakes, organic fish - marine, hydrography, geology / geophysics, oceanography, underwater acoustics mapping and environmental monitoring (Fig.2).

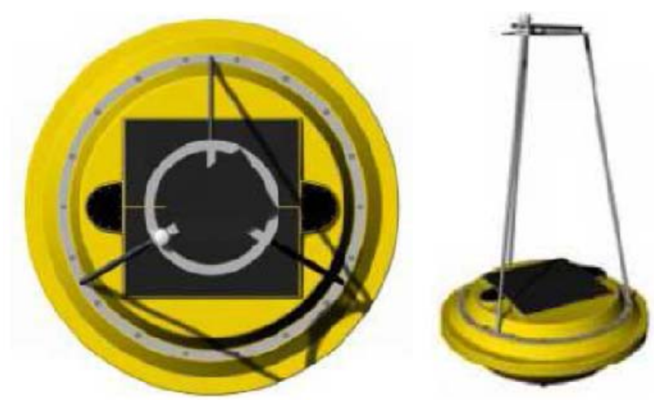

Fig. 1. The proposed buoy with the underwater spheres

The buoy proposed in this paper is an evolution of an existing buoy assembled at Palermo University. The principal novelty of this buoy is the possibility to record and transmit images and video. These activities can be done both above and under water.

II. CASE STUDY

The proposed buoy system is suitable either for shallow water or lagoons areas or no sheltered deeper sea sites. It has been designed by integrating several subsystem [1-4] developed for other tasks at Palermo University. It will be tested in a Protected Marine Area in the north west part of Sicily. The buoy proposed in this paper is an evolution of an existing buoy assembled at Palermo University. The main innovation of this buoy is related to the possibility to acquire and transmit images.

This buoy has important advantages and features, as:

- On line aerial data transmission (telephone line)
- Easy assembling and installation
- Low cost

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- Solar panels maintenance free for the power supply.

The heart of the system consists of a RISC microcontroller Microchip PIC 18F2620 with an internal crystal oscillator with a clock frequency of 40MHz that allows programs to run at a speed of no less than 10 MIPS. The microcontroller supervises all the operations required for operating the device data acquisition, in the monitoring and remote management.

The digital multiplexer allows you to share serial port of the PIC module with the Telit GSM / GPRS / GPS and with the removable mass storage, managed by the micro SD card reader, which is carried on the back-up your data.A suitable network allows to adapt the logic levels of the PIC to those of the Telit module and the reader µDrive.

The figure 2 shows the general architecture of the system.

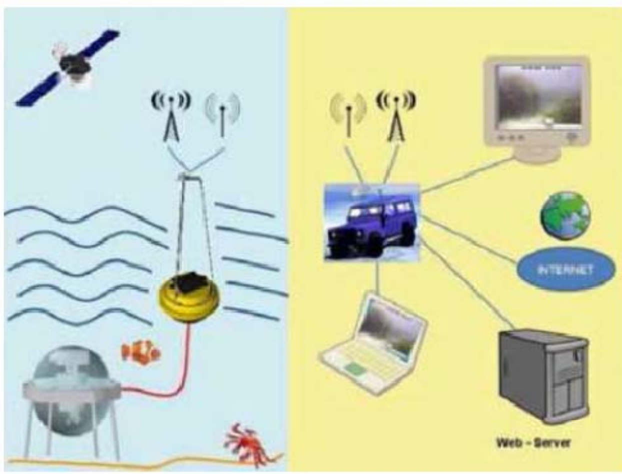

Fig. 2. General architecture of the system.

The figure 3 shows the block diagram of the geo-referenced acquisition and transmission dates mounted inside the buoy.

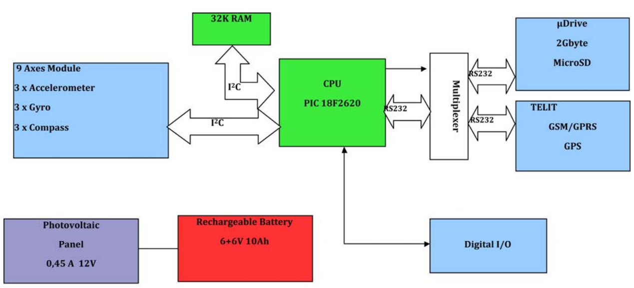

Fig. 3. Geo-referenced system

The main sensor is represented by a tab SMD assembling on board a triaxial accelerometer, a triaxial gyroscope and a compass triaxial; connection to the microcomputer is bidirectional I2C. The resolution of the sensors of the module to 9 axes is as follows:

- Compass 12-bit
- Accelerometer 13-bit
- Gyroscope 16-bit

For a total of 41 bits each of the axes (X, Y, Z) will therefore have 123 bits for each sample (16 8-bit byte). Using the maximum possible speed sampling is possible to have an acquisition every 0.1 sec. To manage this flow of information is required to adopt a compression technique.

The digital inputs mounted are contacts On / Off to inform the system of any openings or openings of the buoy;

Taking advantage of the multi-channel ADC converter of the microcontroller can monitor the charge level of the battery, the voltage supplied by the solar panel and the charging current of the battery. Data is stored on a microSD card with a maximum capacity of 2Gigabyte allowed by the card reader (µDrive) [10]. Considering that the data can be stored using a compression algorithm such as that described later, it is possible to estimate a back-up of over 5 months of data.The Telit module with phone SIM card, manages the connection to the telephone network GSM / GPRS network and then to the Internet Web. On board the same module is also mounted a GPS receiver to 12 satellites[11].

The GPS module also allows you to capture the exact values of date and time, eliminating the need to mount on a board RTC (Real Time Clock) for the timing of activities related to the operation of the module;

The 32K RAM with I2C output is expected to function as a buffer to store the sampled data prior to compression, storing them on the microSD card and the final submission to the Internet Server. Only after the ackowledgement receiving valid data sent in response from the remote server RAM will be erased and rewritten.

A backup battery and a solar panel to complete the system for what concerns the power of the module. Alternatively, they can be studied Power Systems-pack high capacity batteries to be mounted outside of the buoy for easy replacement. The module is powered by a switching regulator that provides 4.2V voltage necessary for the proper functioning of the Telit module and the remaining devices[12].

A careful analysis of the running times of various devices and run-time management program ensures that you can easily sampled 10 times per second for the 9 parameters from the acceleration sensor (3 for accelerations, 3 for position and 3 for gyroscopic the magnetic field), compress them within the static RAM 32K and generate data packets that will be sent to the remote server using the Telit module[1-3]. The machine time remaining is more than sufficient to ensure also the other auxiliary services such as the position control, alarm management and control of the voltages.

As mentioned above, the acquired data are sent via the GSM / GPRS module directly to an Internet server through a PHP script residing on the server. With the POST method sends the entire compressed package. The PHP code will unpack the received data and insert them into a MySQL database. An HTML page, to which access will be password protected, it will allow for consultation or downloading on the part of authorized users.[4]

III. Acquisition Data System

Given the inertia of the system, the acquired data should vary relatively slowly, so it is conceivable that the difference between a sample value and the next is quite small. Determined the maximum variation for each type of data, it is possible to adopt a compression system simple, effective and which requires few resources of calculation by the CPU.

A data packet can be formed by the 9 initial values of the relative sensors (123 bit) followed by 4/5/6 ... bits per channel that indicate the change compared to the previous value.

For example, suppose for a minute of uncompressed samples are needed 73800 bits or 9225 bytes. The following table shows the possible compression with different resolutions.[6].

Data of system				
Max Range	***Coding Bit***	***Bit area***	***Approssimative byte area***	***Compression percentage***
±8 (-8 .. +7)	4 bit	21687 bit	2711	29,38%
±16 (-16 .. +15)	5 bit	27078 bit	3385	36,69%
±32 (-32 .. +31)	6 bit	32469 bit	4059	43,99%
±64 (-64 .. +63)	7 bit	37860 bit	4733	51,30%
±128 (-128 .. +127)	8 bit	43251 bit	5407	58,60%
-	No encryption	73800 bit	9225	0,00%

The number of bits required can be determined experimentally by analyzing a data stream is not compressed. A reduction of the amount of data means more space available in the memory for the data, smaller packets and less transmission time thus saving energy stored in batteries

TABLE I VALUES CALCULATED FOR A MINUTE SAMPLING.

IV. SYSTEM

In addition to the simple task of acquisition, storage and transmission of data, the system is also able able to ensure the following functions:

- Automatic reset due to errors or unexpected random block system (watchdog function);
- Restore the system configuration (time, location, historical data acquired) after reset (using scratchpad RAM);
- Check the connection of GSM and GPS data before sending;
- Check validity of data from the mean value of previous data;
- Control successful reception of the data (acknowledgment) from the remote system;
- Immediate notice of tampering or opening of the buoy;
- Immediate notice of the emergency situation in case the buoy moves significantly from the point of installation;
- Low battery alert;
- Contract failure of the solar panel;
- Setting up a remote time of sending data;
- Setting the remote execution of some basic parameters.
- Recording of images (both above and under water)
- Transmitting images

These functions are carried out directly by the software resident on board. Other alarm functions or management of particular events may be entrusted to the Internet[8] Server such as sending specific alerts in case the buoy does not transmit more for a certain period. Messages can be sent via email by the system itself or from the Internet Server and, if necessary, for critical alarms can be sent a text message to a predefined number.

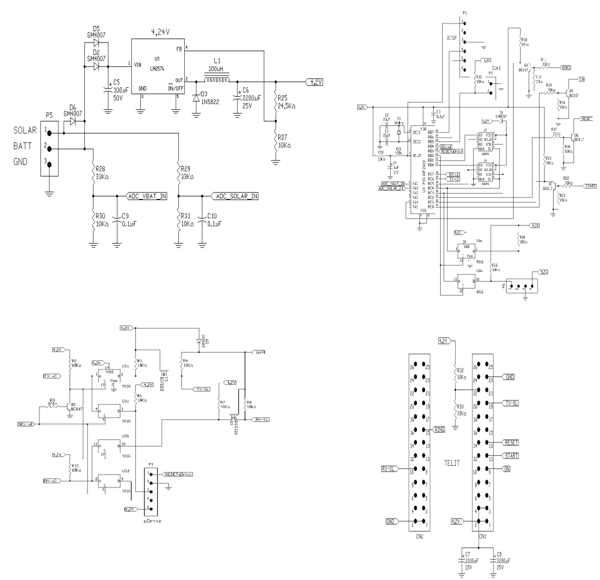

Fig. 4. Electric schemes of thecomponents

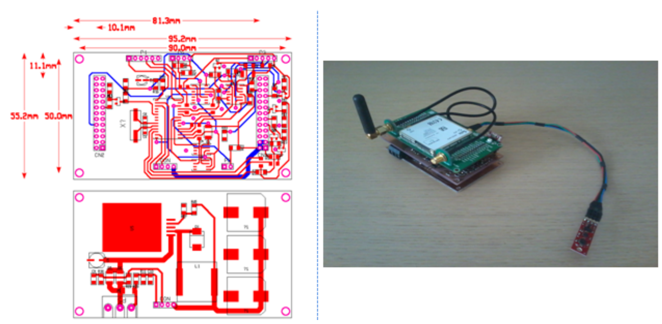

Fig. 5. PCB (Printed Circuit Board) and Module with sensor board

VII. CONCLUSIONS

In this paper we present the result of an experimental weather buoy built by DEIM of University of Palermo, that is characterized by small cost and big versatility. This buoy is able to measure water column parameter and to transmit data to a remote center continuously. Maintanance costs are low.

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