NASA SPACE APPS CHALLENGE

ROSARIO - ARGENTINA

Smart Beach

Smart Beach is an integral system that, by using different devices and processes, obtains information in order to warn and advise the users about the many dangers of the beaches in real time, facilitate the monitoring of them and gather free-access information for future investigations.

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Map of the problematique

1.0 Accidentes

One of the main worries when it's time to get into the sea is the chance of getting dragged by the movement of the water, for example the case of rip currents. People who partake in different sports at sea find themselves also at a constant risk, as it's possible that their equipments gets broken, or exposing their bodies to any sort of damage that could be caused by the adverse currents, from getting hit by rocks to getting too far away from the coast without the chance of calling for help or returning to the beach.

1.1 Fauna & flora

In most of the beaches of the world there are a series of animal and vegetal species which can put at risk the life of the citizens at sea. One of the better known examples are sharks, which according to the latest annual register, caused 104 attacks, of which 6 were mortal cases.

The current solution to this problem only works partially, because the system of nets (implemented in Australia, for example) negatively affects the sealife, and also its confection doesn't stop the pass of every danger.

1.2 Weather

Another determining fact on the matter of security of people who are on the beach is the weather and other meteorological elements. Electric storms are the main condition to take in count, because they constitute one of the greatest risks on this places.

1.3 UV Radiation

The effects of intense exposure to the sun beams on the human health are well-known. It is really important keep in mind when there's more and less UV radiation of types *a* and *b* for its prevention even before arriving on the beach.

The most extreme consequence of a long exposure to the sun beams is skin cancer, but it can cause severe burns, spots on the skin and eye damage, too.

1.4 Lack of information

A great part of the accidents that happen at sea are caused by irresponsible behaviours of those who aren't appropriately informed about beach security. It is therefore necessary for the people that visit this places to know the local norms and signs, how to avoid risky situations and what to do in cases of emergency.

Development of the system

Multifunction Sea Sonar Buoy (B.S.M.M.) (Figures 1 and 2)

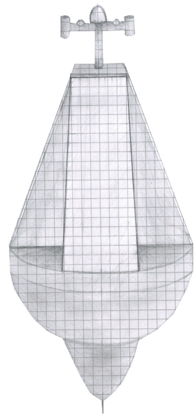

fig 1

2.0 Buoy and SONAR

There is a network of interconnected buoys which are available from a SONAR probe that allows the detection of threats, for example sharks, whales or large debris. The measuring distance is designed to be up to one kilometer, with a width of 600 meters towards each side. The system is designed so that each buoy is 1 kilometer apart from each other, and around 500 meters away from the beach. These are interconnected by a radiofrequency system. Each buoy reports to the base station, where the bather is in charge of receiving and processing the data. Each one has a central processing unit that is responsible for receiving the sonar data and send it by RF, so it can be received by the base station.

In addition, it has the corresponding regulations, which includes a light, position indication, alarm light and emergency light. The color of it must be yellow for the visible sea.

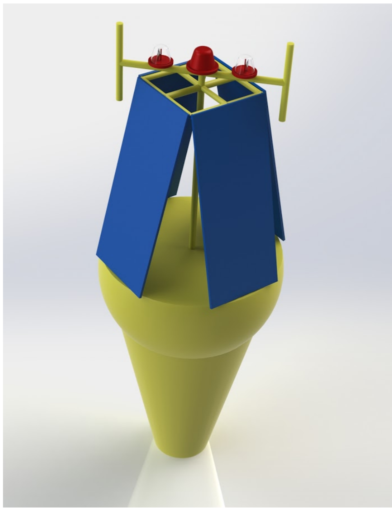

fig 2

Regulation of buoy:

Color: Yellow

Flashing Light: Any flashing except for reservations to Cardinals, Isolated Hazard or Safe Waters.

Material: Polyethylene

2.1 Energy

The buoy is exclusively powered by solar energy, having a reserve battery of about 12v / 180Ah, which would allow it to continue to operate continuously for a minimum of 24 hours in case of absence or weakness of solar energy, maintaining the totality of the functions active. After this period of time, it will enter into an energy saving mode in which the functions will be reduced.

Logically, this will have an integral control of energy that, in addition to being in charge of keeping the battery charged, manage the different modes of energy and give alert in case it is necessary a cleaning of the panels, will allow to have a record of the solar radiation over time, obtaining a measurement parameter without the need for additional hardware.

2.2 Tracker

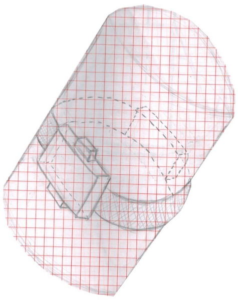

fig 3

Another great part of the system is composed of the bracelets (fig 3 and 4), which fulfill a double function:
They have an emergency system that allows the person who is at the sea to alert the bather in case something has happened to them, so that they can come to their rescue. For that, it has two buttons on opposite sides of the device that must be pressed simultaneously to send the alert. This is meant to prevent false triggers from it.The sent alert also includes the position of the bracelet with the use of a built in GPS. This system will connect to the satellites every 15 minutes to ensure that, in the event of an accident, it only takes less than a second to re-establish the connection and update the position. When someone activates the emergency system, not only the bather will be alerted, but the other people who are using the bracelet will receive a warning, both visual and by means of vibration. This allows the user who is using it to act in case of a near threat to him in the water whose reason is, for example, bad weather conditions, or in case the lifeguard has decided to alert the individuals for some other reason.
The bracelets are connected via LoRa, Long Range WiFi and low transmission rate. These send all the information to the nearest buoy, which from there will be retransmitted to the central station and interpreted by the same. The LoRa transmitter is about 330mW, which in open spaces can easily reach the 4km transmission distance, which ensures that the bracelets can be connected to the nearest buoy and control center.

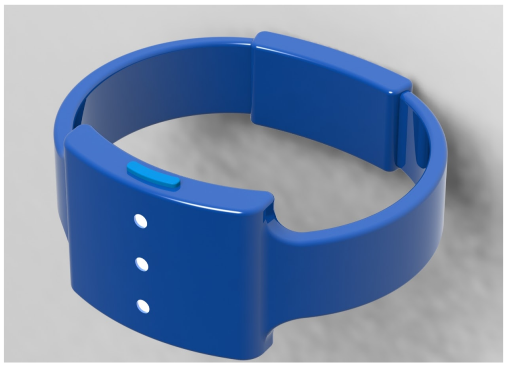

fig 4

We know the limitations when using radio frequencies greater than 1Mhz in salty water, because it almost completely attenuates the signal. To solve that it was thought that when activating the alert, the bracelet will transmit data continuously until receiving a signal of return or completely draining its battery. This ensures that at the moment when the affected person can remove his arm out of the water, the information will be sent. If this information can not be fully transmitted, the alert will also be activated and an attempt will be made to triangulate the position by using two buoys together with the control center to obtain an approximate position based on the power received. The battery used is of LiPo type of 110mAh, thus guaranteeing 30 minutes of continuous transmission of data, time that is more than enough to locate the affected individual.

2.3 Transmission

As for the control base, it will have the necessary communication systems to receive data from the wristbands and communicate in full duplex mode with the buoys. It also includes all the processing systems necessary to interpret all the information received and to alert the bather. It also contains a small meteorological station that is able to obtain data such as temperature, wind speed and direction, humidity in the environment, atmospheric pressure, etc.

2.4 UV sensor

This control base will also incorporate UV radiation sensors, which will constantly transmit information in real time about the intensity of the sun's rays.

3.0 Multiplatform Application

The system is complemented by the implementation of a cross-platform application for mobile devices or PCs. It combines weather information obtained by third parties (The Weather Channel, WindGuru local services, etc.), the information obtained with the local weather station and with notes and warnings of the lifeguard in charge. This could have different "access modes" according to the person who uses them (civilians, bathers, police, etc.).

It also aims to raise awareness among the population about beach safety, providing, for example, information on the time of day when it is advisable to be in repair of the incidence of the sun's rays, or the meanings of the flags that are found on the beaches.

Another of the proposals of the application is to create an active community where information and experiences are shared, in order to make society more knowledgeable about the situation in coastal areas.

3.1 Monitoring

The local data would be presented to the lifeguard in a local application that allows him to see the situation quickly so that, based on that, he can make decisions and give the corresponding alerts. Also the bather will have the possibility to select data to share in the mobile application, in order to communicate the conditions of the beach and the sea in real time.

3.2 Collection of data

All this information will not only have the function of being available to people in real time, but will also be stored in a database. This will allow the creation of records of the situation in coastal areas, which can be classified temporarily and regionally.

Future scientists will have access to this data, facilitating research processes.

This is one of the most valuable proposals of the Smart Beach system, since it allows knowledge to circulate, instead of referring only to immediate and practical use.

Exemplification of the case

In Guadalupe Island, located in the northwest of Mexico,peninsula of Baja California, there are two key times for the migrations of white sharks. During the months of July to December arrive from young sharks to the most adult shores on the peninsula, passing the beaches of this island. Given the situation, the buoy would have a period of greater operation during this time as it is when more people are found on the beach, while in the months that remain, would decrease its activity in the identification of these animals. Nevertheless, the SONAR would do the pan for one second each five seconds, no matter the season. By this way it will consume the fifth part of the nominal power.

Approximate cost analysis

Bracelet:
LoRa RFM95 transceiver module - 6.95USD (unit price)
LiPo Battery 110mAh - 1USD
GPS Module - 10USD
PCB + microcontroller - approx. 1.5USD
Vibration motor - 0.65USD
Housing - 1USD

Buoy:
Structure - To be determined
Solar Panels - 500USD
Battery - 100 USD
SONAR - 1500USD
Charging system - 50USD
RF Systems - 75USD

Base Station:
RF Systems - 75USD
Processing unit - 100USD
Weather station - 75USD

Total Costs:
Bracelet: 21.1USD
Buoy: 2250USD (without structure cost)
Central: 250USD
Total: 2521.1USD

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