M2 DESIGN AND DEVELOPMENT OF A COST-EFFECTIVE GEO-CAMERA

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Abstract
Determining velocity, size, situation and proximity to marine resources of oil or Hazardous and Noxious Substances (HNS) spills is very important. We have developed a camera with the capability of georeferencing[1] pictures. This prototype camera improves the accuracy of the taken data and reduces the amount of post processing time.

Keywords – oil spill management, GPS, GIS, Georeferencing pictures.

I. INTRODUCTION
ARCOPOLplus aims to reinforce maritime safety in the Atlantic area by improving the regional preparedness and response to oil or HNS spills at sea. ARCOPOLplus' activities have been conceived focussing on technology development and transfer, training and innovation. Innovative tracking, forecasting and decision support tools are being adapted to the needs of local and regional authorities that will be trained on their application.
In this context, a Geo-camera (Camera with the capability of georeferencing images) has been developed to be used in coast-guard helicopters. The overall objective is to obtain georeferenced zenithal pictures of oil or HNS spills for those marine pollution events caused by accidental and non-accidental spills. Georeferenced pictures can be loaded in Geographic Information Systems (GIS) and used to estimate the spills size as well as their velocity, situation and proximity to marine resources. Image georeferencing is done by saving in a file GPS data, the calculated real size and rotation of the upper left pixel. Additional parameters like altitude, field of view of the camera and resolution of image are used to calculate the data included in the file.
Hitherto, pictures are taken with a handheld camera and GPS and height data are requested to the helicopter pilot. The camera orientation is referenced to the vehicle compass and a bar placed in the floor of the helicopter. Later on, in the office, a technician uses custom software for georeferencing the pictures. Our objective when developing this prototype is to improve the accuracy of the data used to georeference the pictures and to reduce the amount of post processing time. The user of the prototype just has to press a button to take the picture and, without having to lean out of the vehicle, software calculates the data that will be stored in the SD card with the taken picture.
The initial requirements were that the prototype must have a display, a compass, an altimeter and a GPS, a bar of 2 meters where a camera, of a minimum resolution of 640x480 pixels, should be placed.

II. ELECTRONIC DESIGN
After some tests of several components, the final elements of the device are a mini-computer Beaglebone, 7" touchscreen, a GPS with integrated antenna, an IMU (Inertial Measurement Unit), a barometer and a 1.2Mp webcam. The barometer is used to calculate altitude [2] and it must be set up, each time the user starts the device, with the local barometric pressure. The IMU includes gyroscope, accelerometer and a compass. The gyroscope and the accelerometer are used to detect invalid camera angles. When the camera is beyond an angle defined by user, it will not be allowed to take a picture. Compass is needed to save the orientation of the picture.
The prototype is powered by a battery pack made with 20 AA rechargeable cells. This provides 15 hours of autonomy. Charging batteries at 12vdc is common, so we have designed a battery pack with this voltage configuration. Because the Beaglebone and the touchscreen are powered at 5Vdc a dc-dc converter has been added.

III. MECHANICAL DESIGN
The assembly of the elements to make the first test was performed using a 2-m long bar, but we realized that it was quite heavy and unwieldy. The bar was changed for a 1-m polyethylene tube. A telescopic bar could be good solution in some cases.
A Gimbal, or Cardan suspension system, was added for holding the camera and keep it as stable as possible. GPS, IMU and barometer are placed over the camera because GPS needs to be as close as possible to a window. The camera is placed at the bottom of a cylinder that has sand inside. This is done to improve the Gimbal effect against the electronics wires that go from the polyethylene bar to the cylinder in the Gimbal.

The prototype weight is 2.5Kg.

IV. SOFTWARE DESIGN
Beaglebone includes a Linux operating system called Angstrong by default. We replaced it by a free Linux Debian distribution and modified the default capabilities to reduce processor's load.
To develop the data management software that will run on Beaglebone, we used Python 2.7.3 and PySide for interface design. In this interface GPS data, altitude, compass, pitch, roll and images from webcam are displayed to the user. Altitude can be set manually or obtained from barometer.
The IMU includes an Arduino microcontroller that is programmed in C++ language and manages data reception from the gyroscope, accelerometer and compass and is programmed to send this data when Beaglebone sends an order to receive them.
Communication between the Arduino in the IMU and the Beaglebone is made by RS232 and also between GPS and Beaglebone. Between Barometer and Beaglebone is done by I2C protocol. The webcam is directly connected through USB.
The geo-data are written to a plain text file in the ESRI [3] world file format, then using the GDAL[4] library included in the software a Geotiff[4] file is written to the SD card. To download the data the user can connect an Ethernet cable or directly from the Sd card that stores the operative system and software. Wifi connection is intended to be the future way of downloading.

V. REFERENCES
[1] http://en.wikipedia.org/wiki/Georeference
[2] https://www.sparkfun.com/tutorials/253
[3] http://en.wikipedia.org/wiki/World_file#cite_note-1
[4] http://www.gdal.org/frmt_gtiff.html

ACKNOWLEDGEMENTS
This work has been developed in the framework of ARCOPOLplus, a project funded by Atlantic Area Transnational Programme.

1 View of the Geo-camera and the interface software.