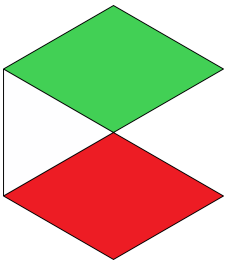
CubeTech Guide

Presented by

PoliTo CubeSat Team



Leva

1 Introduction

A spacecraft is a vehicle designed to operate in Outer Space carrying out various functions such as telecommunications, Earth observation, navigation, meteorology, science and human missions. Accordingly to the function, the spacecraft it's called satellite, probe, spaceship, or lander.
The CubeSat Team is a student team of Politecnico di Torino, founded in 2008, with the purpose of gain experience and competences in designing and building CubeSats.
A CubeSat is a nanosatellite with a defined standard size and form factor. The standard size is called "1U", it meausures 10x10x10 cms and its mass is up to 1.3 Kg. It's also possible create bigger satellite, as 2U, 3U and 6U, just combining more "one unit". They were conceived in California as a gateway to Space for universities, due to their inexpensiveness and reduced development time.
The CubeSat Team, after several projects and two 1U satellites launched in Space, it's currently developing a 3U satellite as a technological demonstration dedicated to Earth Observation. The 3U is equipped with a camera as a payload, to evaluate the phytoplankton concentration in the Ocean, because it's an important parameter and marker of Ocean ecosystem's health status.
To accomplish the task, it's required an high level of hardware and software on-board, in particular a precise camera's calibration and a feature detection algorithm, to correctly identify the area of interest. Analysing the mission, the complexity of the project can be focused mainly on two aspects: the assessment of the correct instant on which the photo needs to be captured and the feature detection algorithm.
Leva is a company founded in 2015 to develop, produce and set up extraordinary spatial installations, starting from the ideas of clients or creative agencies all around the world.
By the mission's designing and the desire to give an opportunity to space enthusiast students to test their problem solving skills, came out the idea of a dedicated challenge event. Thanks to the collaboration with Leva, the CubeSat Team organized an hackathon – CubeTech!
In the next chapters of this guide, there will be the rules and all the details about CubeTech.

2 The problem

To each group has been provided the following equipment:

- Raspberry pi zero 2W
- Raspberry pi camera module v2
- IMU adafruit LSM6DSOX + LIS3MDL 9 DOF
- Breadboard
- Jumpers
- Monitor

Keeping into account what has been said in the ”Introduction” section, it’s possible to simulate the space environment in which the spacecraft is supposed to operate using a set of permanent magnets to represent a simplified model of Earth’s magnetic field and a rotating platform as to imagine the satellite rotational movement.
In particular we ask you to to develop a system capable of completing the following tasks.

2.1 Basic problem

While the platform rotates, using the IMU you are required to correctly assess the moment in which the photo needs to be taken using only the magnetic field value. Through a segmentation algorithm you are then required to correctly estimate the distance between the center of the picture and the center of the image providing an estimation of the value in pixels. Note that the image of which you need to calculate the center isn’t centered in the page.

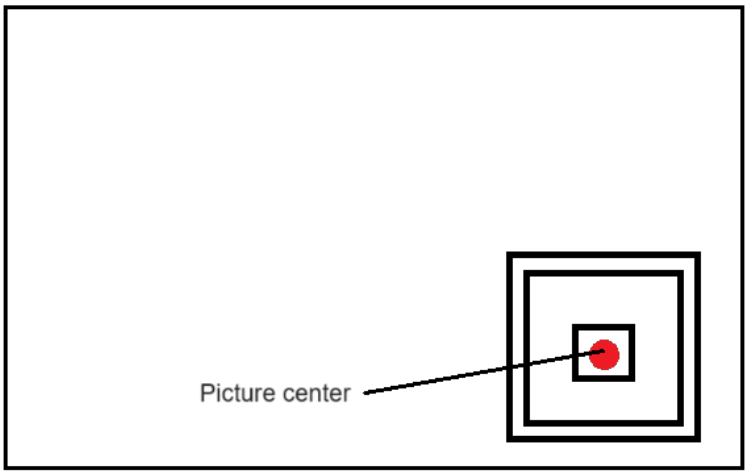


Figure 1: Possible image location

As such the distance should be calculated as it follows.

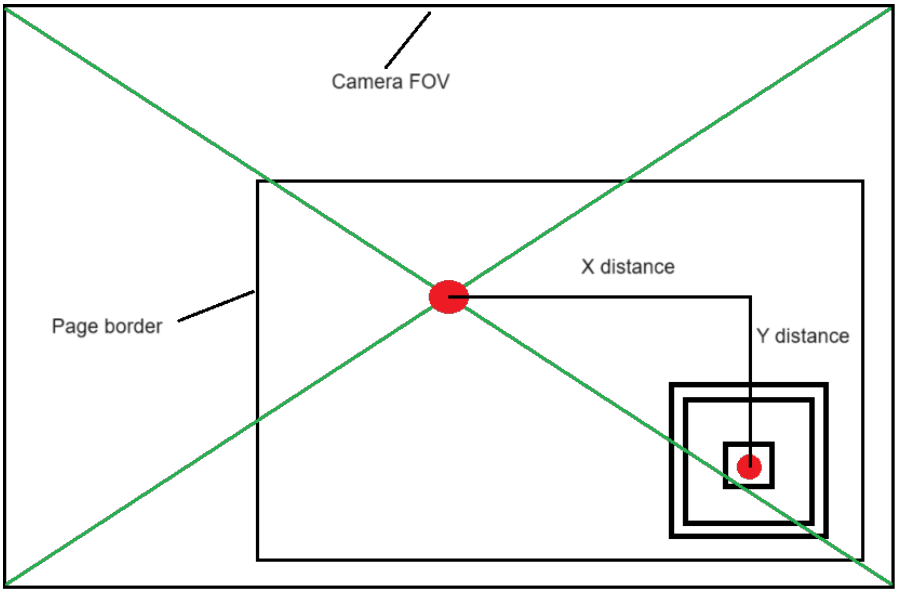


Figure 2: Possible image location

In particular the centering of the image is required to be given using the following formula:

$$\frac{\sqrt{(|X_{distance} - 1640|)^2 + (|Y_{distance} - 1232|)^2}}{3280}$$

The points will be given using the following parameters:

- Time taken
- Energetic Consumption
- Code evaluation (this will be done at the end of the event)
- Image centering

2.2 Advanced problem

The identification of what the camera is looking at can represent one of the major tasks for the payload development. Given so, we have provided you with a database of images representing paintings which can be downloaded using the following QR.

As in the basic problem you will face the task of capturing a photo of the objective, in this, however, you'll have to identify which picture you are looking at.
The image can depict both a part of a painting or full one representing a scenario.
As before there are several parameters that will allow to define your points:

- Number of images identified
- Method of identification
- Time to identify
- Energy consumption

3 Development

The development of your software will be done in your own workspace where you will have access to everything you need to complete the tasks.

Having troubles in solving a problem? Feel free to ask the Leva technicians, note that for each question asked there will be a slight penalty in your scoring, in particular you'll lose 2 points each question.

4 Testing

While the development of your software will be carried out in your own workspace, the testing will be done in the laboratory at the first floor. Here we will test how your product performs and it will be possible to determine your score.
You are free to test as many times as you want and also not to register a score if it doesn't satisfy you. Nevertheless each team will have be evaluated one time on Friday, two times on Saturday and one time on Sunday, both for Basic and Advanced problem, so 8 assessment in total. Pay attention it's not mandatory to get 8 evaluation, but if you skip one of them, you will lose possibility to get points.

5 Final presentation

The last day it will be required to provide a final presentation of the work done, explaining what solution you implemented and the reasons behind your choices.
Please note that the presentation will allow you to obtain extra points for the final rush towards victory so don't underestimate it! In particular it'll be evaluated the exposition, the form and content of the final presentation.

6 Hardware preparation

You need first of all to flash an OS on the micro-SD for the raspberry pi. You can easily find the software to do so online. Pay attention to the wifi options as you can add the Leva's wifi with the following credentials:

- Wifi name: Leva Guest
- Wifi password: blueberry o blueberries (ask the CubeSat Team members)

Since some of you may not have familiarity with this type of hardware we left a quick guide to interface the IMU with the raspberry pi zero.

- Increase swap on raspberry pi using the following link

- Install blinka

- Here you can find the code to operate the IMU

For further information don’t hesitate to ask the staff at the event.

GOOD LUCK!!