



euRathlon 2015 Challenge

Combined Datasets

Aerial domain



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Version 1.0



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1. List of acronyms

AR Augmented Reality

LIDAR Laser Imaging Detection and Ranging

ROS Robotic Operative System

UAV Unmanned Aerial Vehicle

UGV Unmanned Ground Vehicle

2. Introduction

euRathlon project aims at promoting the development of multi-domain robotic systems for outdoor environments within the European robotics community. To achieve this goal, each of the three years of the project a robotic competition and workshop will be organized.

In order to allow the teams to test their systems before participating in the competitions, they will be provided with datasets. These datasets are created from real data collected with real systems in real field experiments. The experiments are designed to be similar to a certain point to the scenarios that will have to be faced during the competition.

To have datasets with real data that can be used to test and improve the robotic systems will also contribute to motivate multi-domain robotic teams to participate in the competitions.

3. Description of the datasets.

3.1. Aerial domain.

Dataset for indoor tasks

This data set was collected using a Hokuyo UTM-30LX LIDAR on-board an AscTec Pelican quadrotor (see Figure 1). The flight was conducted in the indoor flying arena of the Center for Advanced Aerospace Technologies (CATEC) (<http://www.catec.aero>) where a set of PVC pipes was located for inspection and mapping (as can be seen in Figure 2). A motion capture system by Vicon is used in the flying arena for indoor positioning. The data set contains two different types of data:

- LIDAR data collected by the Hokuyo device. For this data the LaserScan type, which is already built-in in ROS, has been used.
- Quadrotor navigation data including position and attitude collected by the Vicon system. Vicon system provides position and attitude estimation with sub-centimeter and miliradian accuracies respectively. For this data custom types defined by CATEC have been used which are described below.

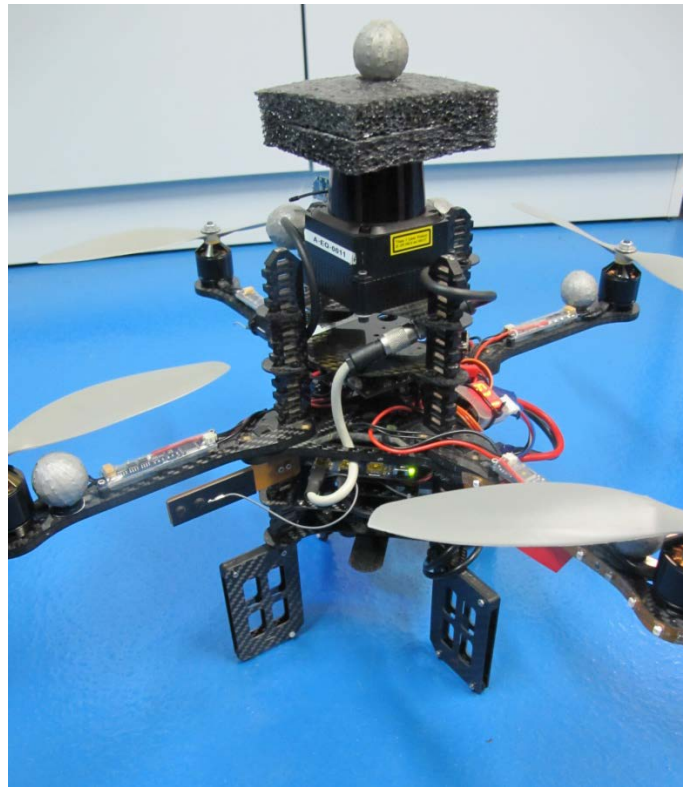


Figure 1. AscTec Pelican quadrotor used for the flight. (Photo: CATEC)



Figure 2. Pipes scenario set in CATEC's flying arena. (Photo: CATEC)

The main data type used for logging the quadrotor navigation data is called `DynamicState` and contains three data whose types are also defined by CATEC:

- `PositionWithCheck`.
 - `Float64 x;` // Position x coordinate
 - `Float64 y;` // Position y coordinate
 - `Float64 z;` // Position z coordinate
 - `UInt8 valid;` // Indicator of valid data

- `OrientationWithCheck`.
 - `Float64 x;` // Roll
 - `Float64 y;` // Pitch
 - `Float64 z;` // Yaw
 - `UInt8 valid;` // Indicator of valid data

- `VelocityWithCheck`. This data is not needed for LIDAR mapping algorithms and can be ignored.

There are two other data types which are `UALState` and `UALStateStamped` which are also included in the ROS bag file but do not need to be used. These data type provide some information about the state of the quadrotor such as the battery state, memory and CPU usage and flying state. The `.msg` files that define all these custom data types are also provided so the `rosmake` command can be used to automatically generate header files with the definitions of the classes for these data types for using them in C++ code. In order to analyze the data contained in the ROS bag file the command `rosbag info filename.bag` can be run.

It is important to know that the LIDAR is located 0.125 meters above the center of gravity of the quadrotor. The quadrotor reference frame that has been used has the “x” axis pointing to the quadrotor nose, the “y” axis is on the left arm and the z axis points upwards. The flying arena reference frame is shown in the upper-right corner of Figure 3. The “x” axis points forward, the “y” axis points to the left and finally the “z” axis points upwards. The

take off point of the quadrotor in the arena frame was located at $[-5, 3, 0.16]$ and the quadrotor reference frame was initially oriented to match the arena frame (so the initial attitude is close to $[0, 0, 0]$).

To illustrate what can be done with the data set Figure 3 shows a representation in rviz of the LIDAR point cloud and the quadrotor. This is just a screenshot of a simulation in which the quadrotor moves according to the position and attitude data from the ROS bag and the LIDAR points that are been acquired are represented.

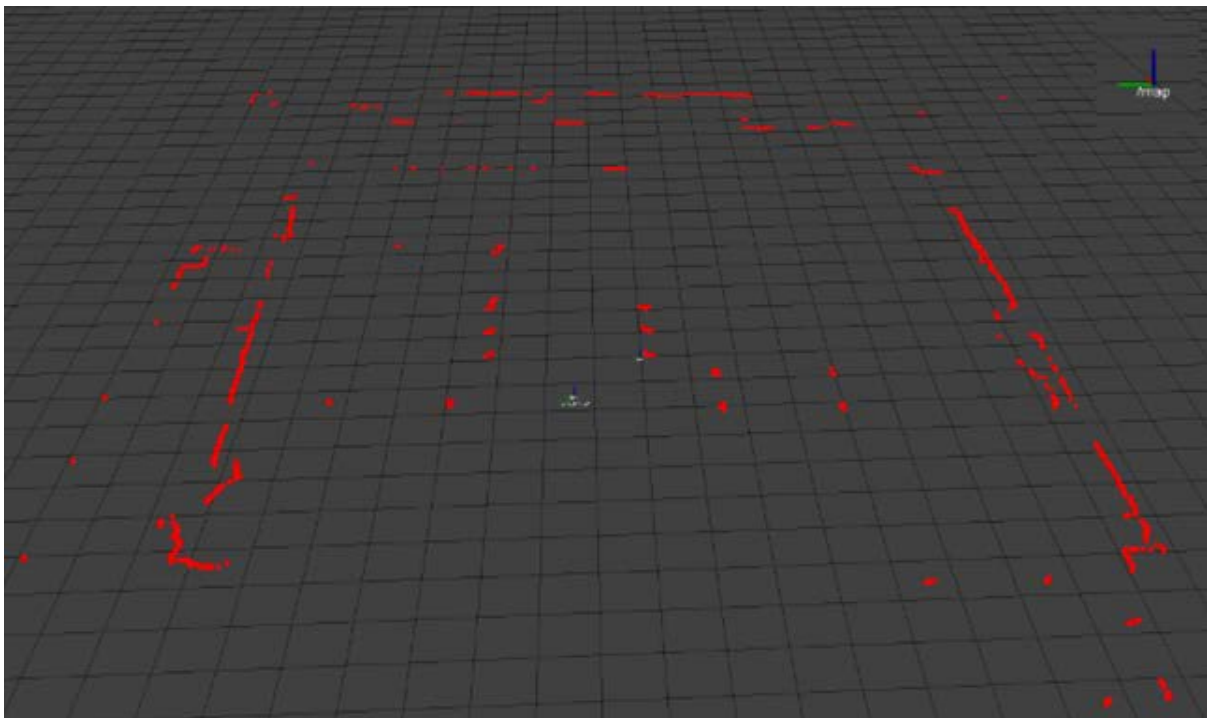


Figure 3. Screenshot of a simulation with the raw LIDAR data represented in rviz. (Source: CATEC)

Download indoor task dataset:

<http://eurathlon.ecmanaged.com/public.php?service=files&t=dd11a6ce172bd6db2c70f329416318a7>

Dataset for outdoor tasks

This data set was collected using a visual camera on-board a SARAH unmanned helicopter manufactured by Flying Cam (shown in Figure 4). It has a payload capacity of 8 kg and uses an electrical engine.



Figure 4. SARAH unmanned helicopters used for the flights. (Photo: CATEC)

A Canon S110 was used for collecting the pictures.

(http://www.canon.co.uk/For_Home/Product_Finder/Cameras/Digital_Camera/PowerShot/PowerShot_S110/). It is a compact camera with a resolution of 12 MP (maximum resolution of 4000 x 3000 pixels) and an optical zoom with focal distance between 5.2 mm and 26 mm. It includes an optical image stabilization system which mitigates the effect of aircraft vibrations on the acquired images. Image acquisition was remotely controlled from the ground using software developed by CATEC. The system acquires two images per second at the maximum resolution and stores them in a class 10 UHS-1 SDHC card.

Two flights were conducted at 100 meters and 40 meters above ground level around a rural runway located in Seville (Spain). Four card boxes with a numerical label (shown in Figure 5) and two Pioneer UGVs with augmented reality markers on top (shown in Figure 6) were set around the flight area. In order to identify those elements, each of them has been given a

name as shown in Figure 8. The coordinates of each element (measured using an RTK GPS receiver) are:

- Box 1: latitude 37.195435°, longitude -5.880361°.
- Box 2: latitude 37.1955175°, longitude -5.8804755°.
- Box 3: latitude 37.1957475°, longitude -5.880585°.
- Box 4: latitude 37.1957983°, longitude -5.8803894°.
- UGV 1: latitude 37.195554°, longitude -5.880335°.
- UGV 2: latitude 37.195691°, longitude -5.8803916°.



Figure 5. Card box with numerical label. (Photo: CATEC)



Figure 6. Pioneer UGV with augmented reality marker. (Photo: CATEC)

The dataset is compound of two sets of images (one per each flight):

- High-altitude flight (100 meters): 81 sequential images.
- Low-altitude flight (40 meters): 61 sequential images.

The main purpose of this dataset is to provide the community with real images taken during real flights that can be used for testing artificial vision algorithms (detection of card boxes and UGVs, reading the numbers of red labels, estimation of the distances between elements, etc).

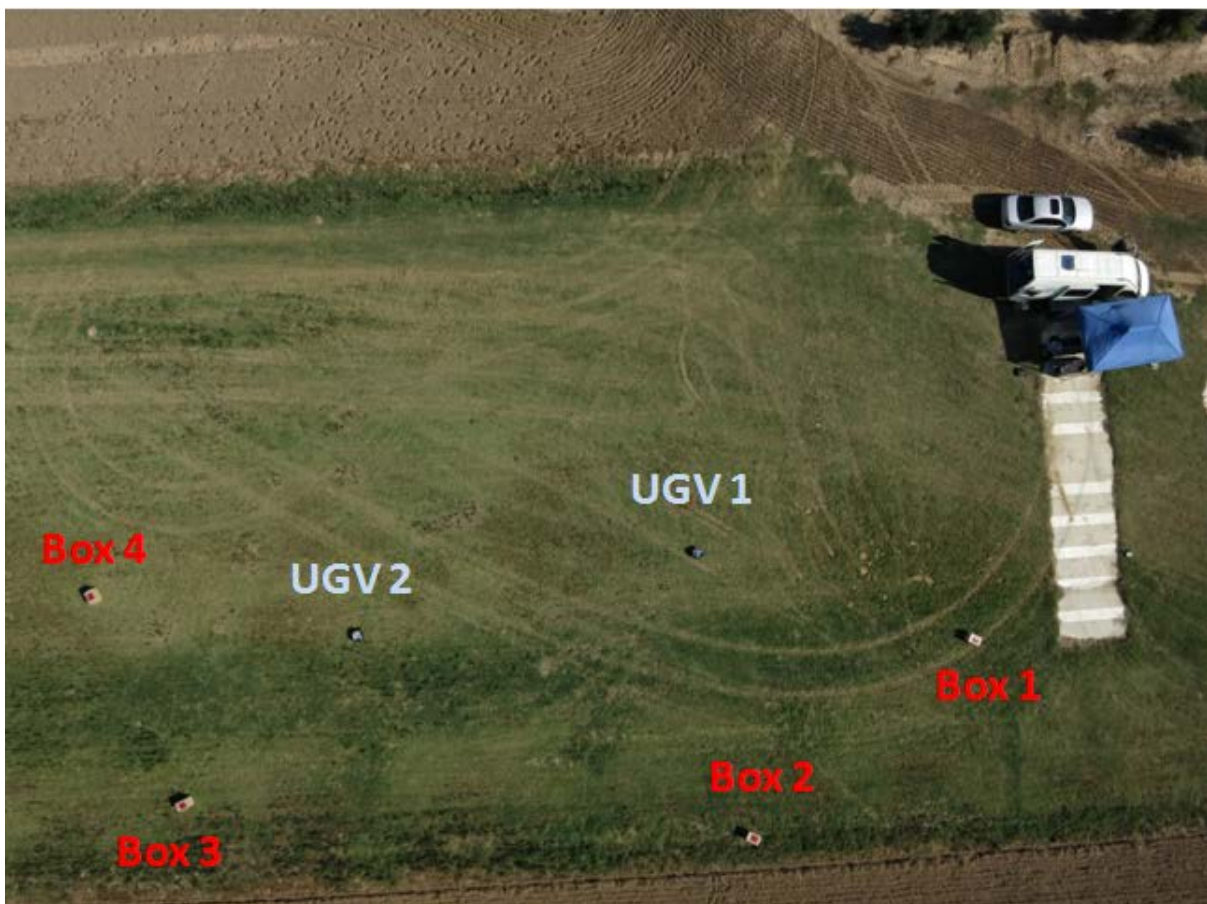


Figure 7. Image acquired by the UAV at the maximum resolution during the high altitude flight.
(Photo: CATEC)

Download outdoor tasks datasets:

<http://eurathlon.ecmanaged.com/public.php?service=files&t=6089bb33d1734dcc3040358bdbb6553a>