# Group 325: First report

# Topographic mapping of open fields by autonomous drone

**Or Costa:** or.costa@mail.huji.ac.il

**Noam Kaplan:** noam.kaplan2@mail.huji.ac.il

**Advisor – Adi Szeskin:** adi.szes@gmail.com

## The Problem

The problem we wanted to deal with is identifying objects in an open field, by a drone that scans the area autonomously, and in particular, can identify humans for search and rescue missions in crisis areas.
This problem led us to another, prior problem – getting to map and understand an unknown area.
Mapping unknown areas can be relevant to agriculture, field construction, architects, real estate, search and rescue missions, archeologists and many other fields. As an example, a drone like that can help in crisis areas, where the surface has changed because of the event, and is currently unknown. The drone can help by telling the users what tools they should use, and even might recognize people waiting to get rescued.
Another application that drone can help is in construction areas, where the surface change rapidly, and the project managers want to follow its progress.

Today, all the big enterprises, like Google, Microsoft, have an online mapping service available for all. Yet, many times this service is not the best solution, because it can be in a low resolution, or just not updated.
A drone can solve this solution rapidly, maybe even in "real time", i.e. collecting and calculating the data in reasonable time so that the user can assist the drone in any unknown place, and get the updated map he needs on site.

There are already similar drone applications, that navigates in unknown areas without GPS. One of these projects is a project by Nvidia, that developed a drone that is designed to follow forest trails and can rescue lost hikers. The main difference from our project is that their project is using live deep learning and computer vision to analyze and follow the forest trails, while we would like to create an aerial footage topographic map.

## The Solution

Our solution is to create an autonomous drone, that works without any prior assumptions, and starts mapping the area by taking aerial photos and measuring the ground height. Later on, we would like that the drone will be able recognize objects.
We would like to merge all the data collected by the drone, and return a topographic map built from the photos, with lines of height or colored areas that shows the height differences.
We would like to reach a point where the user just need to turn on the drone in the unknown area, and from that point the drone will do anything by itself, without any other interference of the user.

## Evaluation and Verification

- The ability to fly and collect data from the field
- The ability of the drone to be independent in:
    - Determine of the flight course
    - Taking photos and measuring the height while flying
    - Sending the data from the drone to the computing unit
    - Flying in an unknown area without using the GPS, except for getting its starting point
- Creating the output in a reasonable time
- Accuracy:
    - Getting a clear map
    - Comparing the height data picked from the drone to the real height
- Integrating all the components together and getting them to work without problems

## Our priorities and schedule:

P0:

Fly the drone from a remote machine (pc) that will send commends to the flight controller on the drone. Collect data from the two sensors on the drone (lidar and barometric) and photos from the camera during the flight.

P1:

Flying the drone without using a code that relies on pre-existing map.
Gathering all the data and create one visual output – the topographic map.

P2:

Streaming the data in live – during the flight.
Add image processing features to the map, classification and detection of objects that are on the surface.

**Project Schedule**

| P0 | P1 | P2 |
|---|---|---|

Already done:

Find a proper drone for the project
Install the program "ArduPilot", that controls the drone, and learn its basics
Meeting "ClearVuze" - A startup company that deals with drones
Find proper Lidar sensor
First test flight

| | |
|---|---|
| | Week 2 |
| Noam | Work on the "ArduPilot" and explore it to find more abilities that will help us |
| Or | Take the barometric sensor from Ziv with a RaspberryPi |
| | first report |
| | |
| | Week 3 |
| Noam | Find a way to connect to the "ArduPilot" and start to write code to control the drone |
| Or | Continue working on the barometric sensor and take first samples (from ground) |
| Or | Start to write the code to control the sensor |
| | |
| | Week 4 |
| Or | test the barometric sensor (on ground by using auto control) |
| Or | take the Lidar sensor from Ziv |
| Noam | continue with ArduPilot - create a test flight test using GPS |
| | second report |
| | |
| | Week 5 |
| Or | Finish with the barometric sensor |
| Or | Start to work on the Lidar sensor - connect it to the RaspberryPi and collect data from ground |
| Noam | Take the GoPro camera from Adi |
| Noam | Find the best platform to connect the camera (Pixhwak / RaspberryPi) |
| | |
| | Week 6 |
| Or | Write a code that control the Lidar sensor |
| Noam | Take some photos with the GoPro - to evaluate the quality |
| Noam | Write a code that control the GoPro and collect the data |

| | |
|---|---|
| Or | Connect the sensors together (to the RaspberryPi) and check ability for coexistence |
| | |
| | Week 7 |
| Or | Combine all the codes we have to one or two files for next week test |
| Or | Test the lidar sensor outside and compare the result to the measures we get from the barometric |
| Noam | Preform calibration to find the camera parameters |
| | |
| | Week 8 |
| | First breakpoint - test and reassessment<br>Report<br>Dry test - connect the sensors and the camera to the drone and check coexistence and the ability to collect the<br>evaluate the main code that supposed to control the drone and send commands to the camera and sensors<br>reassessment the schedule for the next half of the semester |
| | |
| | Week 9 |
| | Fix bugs and problems that may occur in week 8 test<br>Preform calibration to find the camera parameters |
| | |
| | Week 10 |
| | Retest the drone if we need + test it on flight if we can |
| Or | Find the way to avoid using the GPS - write a new code that base on the main code but have only one GPS point (home point/ takeoff point) |
| | |
| | Week 11 |
| | Finish all the tasks and prepare for first test |
| | |
| | Week 12 |
| | First real test |
| Or | collect all the data from the test |
| | |
| | Week 13 |
| Noam | Write a code/script for getting the data from the GoPro and convert it for our needs |
| Or | write the code that preparing all the data for creating the map |
| | |
| | Week 14 |
| Noam | build the code for creating the map - start with stitching few photos |
| Or | write the code for the topographic map, add a fake height data for the map we create last week |

Plans for next semester:

- Create a new main code that doesn't use GPS
- Write an algorithm that activates the drone sensors according to the flight
- Add third dimension to the map by using the collected data from the sensors
- Write a code that connect to the drone, collect the data and create the map
- Try to stream the data
- Implement some algorithm for real autonomic flight
- Improve the map resolution and quality
- Add objects recognition and classification
- Create a GUI