Introduction to Data Science | (LTAT.02.002)

Project A12 DRONE-DETECTION

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Abstract *– The following is meant to be the Introduction to Data Science course homework 10 solution.*

I. SETTING UP

The link for the github is: https://github.com/ristokynnapas/data_science_project

II. BUSINESS UNDERSTANDING (TASK 2)

Task description - link

Solution -

1. Identifying your business goals

1.1 Background

This project is about detecting different objects with a drone camera and finding out which approach is more efficient:

- using image processing techniques;
  or
- using ML models (that have been trained with a small dataset).

Under the "objects" we mean precisely (1) different obstacles in the air that the drone must avoid when flying, (2) the line on the ground that the drone has to follow and (3) a ground vehicle on which the drone has to land in the end. These "objects" can somewhat also be seen in the figure 1, with the exception of the obstacles in the air.

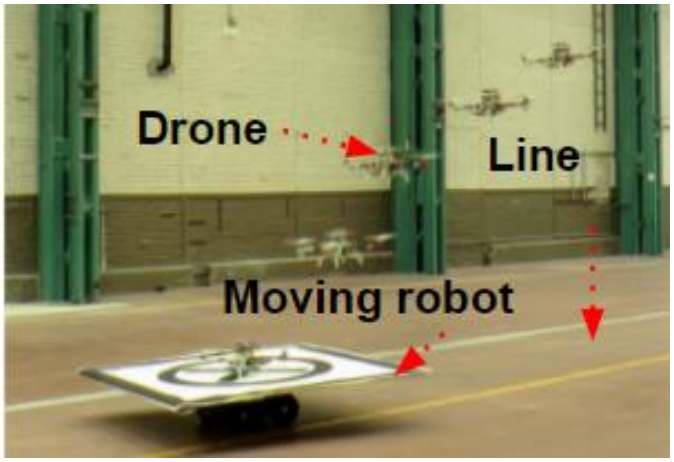

Figure 1 Concept of the use case [1].

The specific goals are enlisted below, but I will mention already so much that this project is not being done with doing "business" in mind.

To state the main reason why we are doing this – the project exists in the name to learn something new and challenge the project holders' skills.

1.2 Business goals

Because this is not a business case, we do not have business goals. But we can state here and now some more specific goals we have –

- Goal 1 - Compare the image detection techniques and ML models parameters in images;
- Goal 2 - Compare the image detection techniques and ML models parameters in video;
- Goal 3 - Demo the results in live or using visualizations (diagrams, graphs).

1.3 Business success criteria

In this project we can clearly state the success criteria – all of the goals or goal1/goal2 with goal 3 should be achieved. This will mainly be decided in the end by the course instructors.

There are a number of ways these goals can be achieved, and we will not go into the details right know, but this will (has to) involve specifying our own understanding what is “efficiency”.

2. Assessing your situation

1.1 Inventory of resources

The resources available for this project are:

- Human resources:
  - 2 project holders
  - The course instructors
- Data:
  - This is collected in the form of video probably for consistency reasons and the images are subtracted as frames from the video.
- Hardware:
  - PC-s
  - Drone
- Software:
  - Python
  - Jupyter
  - ML and data science libraries
  - etc

1.2 Requirements, assumptions, and constraints

Requirements:

- Schedule:
  - Start time: ~in the end of November
  - End time: December 17, 2020 at 14:00-17:00
- Legal and security obligations:
  - Non-existing: just have to follow Estonian laws
- Acceptable finished work:
  - Specified in *1.3 Business success criteria*

Assumptions:

- If we work hard, we can do this!
- The course instructors will be pleased with the results and grant as the points?

Constraints:

- Time: time is running out.

1.3 Risks and contingencies

Main risk is not acting and putting a concrete plan in place. For example –

- Which ML models are we going to train and evaluate?
- Which image processing techniques are we going to apply and evaluate?
- How many of them are we going to use?
- Which evaluation criteria do we have?
- Which visualizations are we going to do?
- When and what are we going to do (timeline)?

1.4 Terminology

- Image processing techniques – these are tools applied to the smallest elements in the images; namely pixels. These tools can be meant to derive info from the images, to project info on the images, to improve the images by manipulating with the pixels. Etc.
- ML models – these are the finalized versions of ML algorithms. For example: ML algorithm can be a linear function y=ax+b, the ML model on the other hand is y=5x+39. So to achieve the proper model we have to train our algorithm with proper data to get the output we expect in certain situations.

1.5 Costs and benefits

Because this project is for research purposes … then there are no clear measures of the actual benefit. We just want to find out if there are any. If it turns out that we can do more with ML training ML models than using image processing techniques then if the efforts are also comparable it is very likely that we will also incorporate this knowledge into our future projects.

3. Defining your data-mining goals

1.1 Data-mining goals

We already, under the business goals, took a more technical approach then business approach, so I will try to be brief.

This project will have a:

- Report
- Presentation
- Code
- Data

1.2 Data-mining success criteria

Keywords:

- ML models are more accurate than image processing techniques (or comparable);
- The effort for both cases is the same.

Word count: 791.

III. DATA UNDERSTANDING (TASK 3)

3.1. Gathering data

To complete this task our aim is to find, where it is possible to collect the required data.

3.1.1. Outline data requirements

The gathered data, that would address the requirements of our goal is in the form of video, which should be taken during a drone's flight. The gathered data is of type .mov or .mp4, which is then split into frames.

3.1.2. Verify data availability

This data is quite easily attainable from a camera, which is mounted on a drone and flown using a controller.

3.1.3. Define selection criteria

We will be using the video taken with the drone to determine the different obstacles. The video however should not be a random drone video, it should have clearly marked out paths. The selected parts of the video should include the path and objects in the drone's path.

3.2 Describing data

As stated in the previous task, the data was collected using a drone, which was remote controlled. The collected data is in the form of video files, which are of types mp4 and mov. At this moment we have about five videos, but we may need to make more videos to get even more data. The data collected so far is suitable to complete our chosen goal. The videos include the necessary objects to carry out our plan.

3.3 Exploring data

The video taken of the flight shows the object and the path clearly, but the problem may arise when determining objects that when the object path is in a weird position or at a weird angle in relations to the video output, so the object classifier can maybe make mistakes. So, to help in classifying objects correctly it may be needed to look for frames that also have awkward angles of different things not just the ones that have clear outlines. Also, we need to be aware that there may be false positives too, but as we have not yet made it so far, we do not know, what could be construed that way.

3.4 Verifying data quality

The data we need exists and collecting additional resources should not be very difficult, but when processing or classifying the images we need to make it efficient enough, that it would be able to choose its own path using the video and if the process of determining its further path is very slow, then the object classification is not efficient as the movement and processing of a frame should be done quite simultaneously, if there was a lag then the object could collide with something or fly our of bounds. At this moment we have not come across any major issue, but those may arise later, when working on actual parts of the project. So, taken this into account the data should be good enough for us to achieve our goals and any future problems that may arise should not be a huge obstruction on our path to success.

IV. PLANNING YOUR PROJECT (TASK 4)

Please perform the following tasks:

- Make a detailed plan of your project with a list of tasks. There should be at least 5 tasks. Specify how many hours each team member is going to contribute to each task.

1. Acquire data – specifically video material with different environmental conditions, angles, proximity. The data can be in one video, but it could be easier to manually collect it in different videos.

Total time: 5 h

Risto: 5 h

Friedrich: 0 h

2. Data processing and review – remove camera distortion from video, then we do not have to think about it in the images. Processing should be minimal, because the aim is to use raw data that the drone gets.

Total time: 10 h

Risto: 5 h

Friedrich: 5 h

3. Literature research: find most effective models for small dataset. Find the best image detection methods.

Total time: 10 h

Risto: 5 h

Friedrich: 5 h

4. Decide on the nr of models and image processing techniques investigated. Decide on proper evaluation criteria. Decide roughly which visualizations you are going to use.

Total time: 10 h

Risto: 5 h

Friedrich: 5 h

5. Start training models and applying image processing techniques. Both will do these things.

Total time: 30 h

Risto: 15 h

Friedrich: 15 h

6. Report writing, illustrations, text.

Total time: 15 h

Risto: 10 h

Friedrich: 5 h

7. Presentation and rehearsal.

Total time: 12 h

Risto: 6 h

Friedrich: 6 h

Total nr of project hours: 60 h

Our estimate: 92 h

- List the methods and tools that you plan to use. Add any comments about the tasks that you think are important to clarify.

Image processing techniques: canny edge detection, Sobel operator, Hough transform etc, thresholding.

ML models: initial thought is to use the course ML models that we learned, but probably we are not going to do this and instead use some more specialized models for images. But classification is the keyword here – we do not see that we will use regression.

Software: Jupyter, Visual Studio etc.

Word count: 215 + 64 + 7