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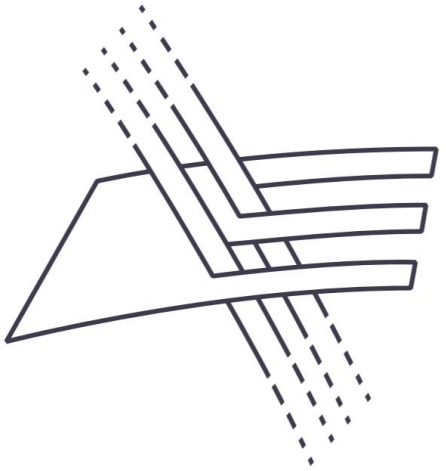
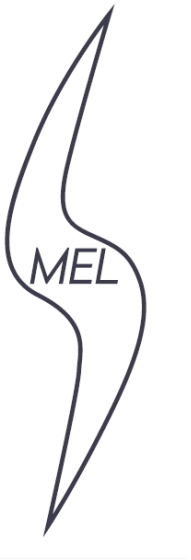


Przedstawienie dotychczasowej działalności na Politechnice Warszawskiej

Michał Hałoń

Warszawa, 2018

Politechnika Warszawska



Engineering diploma thesis

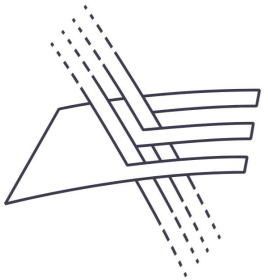
Road signs detection and recognition with application in mobile robotics

Michał Hałoń

Supervisor

dr inż. Grzegorz Orzechowski

Warszawa, 2017

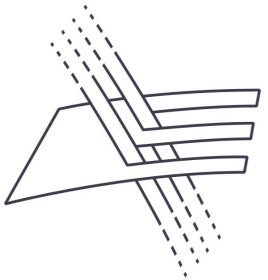


Goal of the project

- **review of existing solutions** used in road sign recognition systems,
- on the basis of the review, the **development of own algorithm** recognizing selected road signs in Poland,
- **construction of a test stand** to test the developed algorithm,
- **perform** basic tests of the developed algorithm.

Detection and extraction of the road sign image

- edge detection,
- **thresholding + morphological operations.**

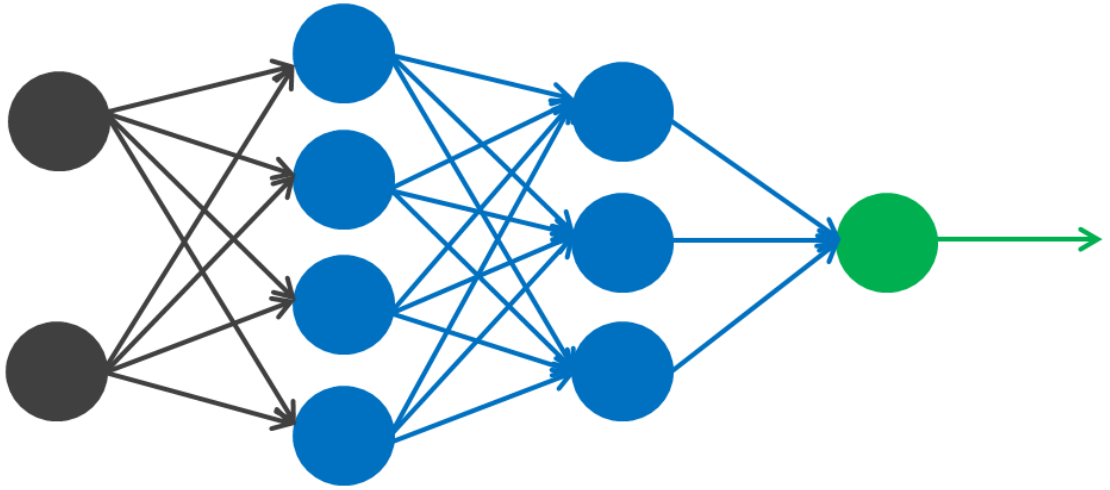


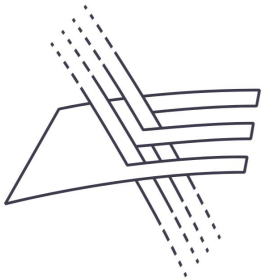
Data analysis and preparation for usage in a neural network

- **reduction of the amount of data** entered into the neural network,
- there are algorithms in which the values of **all pixels** of the image are entered into the neural network,
- operations on **color**, **grayscale**, and **binary** images.

Recognition of the road sign

- among the many available classifiers, the present work describes solutions based on the use of **neural networks**,
- **the most commonly used** MLP (Multilayer Perceptron) neural networks of the feed-forward type, trained with the backpropagation algorithm.





Description of the algorithm

- **goal:** development of an algorithm detecting and recognizing road signs in Poland,
- environment: **Matlab**,
- frame frequency: **about 3 Hz**,
- size of frames taken: **1280x720 pixels**,
- types of road signs detected: **information**, **warning**, **mandatory**, **prohibitory**,
- number of road signs detected: **19** (including 'stop',’pedestrian crossing' or ’give way’),
- additions: **voice support**, **display of detected road signs**.

Road signs images database

- **634** images of individual road signs

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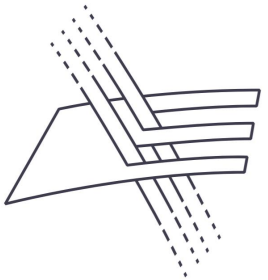
Algorithm test results

- **most** of the detected non-sign objects assigned to the ‚no sign' category,
- **the majority** of objects being sought-after signs correctly recognized,
- condition of occurrence of the mark three **times in a row**.



Achieved project goals

- **review of existing solutions** used in road sign recognition systems,
- on the basis of the review, **development of own algorithm** recognizing selected road signs in Poland,
- **construction** of the test stand,
- **perfom basic tests** of the developed algorithm.

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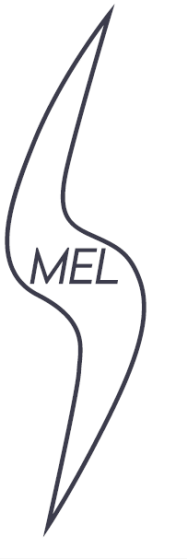


Master diploma thesis

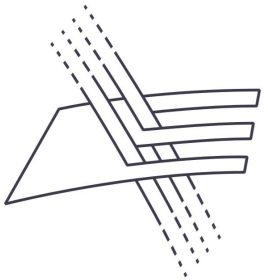
Detection and recognition of artificial landmarks for European Rover Challenge mobile robots competition

Michał Hałoń

Supervisor

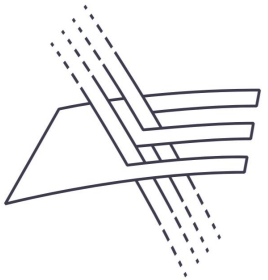
dr inż. Andrzej Chmielniak

Warszawa, 2018



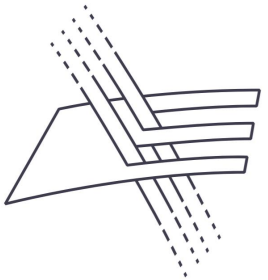
Project goals

- **defining the requirements for the algorithm being developed** by the regulations regarding the Traverse Task
- **examining the current state of knowledge** regarding the recognition of information contained on artificial landmarks
- **development of own algorithm for detecting and recognizing landmarks**
- **perform basic and necessary tests of the algorithm**, allowing to determine its basic properties



Required parameteres of the algorithm

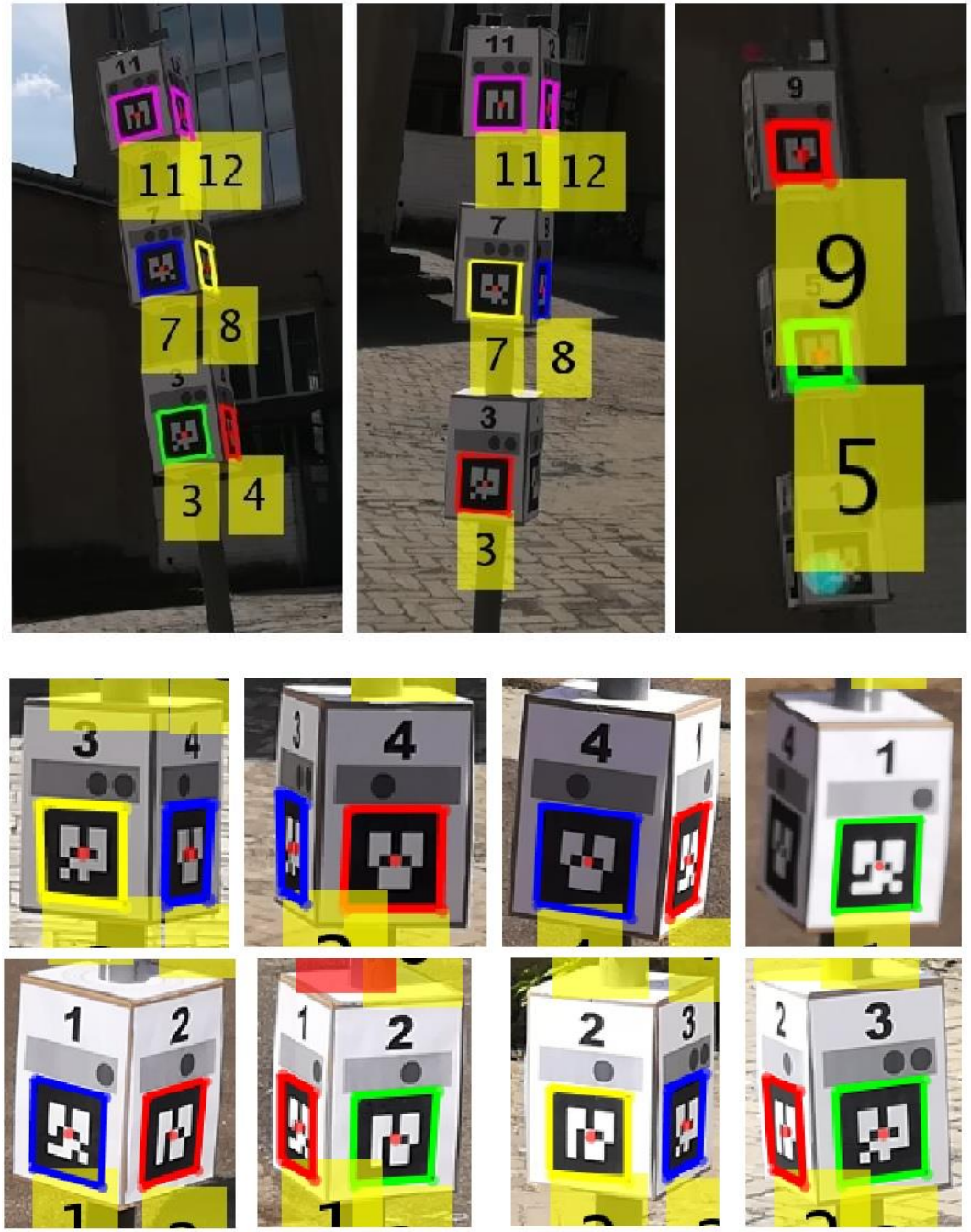
- **detection of landmarks from a minimum distance of 11 meters** and less with a sufficiently high accuracy (detection of the vast majority of such objects)
- **detection of checkpoints from a distance of 3 meters** and less (if possible)
- **the whole process**, from taking photos to providing data on detected landmarks, **can not last longer than 13 seconds**



Description of the developed algorithm

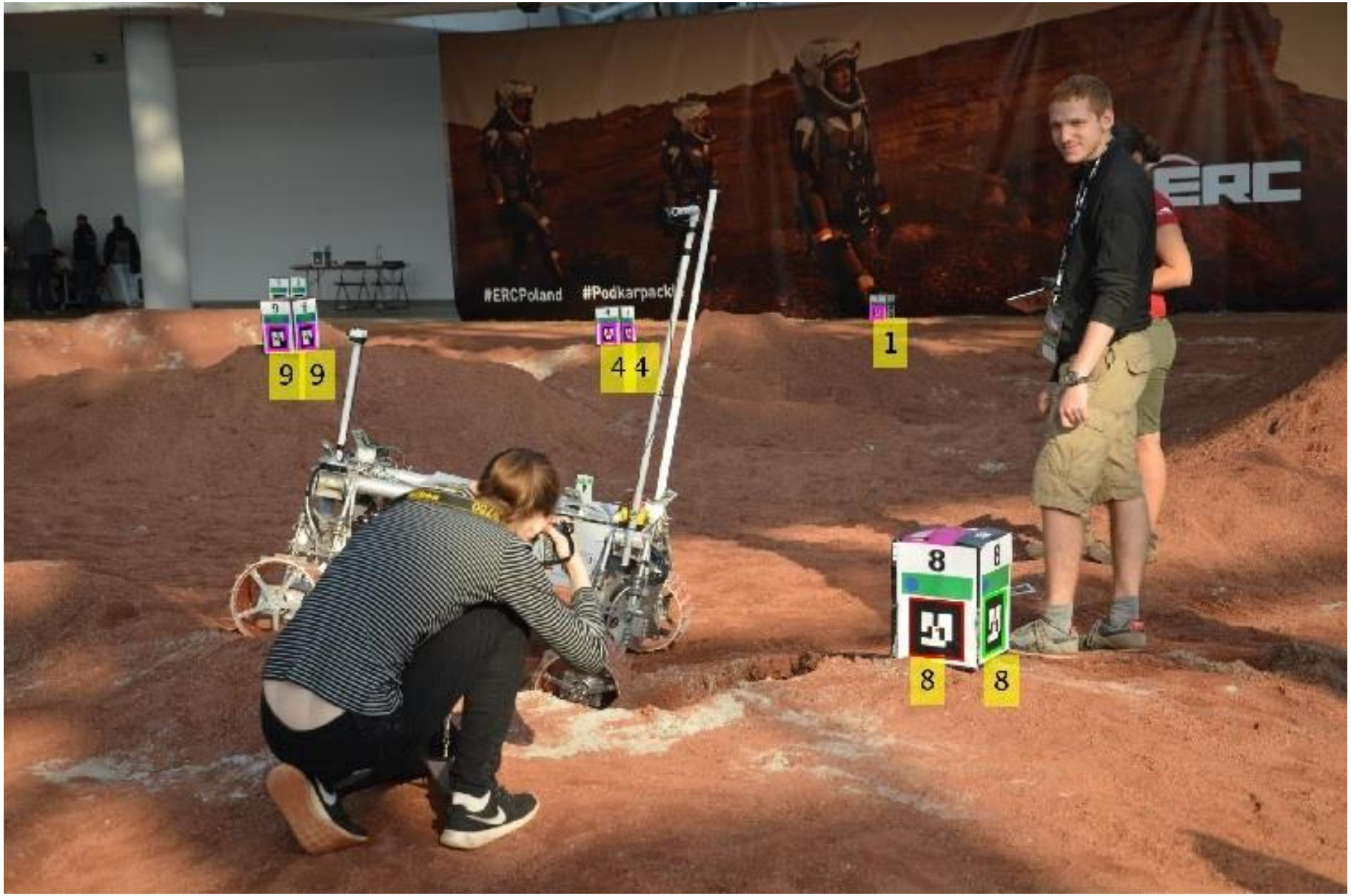
- **two** very similar **algorithms** were created (implemented in the Matlab **environment**) - one recognizing landmarks, while the other checkpoints
- main stages of the algorithm's operation:
  - **detection** of a quadrangle
  - **recognition** of a marker
- **input** data
  - photo
- **output** data
  - list of recognized landmarks along with their positions on the image (or relative to the camera)

Photo analysis in various conditions



Photos (or their fragments) of landmarks containing the Sun in the frame (on the right and on the left at the top) and fragments of photos depicting landmarks from various angles (on the bottom left)

Analysis of photos from ERC 2016



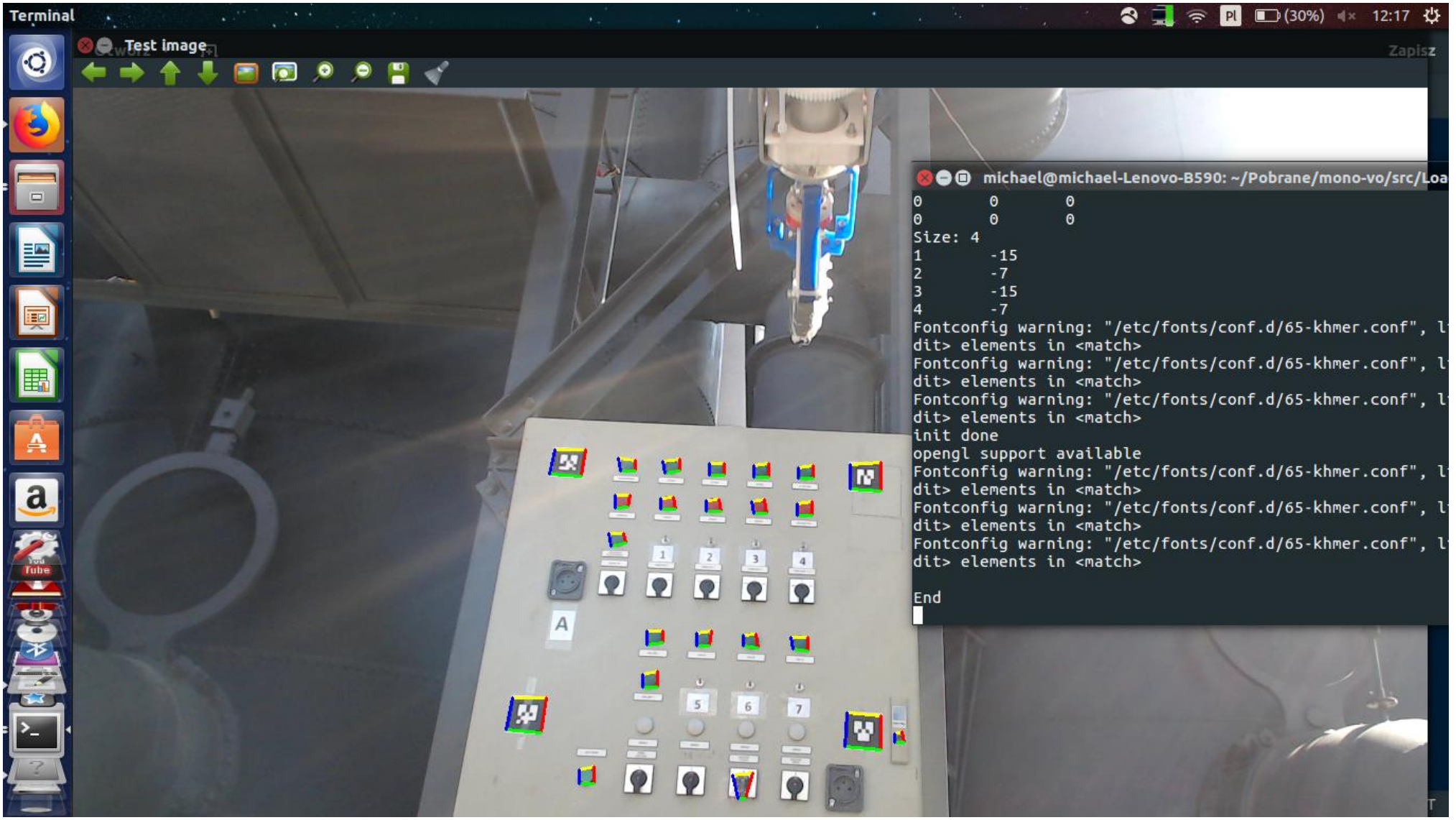
One of the analyzed photos from the ERC 2016 competition with marked landmarks. **The nearest** marker (number 8) was detected from a distance of about **2 meters**, while **the most distant** marker (number 1) **from about 26 meters**. Author of the photo: Edyta Żak

Proposals for further work

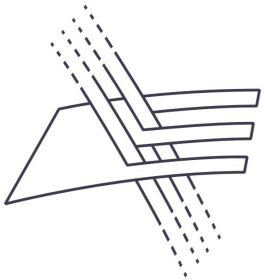
- performing **tests of the algorithm with the use of a rover** in conditions simulating the competition - for example in a quarry
- optimization, modification or **change of the line detection algorithm**
- making further attempts to **optimize the values of the basic parameters** of the algorithm

Ares rover in a quarry, in which the conditions resemble those prevailing during the ERC competition.
Author: Mikołaj Owczarzak

The use of the algorithm during the ERC 2018 competition



An example of usage of the developed algorithm during the ERC 2018 competition. Author: Michał Ołdak



Summary

- **all the goals** were achieved:
  - **the requirements** set out in the competition rules regarding the Traverse Task **were specified**
  - **the state of knowledge** on the recognition of information contained on artificial markers used during the competition **was examined**
  - **development of algorithm** for detecting and recognizing landmarks and checkpoints (for the images from the smartphone, the requirements for detecting landmarks and checkpoints from the appropriate distance and the length of the algorithm's execution time were met)
  - **basic tests were carried out** to determine its properties
- it was suggested to **use smartphones** to take pictures of landmarks and checkpoints, however the final decision will depend, among others from the location of markers on the new competition map