

## **Bachelor thesis: Autonomous runner training assistant – vision system and virtual reality**

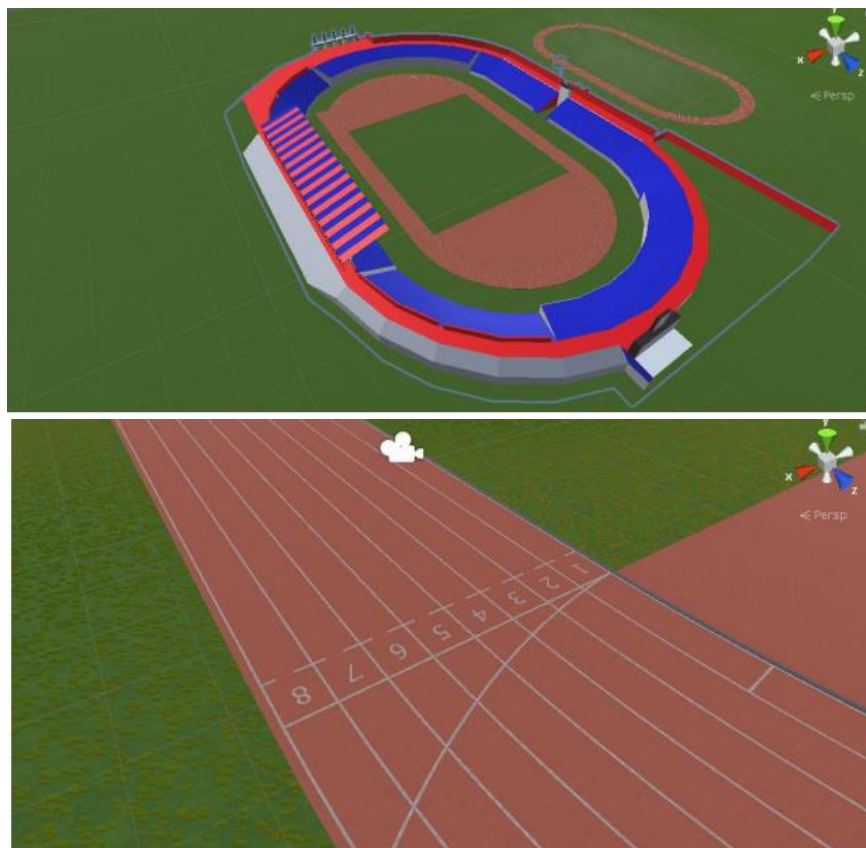
Point of my bachelor thesis was building fully functionable robot with can support runners during their training.

Long distance runners can achieve better results if their training will be conducted with proper pace. The most convenient is constant speed. Sometimes it is hard to keep it, particularly during the interval training or when the runner is tired. Moreover, it is necessary to look at the GPS watch from time to time. All this issues causes that real pace always oscillate in some range.

Solution for this problem is Runner Assistant — robot with can drive in front of the contender on the athletics track with ideally constant speed.

Robot is using advanced image processing algorithm for navigation purposes.

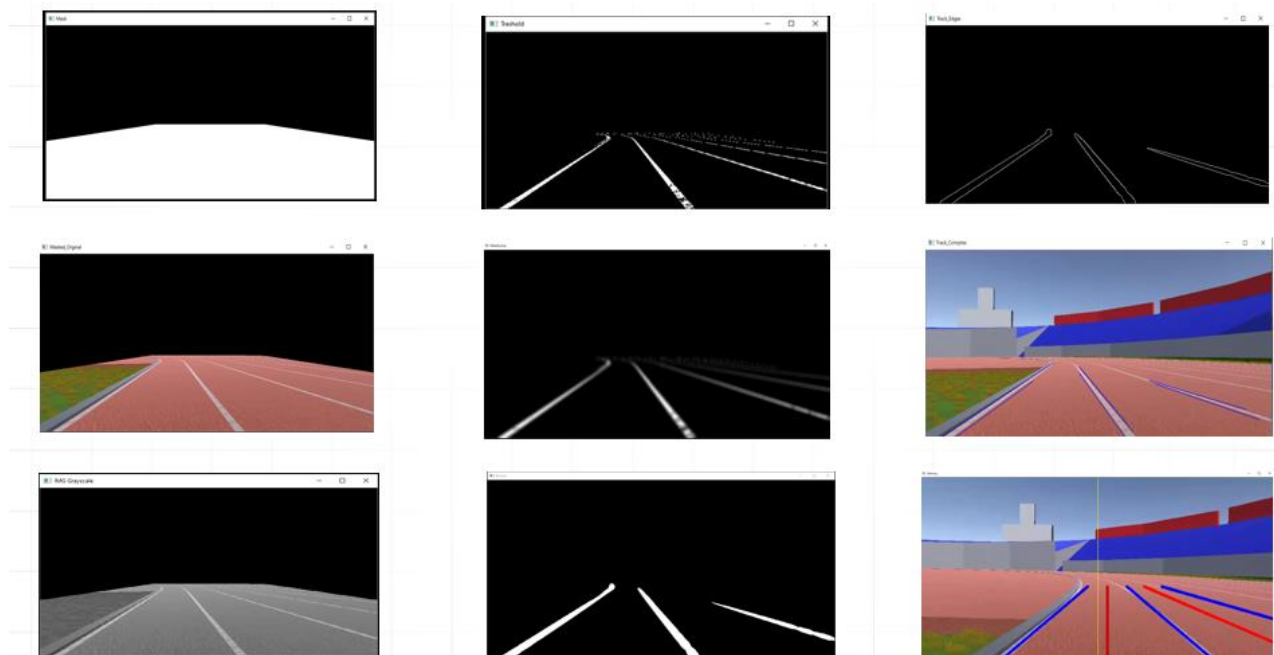
I decided to develop my project in innovative way — firstly I prepared 3D simulation with realistic track where I can develop my algorithm step by step and examine various cases. For this purpose I used game engine — Unity.



*Figure 1 Virtual track in the Unity*

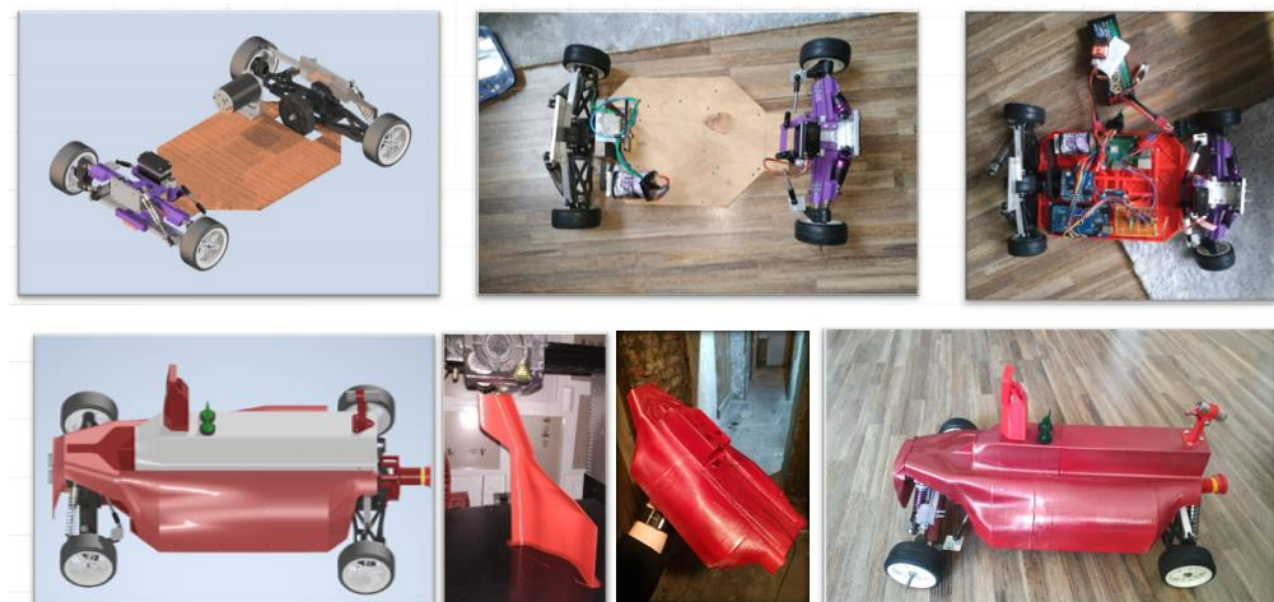
After that I started to develop my image processing algorithm using OpenCv. I used similar solutions like in the autonomous car street lines detection and adapted it to my requirements. The most significant problem was to ignore lines perpendicular to the driving direction and other

obstacles By using dynamic linked libraries I attached my algorithm to the Unity with allowed me to test it in live mode and check its behaviour in critical spots on the track.



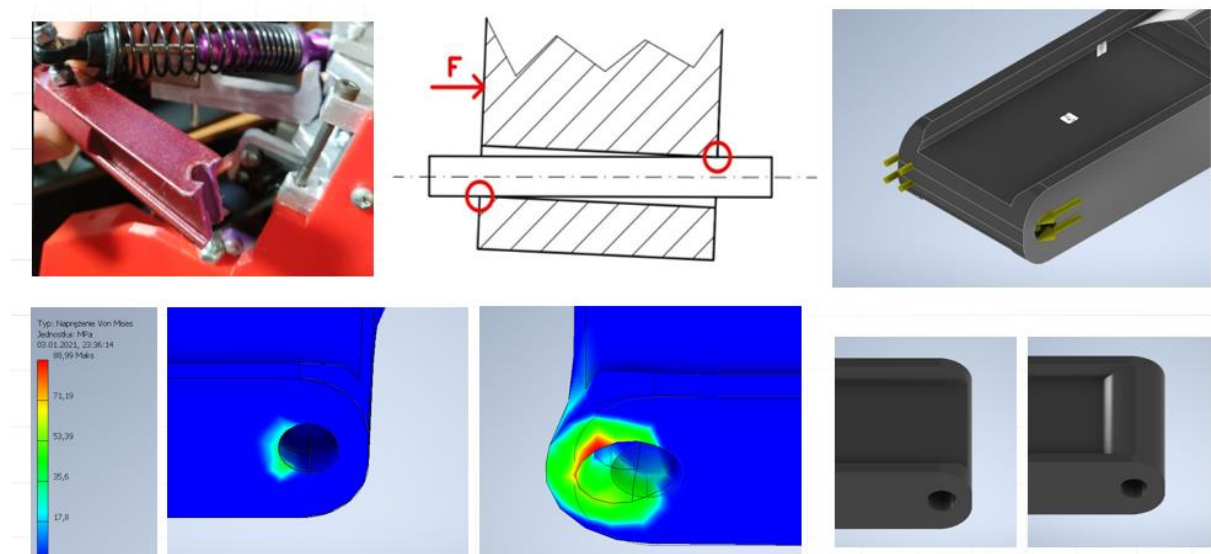
*Figure 2 Example steps of image processing*

Then, I projected and built real model of the device with all mechanical and electronics components. Main microprocessor responsible for most of the processes is Arduino Mega supported by Raspberry Pi for image processing purposes. There are a lot of other relevant elements required to proper work like step-down converters, Bluetooth module motors driver and tons of wires and connections.



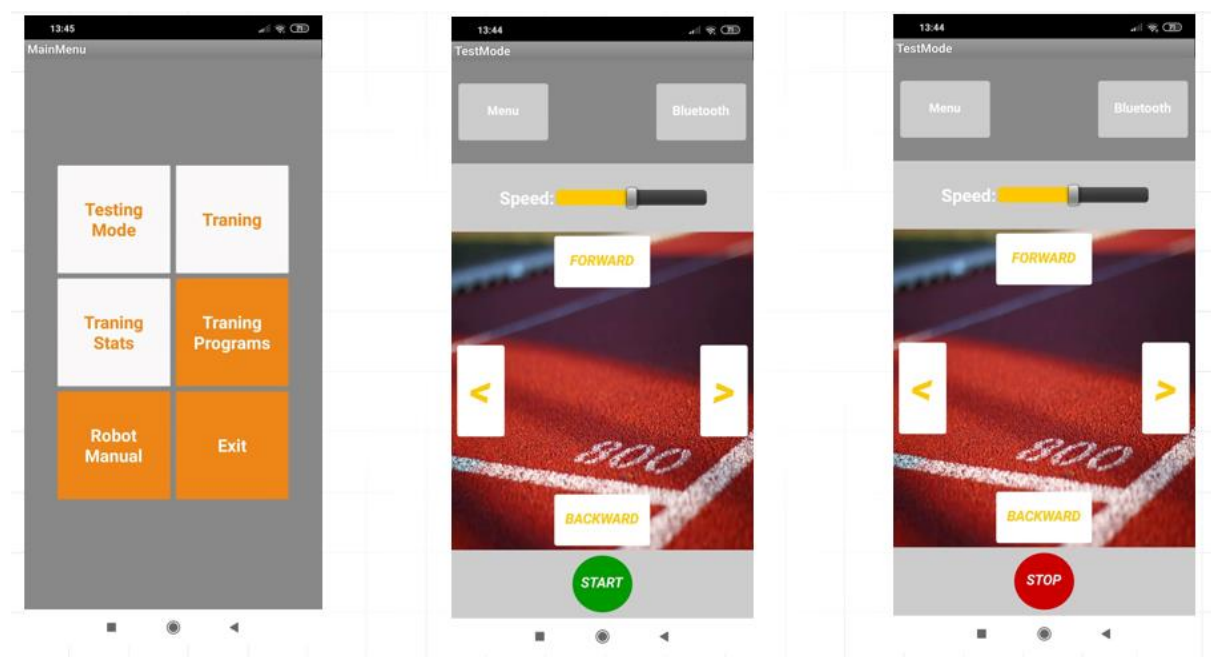
*Figure 3 Development of construction*

To avoid failures during usage I conducted MES calculations of the most fragile elements and improved and optimized construction.



*Figure 4 MES analyzys the part of chassis*

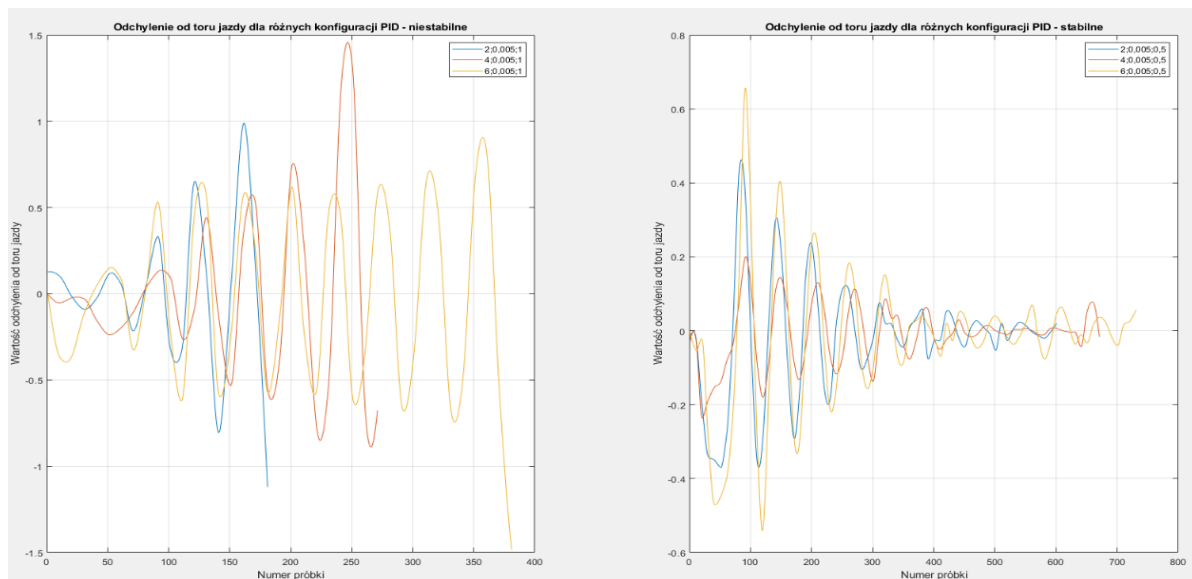
User can chose training program by simple android app.



*Figure 5 Android application*

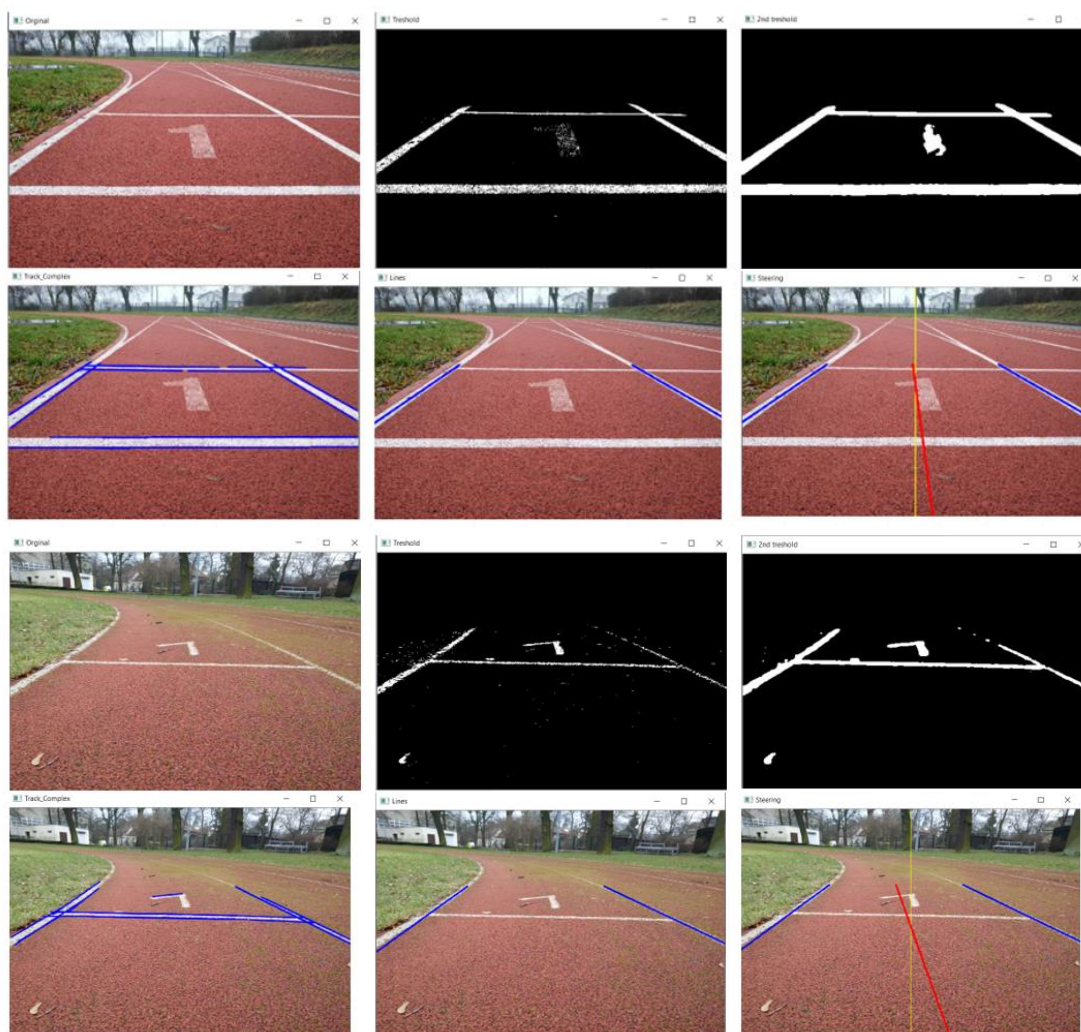
After connecting all elements, programs and systems it was necessary to adjust PID coefficients. I used my simulation next time. Advances liblaries supporting physics calculations in Unity causes that I would be able to build model of the very similar to real device. After that after some tests I got optimal PID for virtual robot with was accurate for real one too.





*Figure 6 Effects of usage various PID coefficients*

At the end I conducted some tests on various real tracks.



*Figure 7 Real world tests*



*Figure 8 Final effect*

After finishing my thesis I decided to project new design of the robot and add some new features.



*Figure 9 New design of the Runner Assistant*

Project has a lot of developments possibilities and I continue working on it.