Self-Driving Car

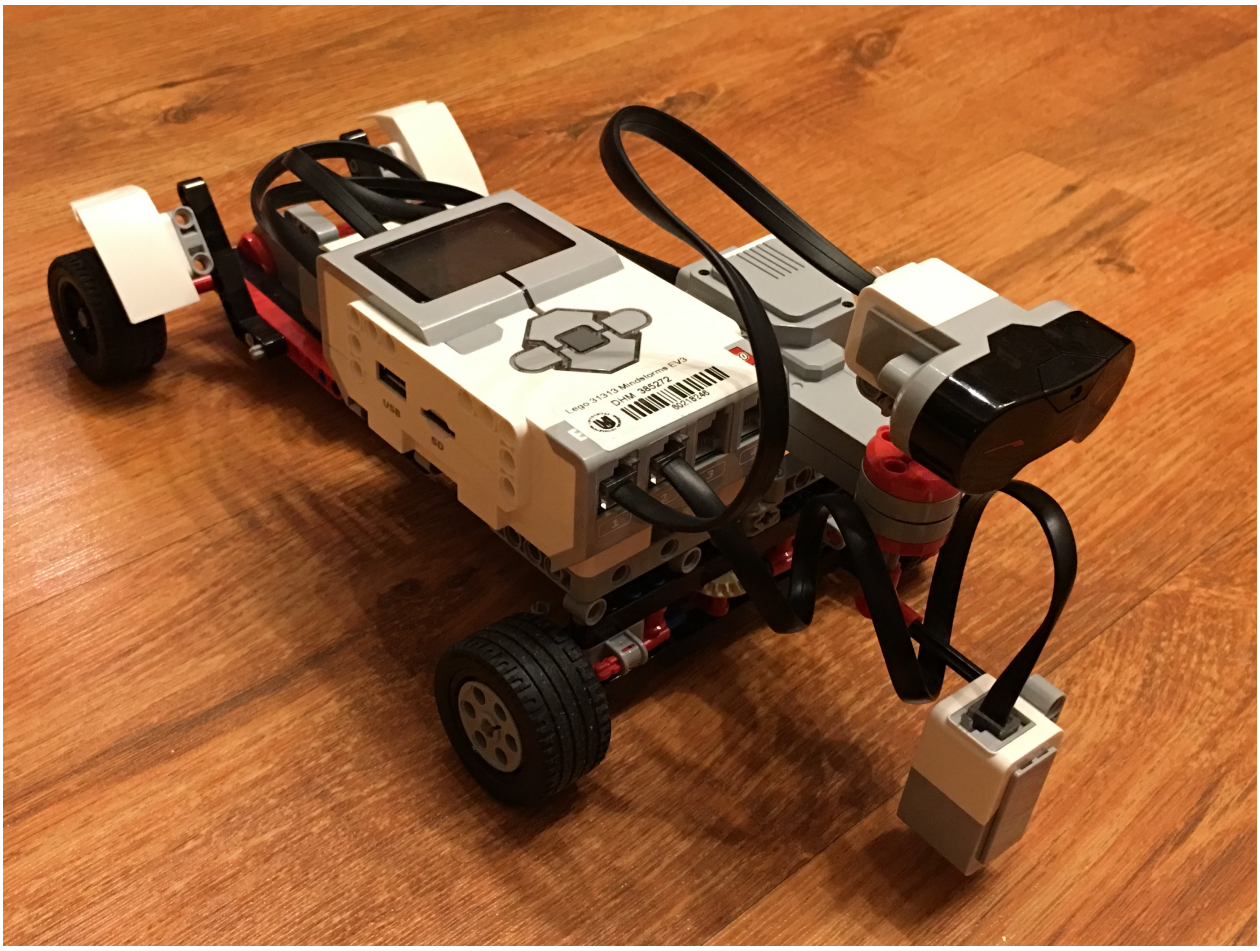
Project Report

Marek Čepček, Karol Kuna (leader), Peter Soóky

Task

The goal of this project was to build a four-wheel car from Lego Mindstorms EV3 capable of limited autonomous driving. The vehicle was built with a rear-wheel drive layout with steerable front wheels and powered rear wheels. The car is able to follow path marked by red tape on the ground (as long as the curves are not too sharp). It is also capable of avoiding collisions with obstacles placed in front of it by halting to a stop. After the obstacle is removed, vehicle continues to follow the path.

Implementation



At the front of the car, there is a rotating base with infra-red and color sensors. This base rotates periodically left to right which helps detecting precise position of line under the color sensor. It also increases the angle of view for detecting obstacles.

The program running on EV3 brick is implemented in Java using leJOS. It consists of two threads for the sensors and two behaviors. First behavior with high priority is collision

avoidance. It routinely checks the distance to obstacles detected by infra-red sensor and stops the vehicle if needed. After the obstacle is removed, vehicle continues forward.

The second lower priority behavior is driving forward at constant speed. This behavior rotates the base with sensors left to right in order to detect how much off center the line is and then it steers the front wheels in that direction. Exact angle of steering is determined by a PID controller with empirically found constants.

Source code is available on GitHub: https://github.com/karolkuna/IA158-self-driving-car

Deviations from Abstract

Bypassing obstacles was not implemented because of time constraints :(

Difficulties

There is no way of finding absolute rotation of motors, since they only report relative rotation since start. This requires manually adjusting steering angle of wheels and sensors to initial position before every run. This means that steering could be off by several degrees from correct initial position.

Sharp curves can confuse the rotating sensor if they are curving away faster than the rotational speed of sensor base. As a result, the car steers away from the line.

Precision of line tracking depends greatly on rotational speed of the sensor base, since position of the line is detected once per rotation. If it takes a second to rotate it left to right, then the information about line position may be delayed by up to a second.

Contribution

Marek Čepček - building the car, implementation of sensors, basic steering, behaviors

Karol Kuna - building the car, rotating base, steering with PID controller, abstract, report

Peter Soóky - part of abstract and report