

Development of the (3,0) mobile platform

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February 11, 2017

Class: Intermediate Project
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Abstract:

The aim of the project was to develop further mobile platform of class (3,0) which was created for engineering project. Platform will be used in Master Thesis in order to write and test some trajectory tracking problems, so robot's functionalities must be enhanced. The main goals of project were: replacing main chassis for more precise one, adding encoders to the motors, developing PD controller for motors, adding Bluetooth module to robot and control it via PC. Also there was additional goal to implement robot positioning algorithm using IMU module. Almost all goals were achieved. Only positioning algorithm wasn't implemented and PD controller didn't work well.

1 Introduction

The mobile platform used in project is presented on Figure 1. It was firstly created as an engineer project. It was remotely controller via radio controller. Robot has implemented internal kinematics allowing user to control it just by giving the coordinates of (X, Y, ω) . Chassis of platform was manually cut and drilled, which was not very precise.

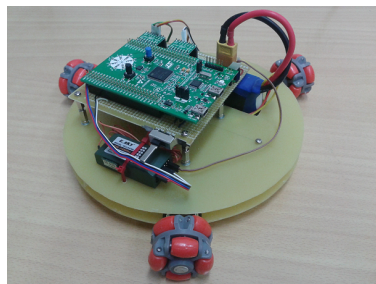


Figure 1: Platform first look

The platform is going to be used in Master Thesis project. It should complete motion or trajectory planning task. In order to do that it must drive precisely. It will be not possible with imprecise chassis and plastic wheels with small friction. The motors should also rotate with proper velocity as it is wanted. For controlling whole robot the best choice is to use PC application which communicates with robot via Bluetooth module. All these goals created a need to develop whole platform and get it ready for further studies.

Figure 2 below shows the result of project work.

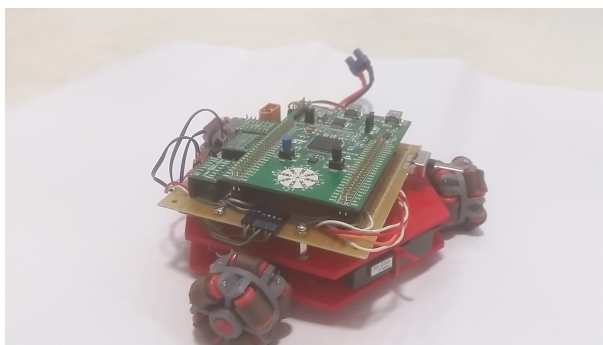


Figure 2: Final form of platform

2 Chassis and wheels

There are not many models of swedish wheels on market. They are not cheap but also not very good. Rolls covered by plastic does not have good friction and whole wheel slips on the ground. In order to improve their properties, they were a bit cut and covered with simple window seal which has very good friction properties. Although they do not look much pretty and may not precisely cover radius of original wheel, they roll much better.

The new chassis of robot was designed in program *Autodesk Inventor*. It is smaller, so the robot looks more proportionally with the wheels and is more handy. Also other elements (except wheel's rolls) were added to 3D model in order to match their places in real connections. All drills were set in precise places, so every element is just where it is supposed to be. It will make kinematics and dynamics of robot more precise with less operational errors. Figure 3 shows 3D model of robot with all elements attached (wheels, motors, battery, bluetooth module, radio receiver, supply board and main CPU board). New chassis was manufactured using 3D print technology. The main CPU board is based on Discovery F3 module. Program was written using *System Workbench for STM32*.

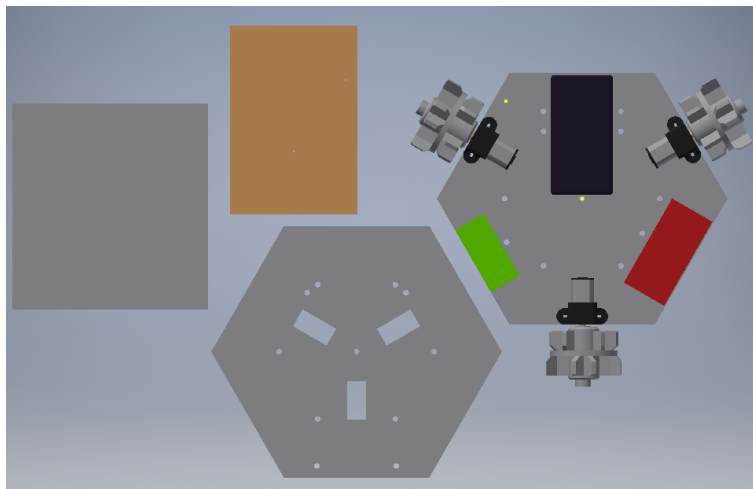


Figure 3: 3D Model of robot

3 PC application and Bluetooth connection

For connection with PC, HC-05 bluetooth module was used. It is simple in use and can be programmed easily in order to change bandwidth or handshake password. It communicates with microcontroller using UART interface. Establishing good communication was the hardest part because simple UART receives only given number of signs. Here it was necessary to read and write different number of signs. Problem had to be solved by special reading functions implemented on both devices.



Figure 4: HC-05 bluetooth module

PC application was implemented using C++ language in QT framework. It allows user to create graphical interface in simple way with all functionalities needed.

Application has several features allowing to control robot in different ways:

- Connect/Disconnect Bluetooth in Options
- Green/Red light saying if the connection is established
- Emergency Stop for robot
- Overall velocity divider for scaling robot velocity
- PC/Radio control allows to drive robot via radio controller (PC is still Master)
- Field to control robot via numerical keyboard
- Field to enter robot velocities in three control axes
- Terminal to check, what robot received

Application can be easily extended to gather data of robot actual position (when the IMU works) or set robot trajectory. It is good base to make advanced calculations on robot's behavior needed for Master Thesis. The look of application is shown on Figure 5.

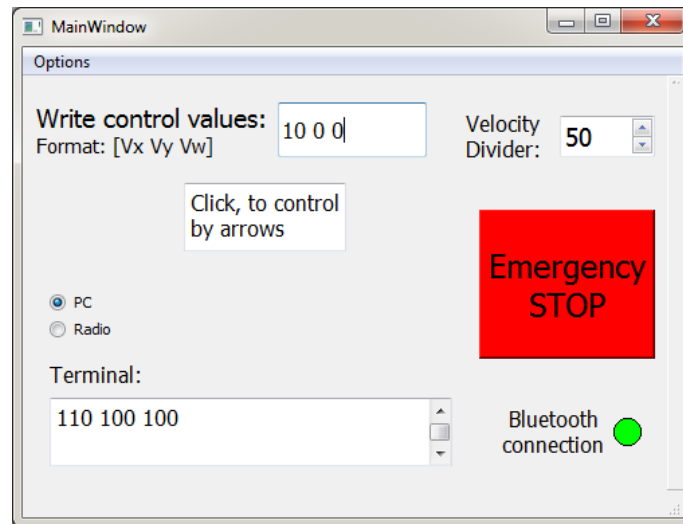


Figure 5: PC Application

4 Results

The project was done successfully. Unfortunately there was a little lack of time to implement IMU positioning algorithm and to tune PD controller for motors. Although on this stage of works, it can be easily added. Especially PD controller. There are encoders mounted with implemented reading of the velocity of the wheels. The controller function is also written and ready to tune. Bluetooth connection works fine and allows to control robot wirelessly. It can also be used to change values of some variables on the run. For example tuning the PD controller without reprogramming it every time.