RoboCup Junior 2018

Soccer LightWeight League

President lyceum of physics and maths #239

Engineering journal

“DOT.” team

Members:

Ustinov Ilia

Chistyakov Aleksandr

Sviridov Andrey

Mentors:

Romanko Pavel Nikolaevich

Saint-Petersburg, Russia

2019

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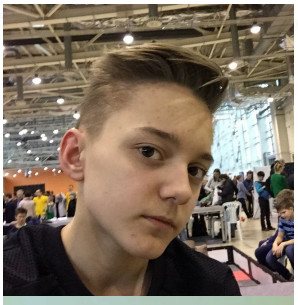
Team info

Ilja Ustinov - constructor, PCB-designer, programmer.
Takes part in RoboCup for the third time



Alexander Chistyakov - PCB-designer, programmer.
Takes part in RoboCup for the second time.

Andrey Sviridov - PCB-designer, electronic engineer

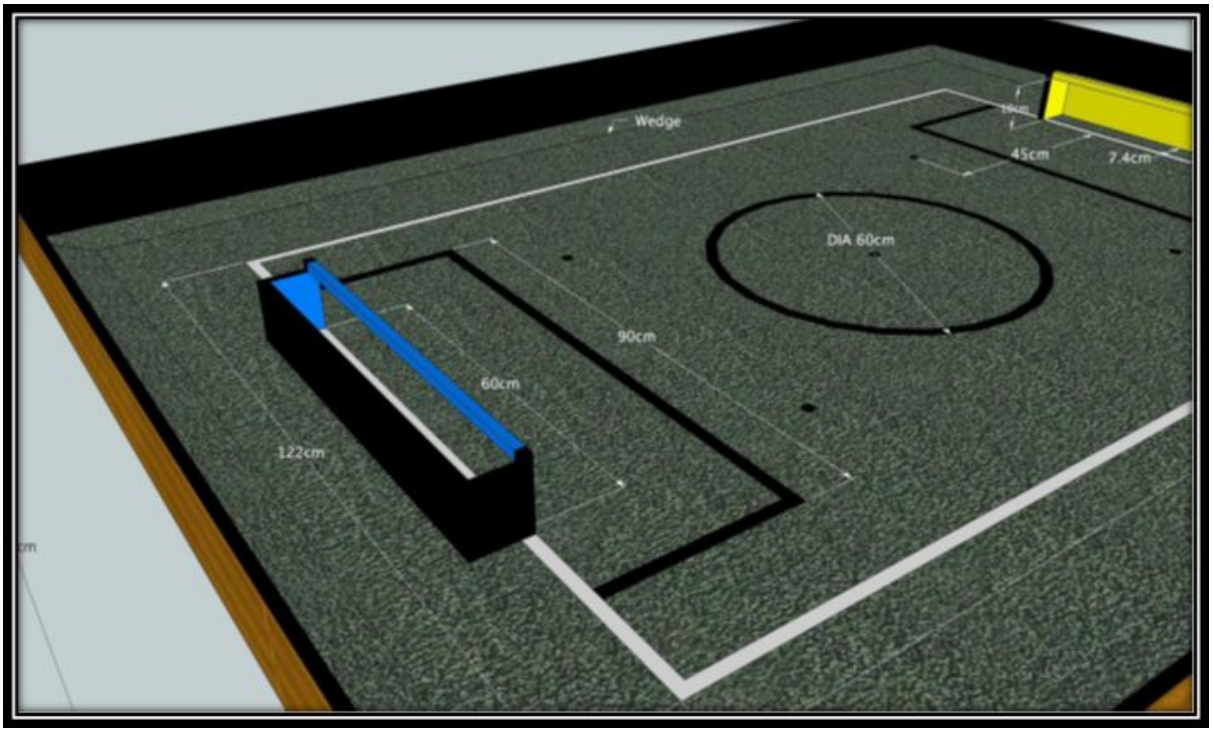
RoboCup Junior Soccer Lightweight

League rules

In the robots football competition, a team consisting of two autonomous robots competes with another team in a football match. The games use infrared ball. Gates rivals marked with color markers and are located on a special playing field, similar to the field for the “big” football. The game consists of two halves. The duration of each half is 10 minutes. The break between the halves is 5 minutes.

The robots used are completely autonomous, the design and software developed by their creators. Competitors must demonstrate their skills in programming, robotics, electronics and mechanics, as well as the ability to work in a team.

The design and software of robots must be created exclusively by the participants themselves. The participation of teachers, coaches, parents or companies in the process of creating robotic footballers is not allowed.



Goals and Ideas

Goal

Training in programming, design and circuit design. The study of control theory on the example of an autonomous robot footballer.

Idea

We will make a robot based on the ATmega2560 microcontroller and OpenMV Cam m7 from printed circuit boards, plastic, as well as other components and materials. In order for the robot not to catch the ball, the gate and other robots, it will be rounded.

Navigation on the field will be carried out using the IMU-MEMS sensor, which includes a gyroscope, accelerometer and magnetometer; video cameras; light sensors. The ball will be recognized by a set of phototransistors. The camera and light sensors will be used for navigation. The camera will be installed at the last level of the robot, it will be aimed at the conical mirror located above it, allowing you to project the entire field onto the image.

Omnidirectional omni-wheels will be installed on the robot, allowing the robot to move in any direction without turning it.

Tasks

1. Distribute responsibilities in the team in accordance with the individual skills of the participants and coordinate work on problem solving.

2. Develop a robot design consisting of printed circuit boards, parts printed on a 3D printer, and more.

3. Pick up all the necessary electronic components: Video camera, IMU-MEMS sensor, engine drivers and others.

4. Develop a sensor board based on an optocoupler KTIR0711S and a multiplexer CD74HC4067 and a motherboard based on an ATmega 2560 microcontroller, which has the functionality we need.

5. Development of algorithms for ball determination and field orientation. Writing global and inertial navigation. Development of tactics and prescription of its algorithms.

6. Debugging the program on different equipment, sensors, components and selection of coefficients of regulators.

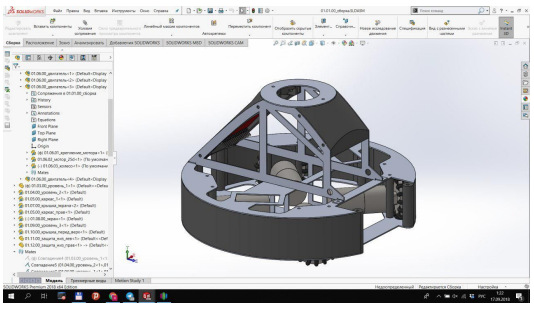
7. Speak at test competitions at different levels: the regional stage of the RoboCup 2019 Championship in national competitions RoboCup Russia Open 2019. According to the results make the necessary improvements in the design and program.

Plan

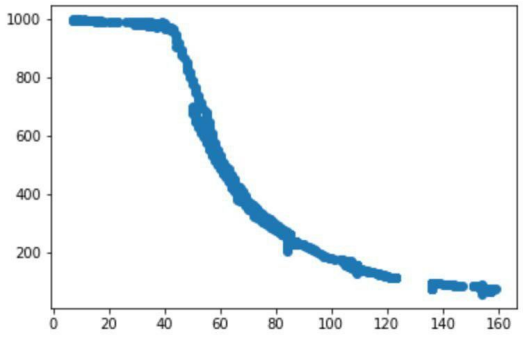
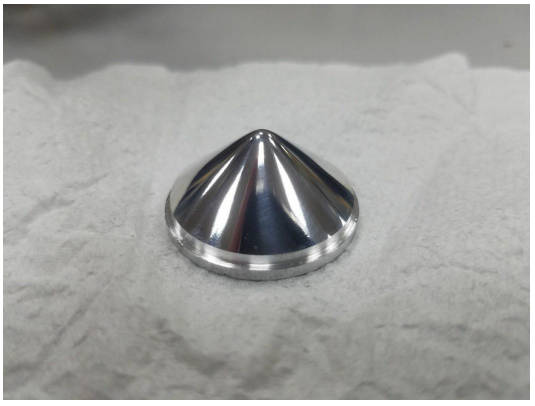
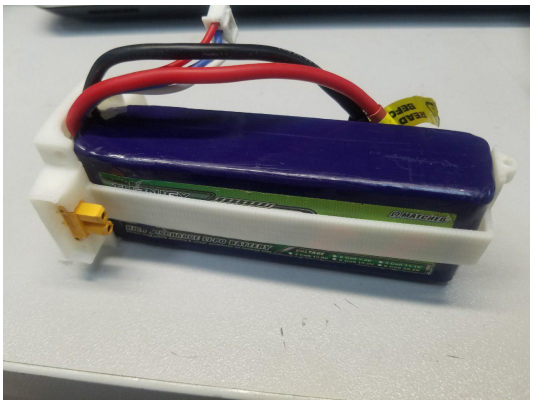
Date	Alexander	Ilja	Andrey
01.01	plan development	plan development	plan development
05.01	Writing libraries	selection of components	selection of components
08.01	Writing functions	selection of components	selection of components
13.01	Work with OpenMV	selection of components	selection of components
21.01	Writing OpenMV Libraries	designing 3d models	sensor board development
31.01	Library Optimization	designing 3d models	manufacture of sensor board
07.02	debugging of motors and movement of the robot on the field	make dribbling	manufacture of sensor board
15.02	debugging of motors and movement of the robot on the field	assemble a robot	design PCBs
23.02	line debugging	designing 3d models	design PCBs
02.03	line debugging	designing 3d models	design PCBs
11,03	line debugging	modeling mirror mount	design PCBs
19.03	debugging video / optimization FPS	Install a mirror on the robot	Finish the motherboard
21.03	Debugging the attacker, changing the code under the mirror	Pour dribble roller Finish modelting dribbling	Finish the motherboard
23.03	code change taking into account dribbling	make dribbling	Finish the motherboard
24.03	Debugging goalkeeper	Fully assemble the second the robot	Start the second motherboard
26.03	fix goalkeeper problems	Fix problems	Finisht the second motherboard

Project journal

Development of the first version of the 3d model of the robot and the selection of components

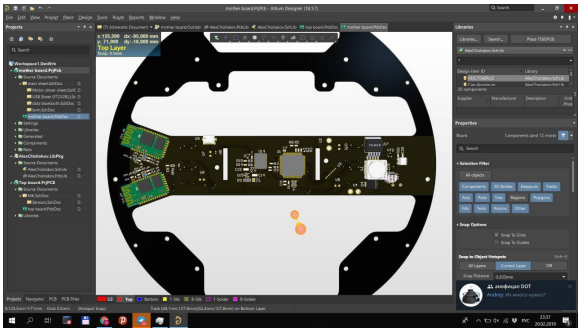
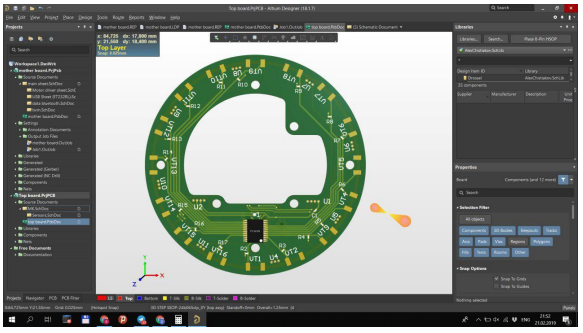
description	Foto
Key ideas: Our team decided to design a printed circuit board based on the ATmega 2560 microcontroller. All the printed circuit boards of the robot will simultaneously perform the function of the frame. **The first 3D model:** The first 3D model was also developed, later the model was completely redone and improved.	ATmega 2560  The first 3D model of the robot 
Total: After the first week of work, we had an idea of what our robot will look like and what components we will use.	**Specification:** we began work on finding sensors to detect infrared ball

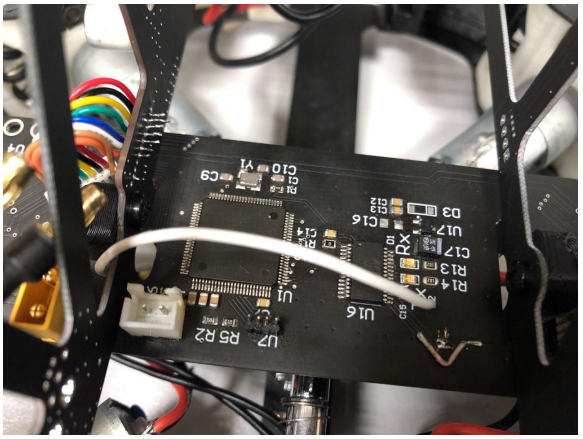
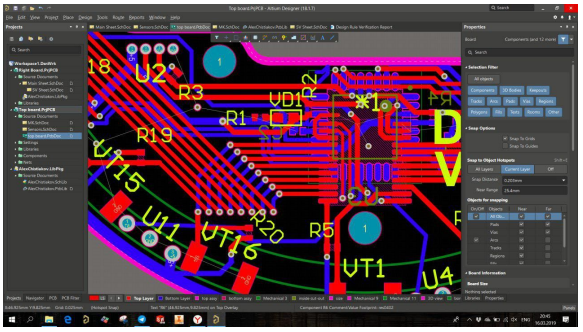
Continued work on the 3D model and a detailed study of previously selected components.

description	Foto
Components: The next few weeks, we studied in more detail the components. In particular, a sensor was found to detect the infrared ball, tests were carried out with it, and the dependence of the signal strength on the distance to the ball was revealed. Nearby is a schedule of this dependence **Design:** At the same time, we were finalizing the 3D model and inventing new structural elements, such as a roller for dribbling. Several interesting design solutions have been made, such as the use of a quick-changeable battery and modular protection of the robot**.**	 Conical mirror made on a lathe   Li-Po Battery

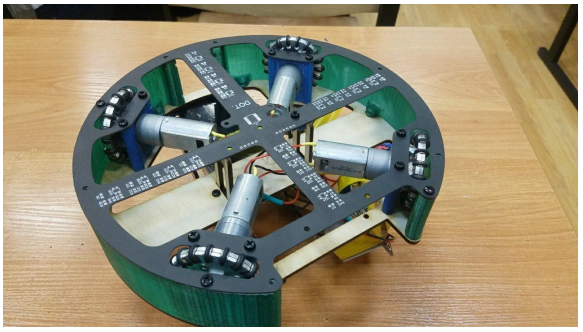
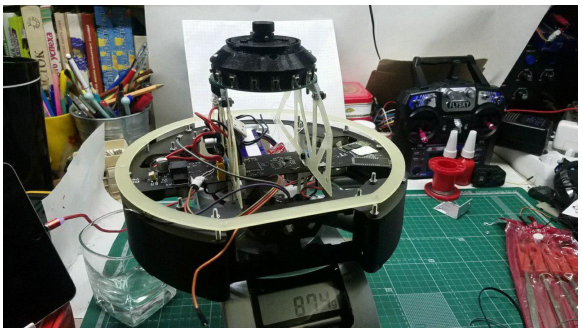
Total: The latest version of the 3D model of the robot was designed, suitable sensors were found, a mirror was made.	

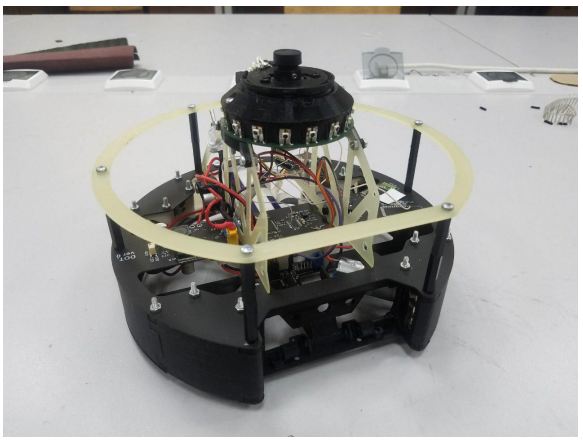
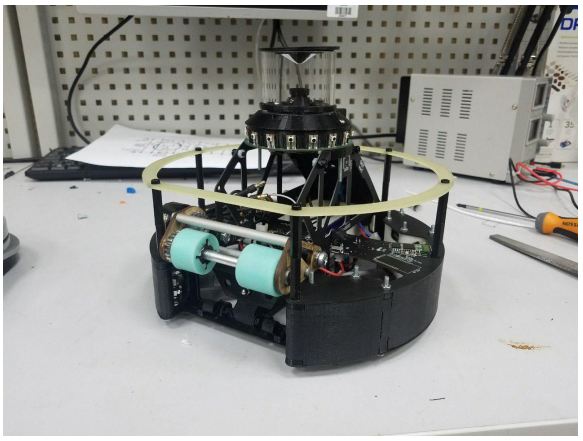
PCB Manufacturing

description	Foto
It was decided to use the printed circuit boards as the frame of the robot and in order to replace the wires in order to save weight and free space. The design of printed circuit boards was started using Altium Designer CAD. All boards are double-layered, with the exception of line sensor boards (it is four-layered). The line sensor board, the motherboard, the top sensor board, the left, right board were consistently designed.	 

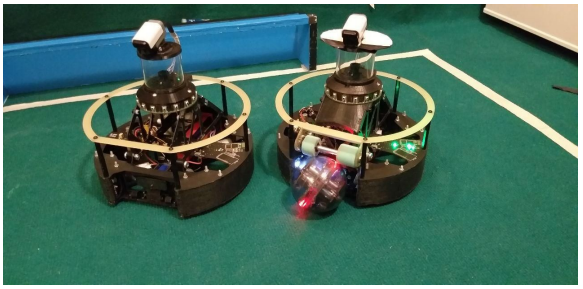
When all the PCBs were designed and manufactured at the factory, they were soldered	
Total: A number of errors were identified and corrected both at the design stage and during the work with the board. These errors will be taken into account and corrected when designing the next versions	

Building robots

description	Foto
After the production of printed circuit boards at the factory and their wiring, the assembly of the robot began. During the assembly process, some technical solutions were changed, new ideas appeared, we abandoned old ones. It was carried out a fairly extensive work on the search and selection of motors for the robot. We tested various motors, changed the gearboxes, checked the motors for heat, for a ratio of speed and torque. Having experienced many different options, we decided to use different types of motors: Pololu MR20D 25: 1	 

on the goalkeeper and Sumozade on the striker. Later, the goalkeeper was finalized completely in the image and likeness of a striker.	
Total: During the assembly process, the design of the robot changed and improved, which made it possible to create a design that was both light and functional.	

Building the second robot and debugging

description	Foto
Making a second robot: The second robot is assembled and manufactured in the same way as the first one. **Debugging programs.** The rest of the time, we continued to debug programs. **Making of boxes for transportation and storage of robots:** The boxes are cut on a CNC laser cutter.	 

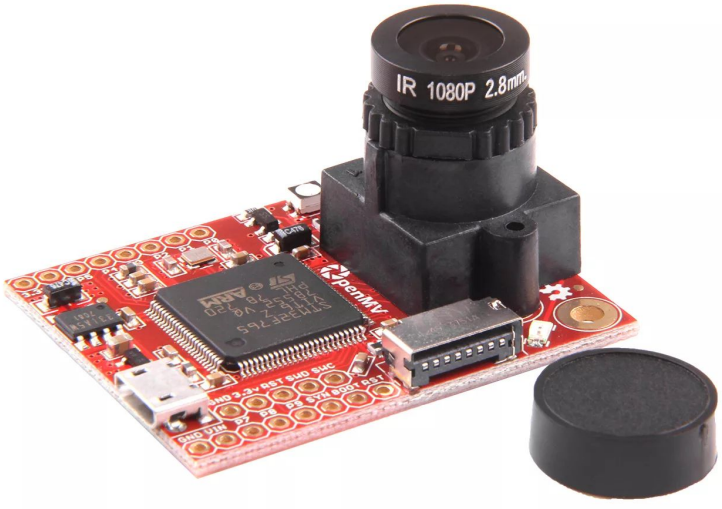
Equipment

Atmega 2560

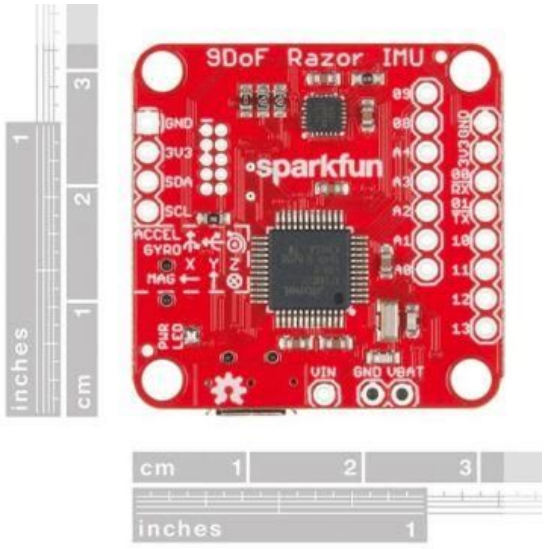
Motors Pololu 25: 1 Metal Gearmotor 20Dx41L mm 12V CB

Solenoid Pusher

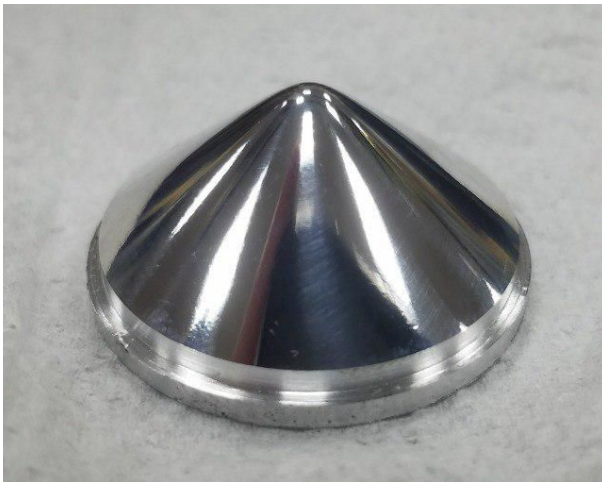
OpenMV Cam M7



Inertial module Adafruit 9DOF RAZOR M0

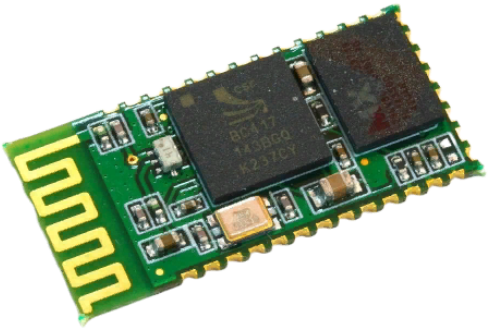


Self-made conical mirror



Optocouplers KTIR0711S

Bluetooth module HC05



Phototransistor TSOP 2240

Progress

In the process of working on the project, we summarized the experience and learned new ways to create 3D-models; design of basic electrical, and subsequently printed circuit boards; constructing mathematical and probabilistic models of computer vision: color marks, contours, optical shifts, etc.

Gratitude

Our team wants to thank the director of the Presidential School of Physical Education #239 Pratusevich Maxim Yakovlevich and the team of teachers of the Presidential Lyceum Physico-Mathematical No. 239, who helped in the creation of robots, namely: Romanko Pavel Nikolaevich, Ivanov Vasily Leonidovich and Filippov Sergey Aleksandrovich am not the only one to give my thanks . We also want to thank our sponsors: the Temur Aminjanov Charitable Foundation “Finist”, Kirovsky Zavod CJSC and the Anabasis Foundation for the Support of Classical Education.