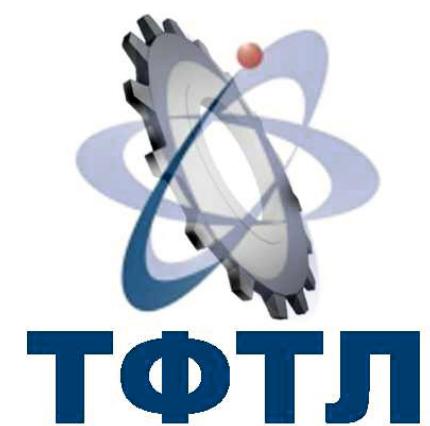




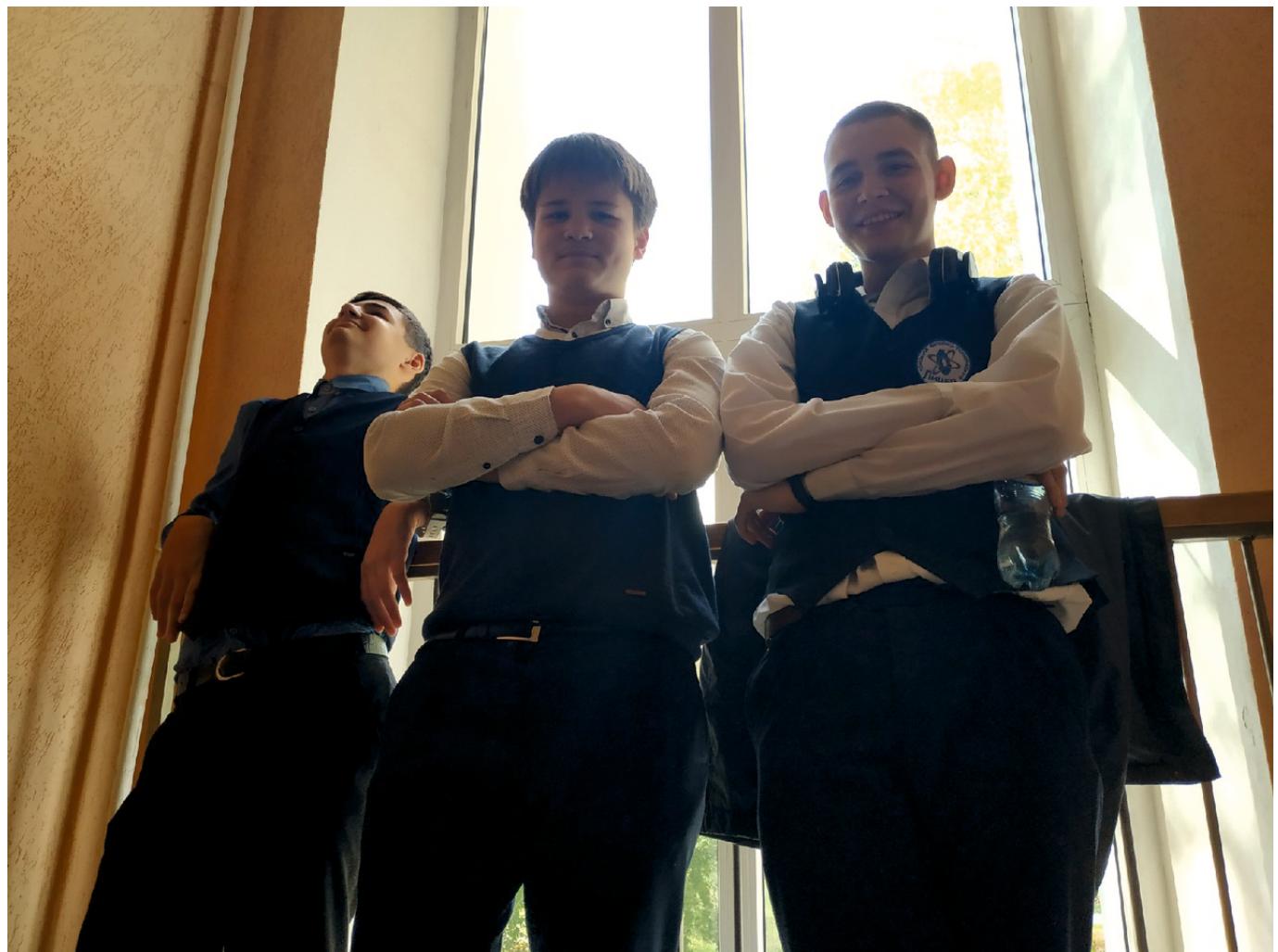
Team **Enigma**

Technical journal



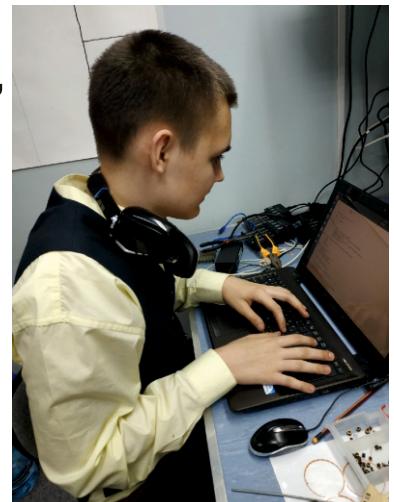
Introduction

We are school team from Tomsk physical and technical lyceum and we have experience of participation of different level competition. In Robocup Junior soccer lightweight we are two years.

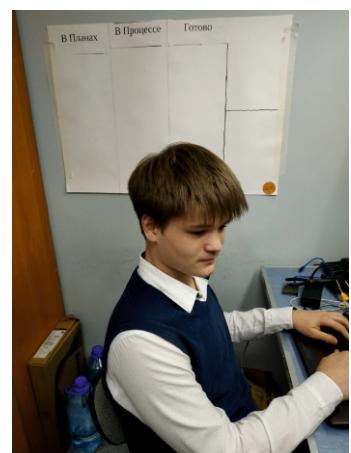


Line-up

Vinnichenko Ivan - team leader,
his work front: breeding boards, programming,
soldering.



Hammatov Nikita - his work front: modeling
of construction, programing.

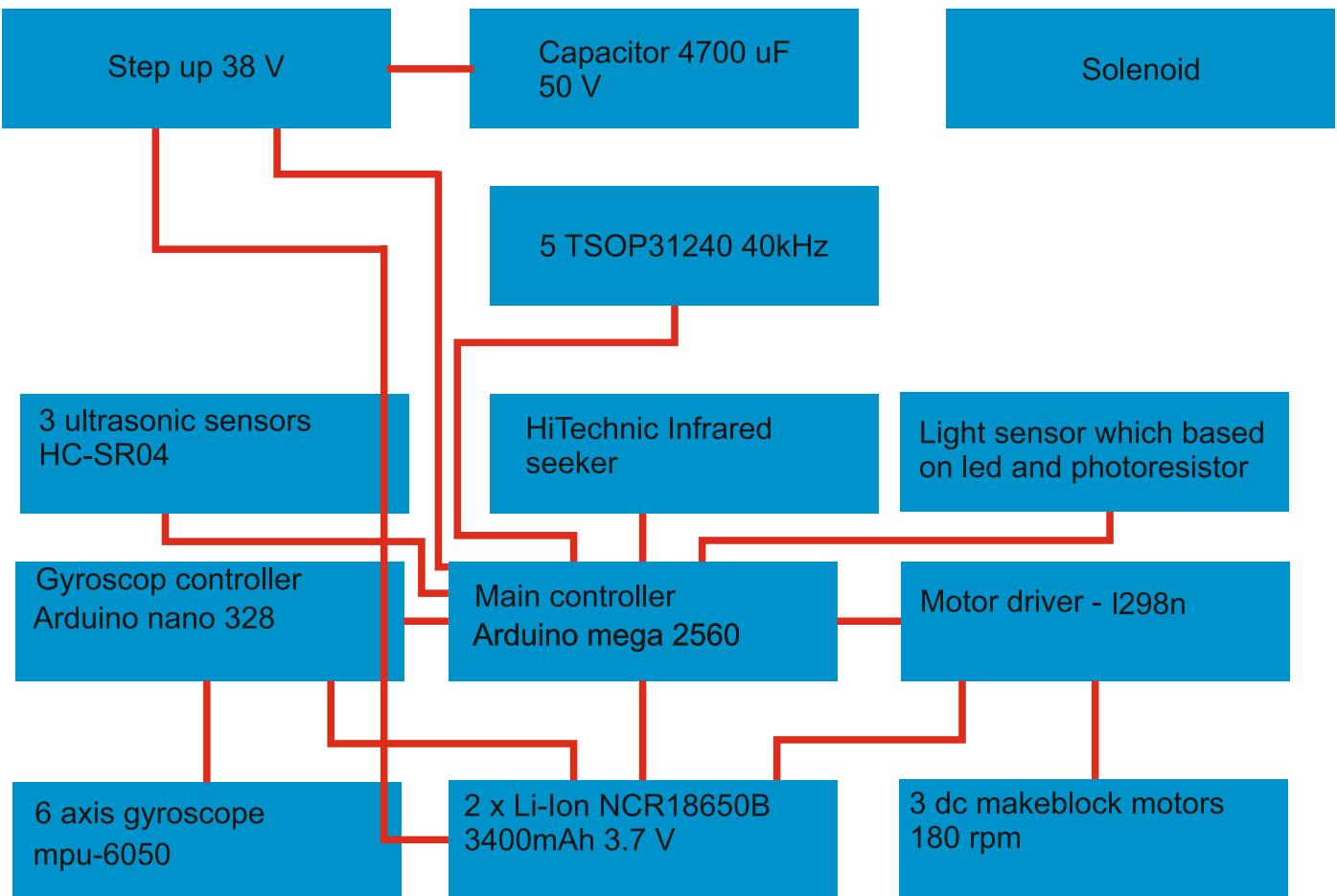


Gubin Sergey - his work front : soldering,
assembly.



Kosachenko Sergey Viktorovich – trainer
of the team.

Robot architecture



Mechanical part of robot

Construction of our robot have designed by CAD Autodesk Fusion 360 because we have academic license and function that check strength of construction.



Mechanical part of robot. Description.

Robot are three wheel round trolley which have three levels

In first level there are:

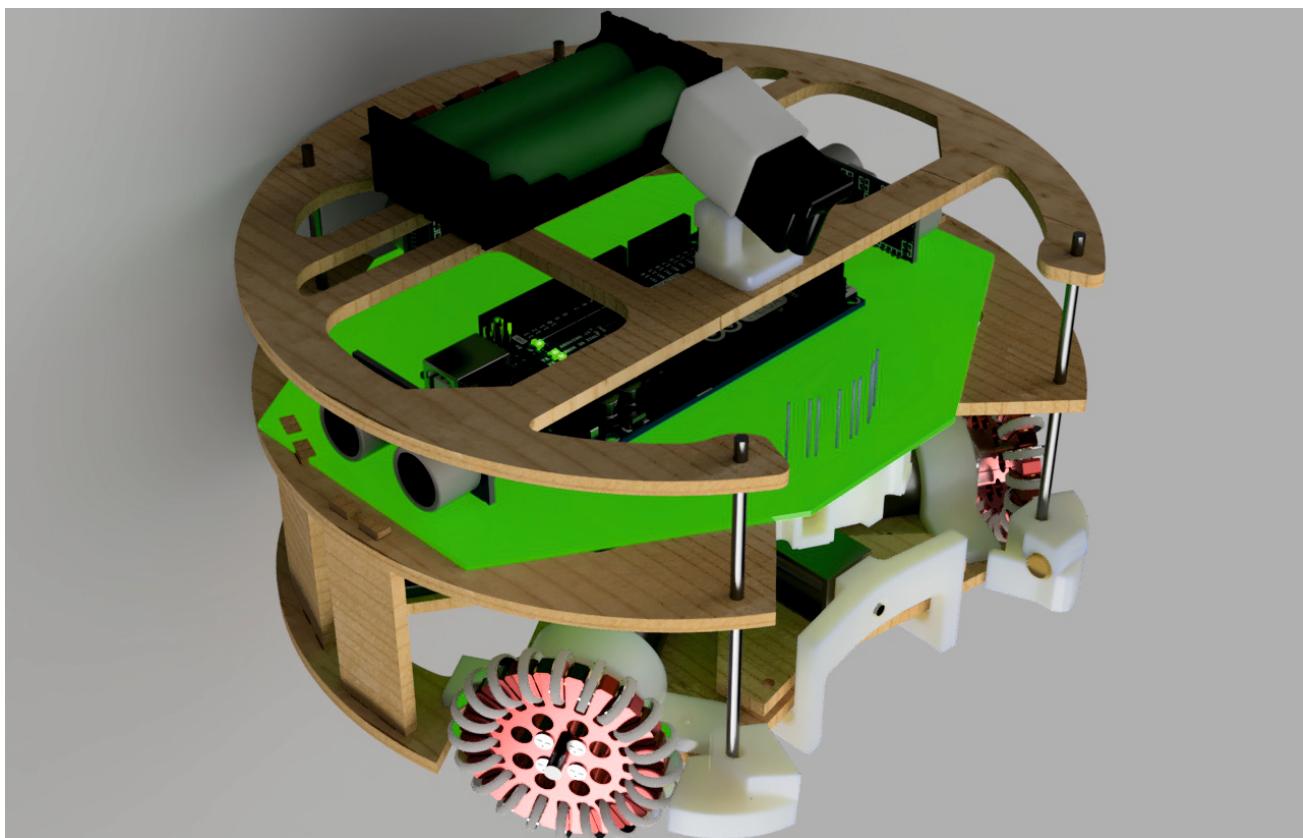
- laser gate
- motor shields
- motors
- solenoid
- light sensor

In second level there is:

- motherboard

In third level there are:

- switches
- Infrared seeker

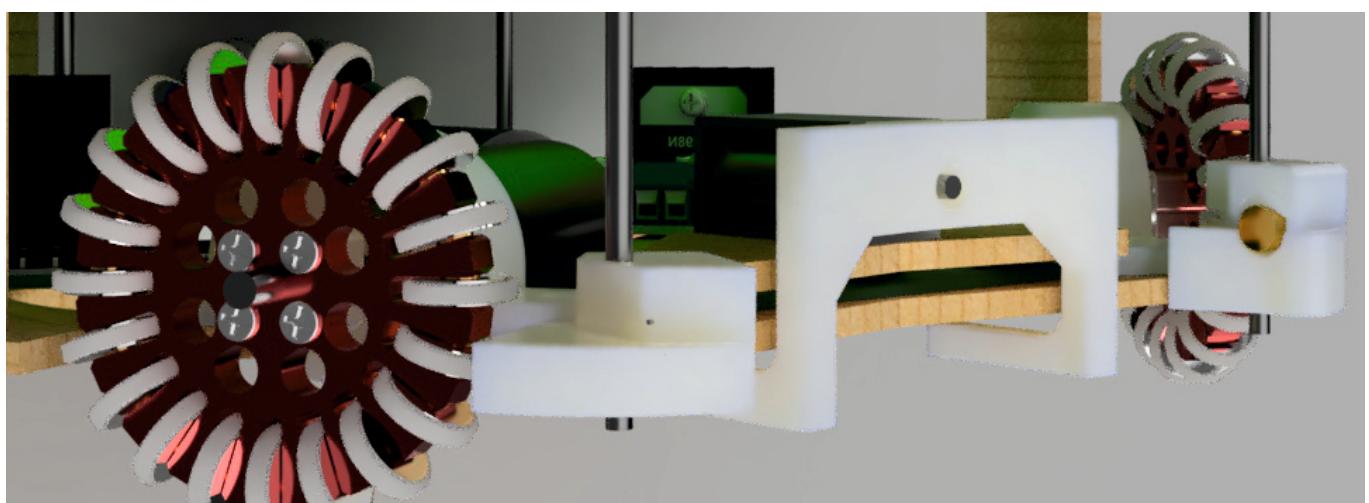


System of kicker

Kicker mechanism is solenoid with plastic plate that serves for increase place of kicking and shooting in the middle of the ball.



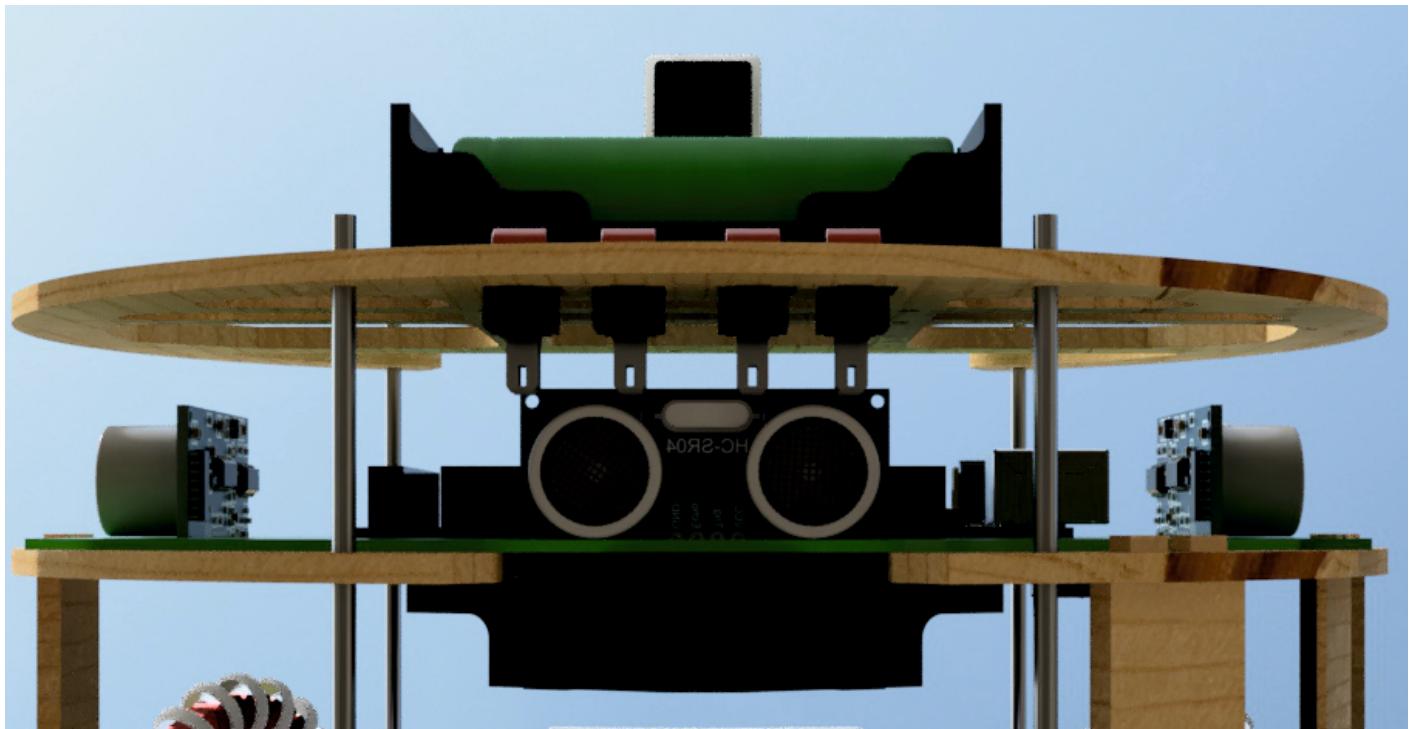
Control of solenoid is carried out by means of a photo interrupt, consists of lazer and photoresistor



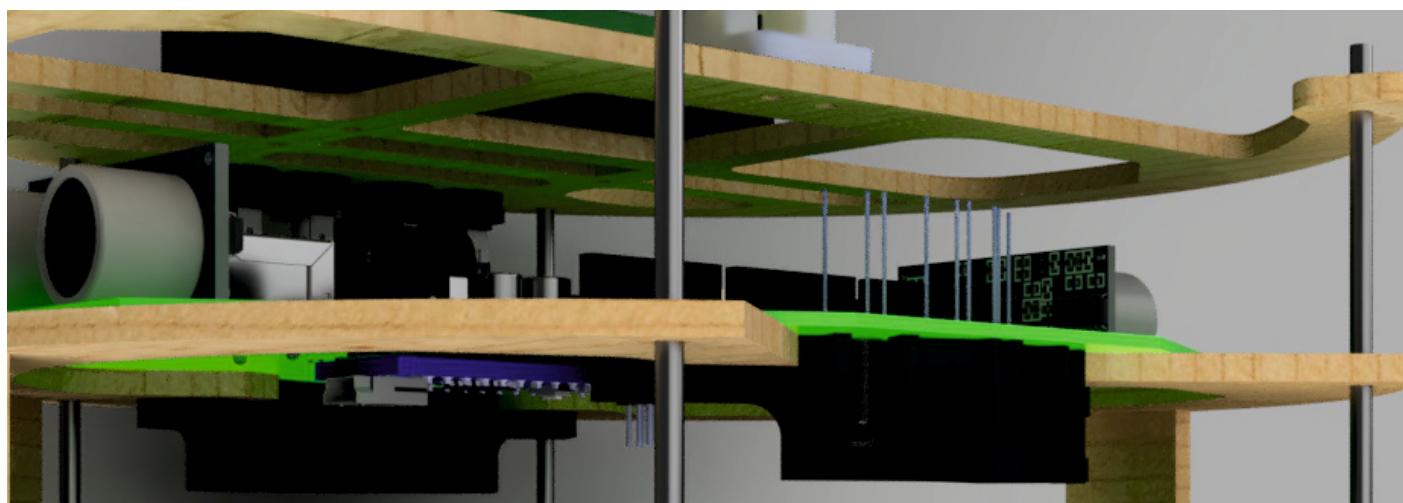
Mechanical part of robot TSOP.

TSOP have placed in front and back part of robot.
This construction have been designed for control
their space of view.

For back part



For front part



Electronic part of the robot

The electronic part of the robot was placed in the motherboard and the light sensor Board, because the electrical part is large enough it is designed by the kicad program group because of the accessibility and convenience



Motherboard

Mother double sided printed circuit board

In the first side:

main controller - Arduino Mege 2560

system of controlling solenoid

indicators and calibration system consisting of LEDs
and buttons

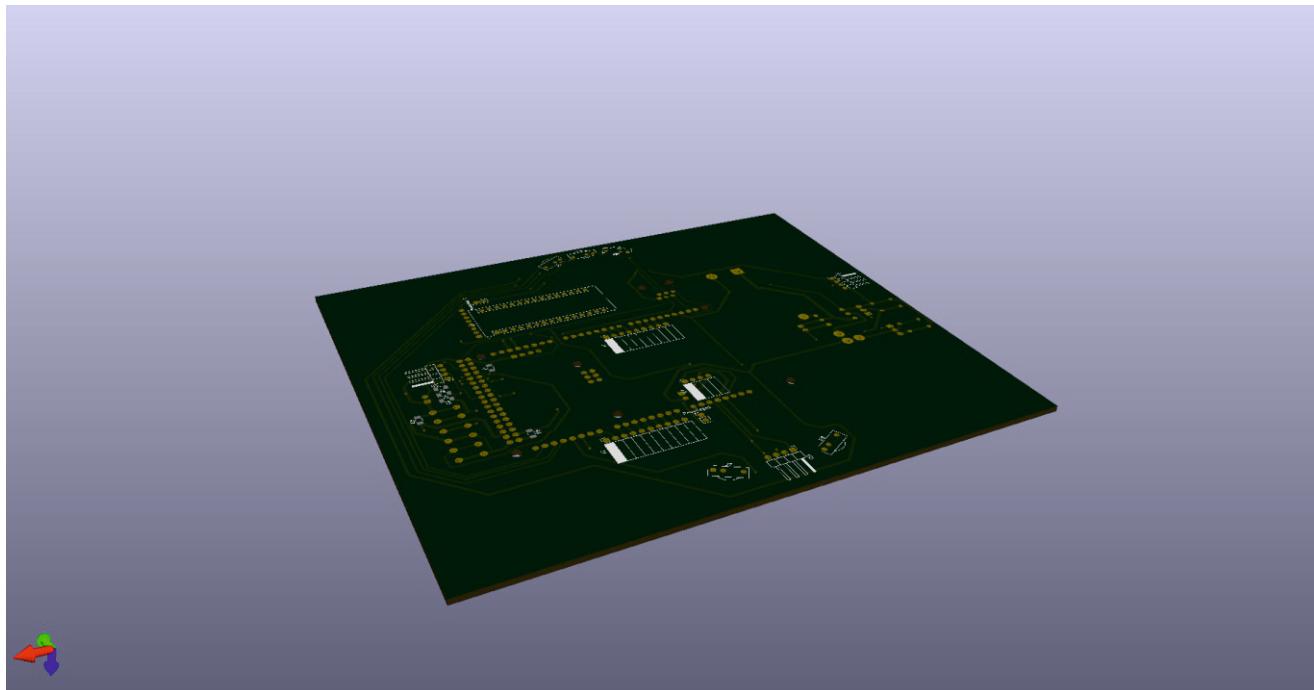
bluetooth module HC-05

In the second side:

gyro mpu6050

controller of gyro - Arduino nano

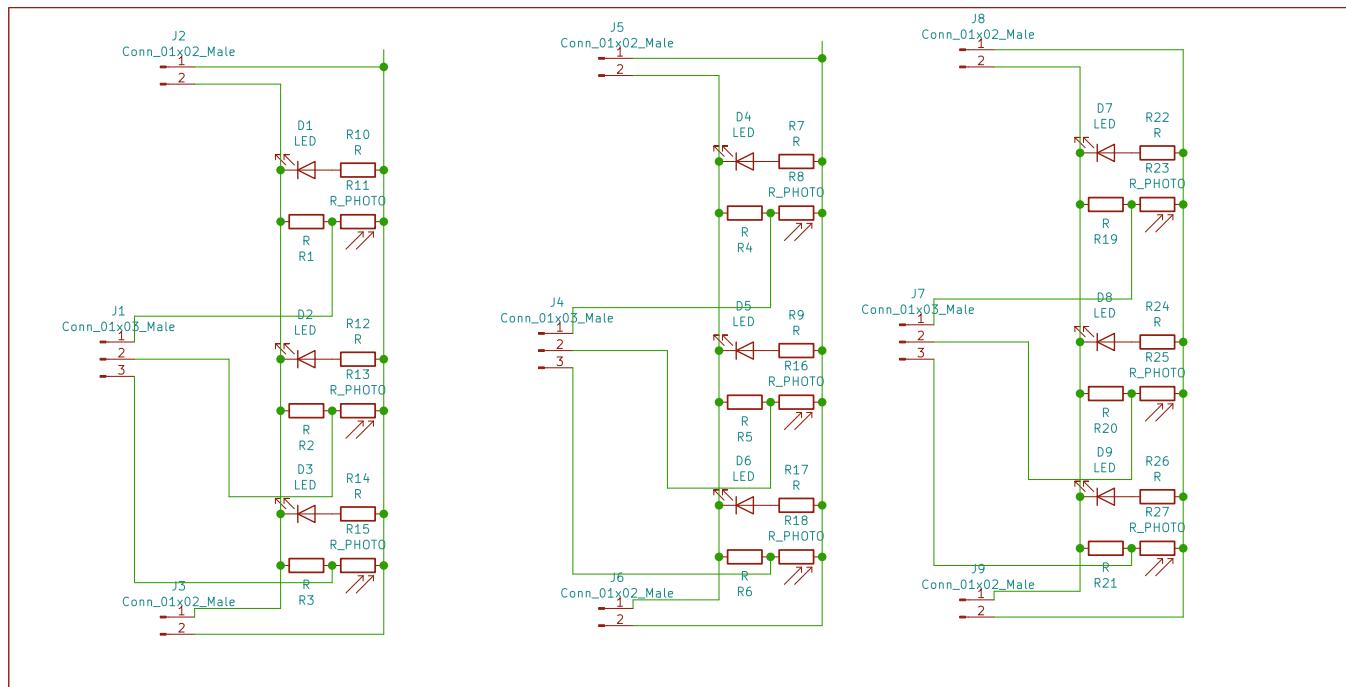
5 TSOP31240



Electronic part of the robot. Line sensors.

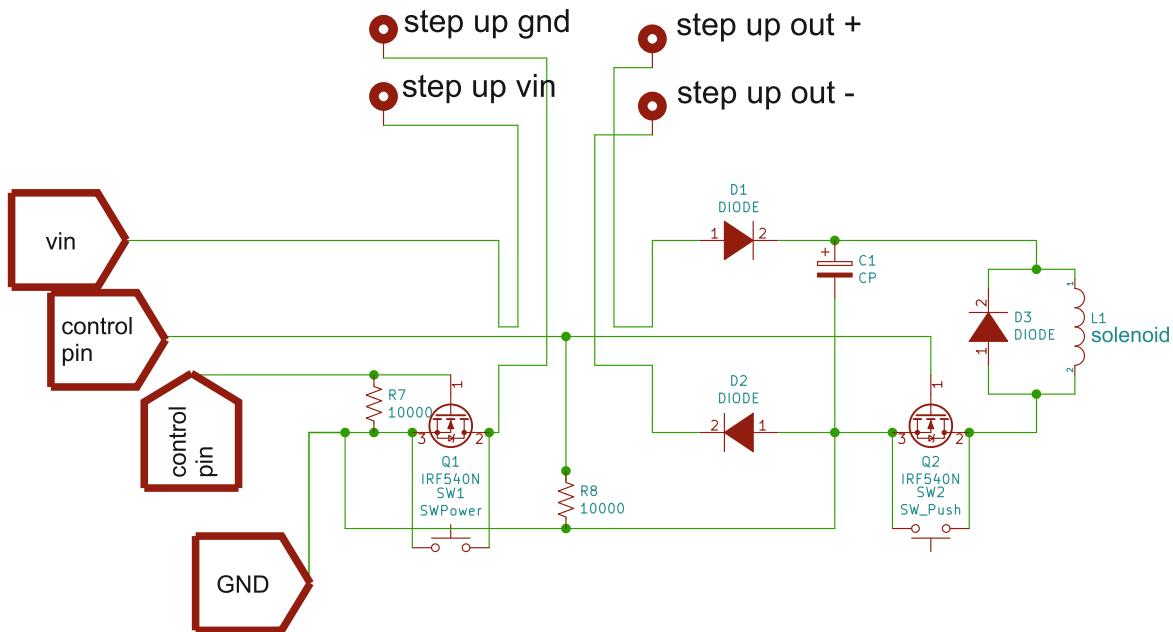
light sensors consisting of LED and photoresistor in this scheme we use white SMD diode and photoresistor Gi5516

Scheme of the plate:



System of controlling solenoid

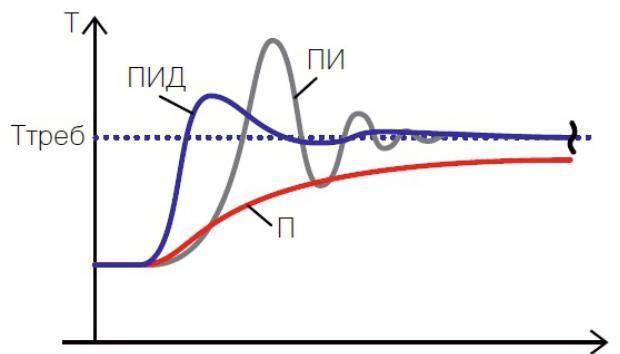
System of controlling solenoid based on transformation current in step-up station up 38V and charging it in capacitor, control of current have based in system that have based in field-effect transistor IRF3205.



Programming part

Moving and navigation

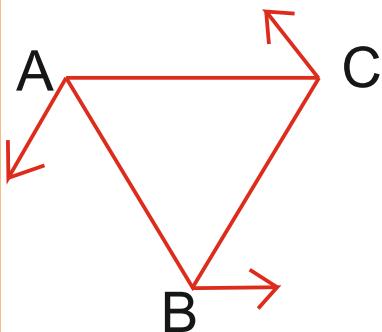
Program part have written in C/C++ by using Arduino library, for navigation in space we using gyro that output have been filtrating by Kalman filter, to increase ride evenness when calculating the deviation of the robot from the azimuth we use the pid controller.



For calculation deviations from azimuth we using this formula where azimuth — is direction on gate, gyro – is absolute position of the robot, up - is deviation of the robot from the azimuth.
 $up = (\text{gyro} + 540 - \text{azimuth}) \text{ MOD } 360 - 180$

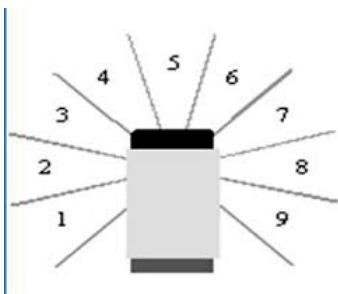
There was also a problem with the calculation of the ride certain angle to solve which this vector model was constructed.

The final formula, where angle is the desired angle, power- is gain factor,error- is deviation from azimuth with pid controller.

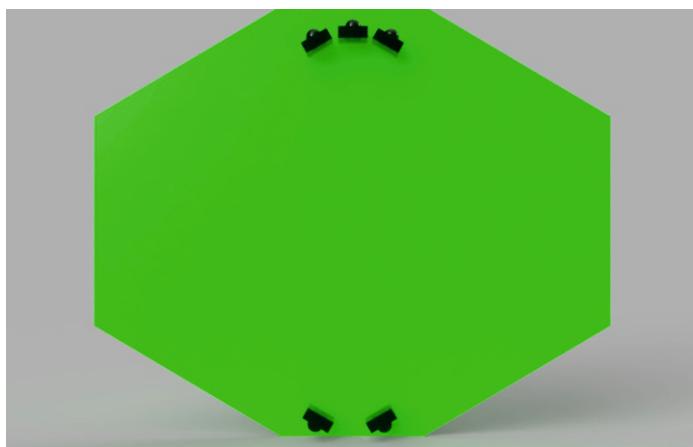


$\text{powerA} = (\cos(150) * \sin(\text{angle}) * \text{power} + \sin(150) * \cos(\text{angle}) * \text{power}) - \text{error}$
 $\text{powerB} = (\sin(-90) * \cos(\text{angle}) * \text{power}) - \text{error}$
 $\text{powerC} = (\sin(30) * \cos(\text{angle}) * \text{power} + \cos(30) * \sin(\text{angle}) * \text{power}) - \text{error}$

Programing part. Search ball.



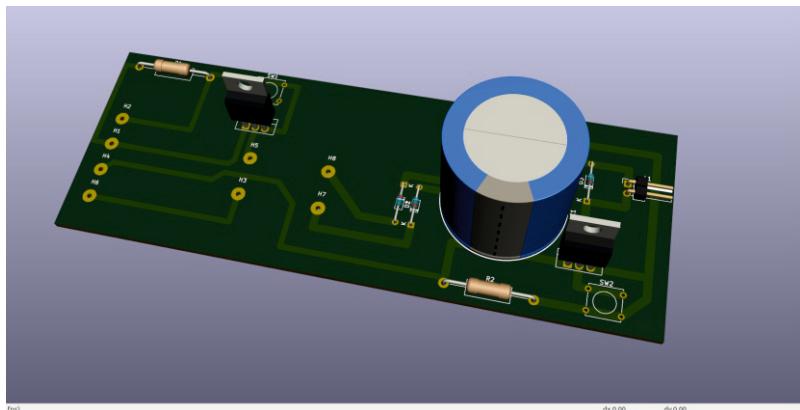
Basic information about the position of the ball we gain from Lego HiTechnic Infrared Seeker. It output position of the ball in nine zone, also our robots has 5 TSOP that located at robot in the following way, this allows the sensors to cover the area that is needed to coordinate detour and capture the ball



Our photo chronicle of events

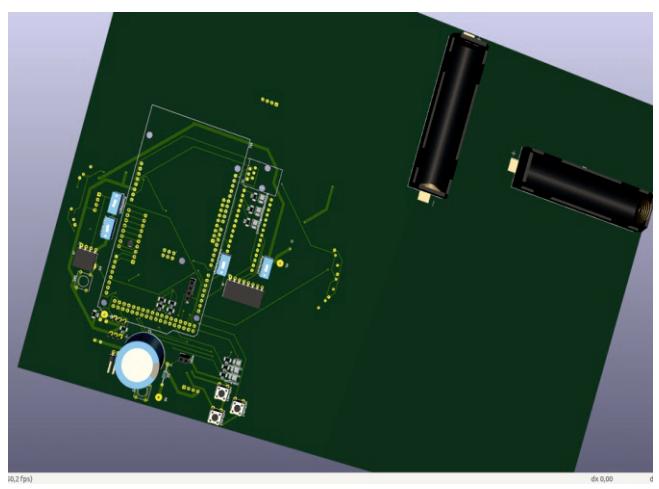
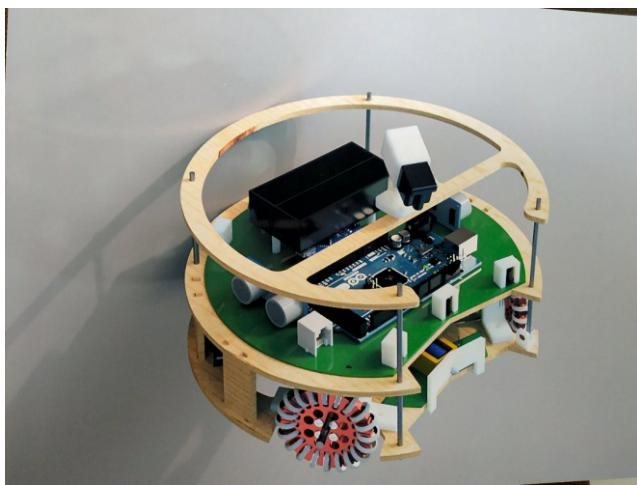
16 of May start of design:

Nikita model robot, Ivan make printed circuit board.
In photo there is scheme that will control solenoid



28 of may end desigh of first prototype

3D model of prototype of first robot 3D model first prorotype of motherboard



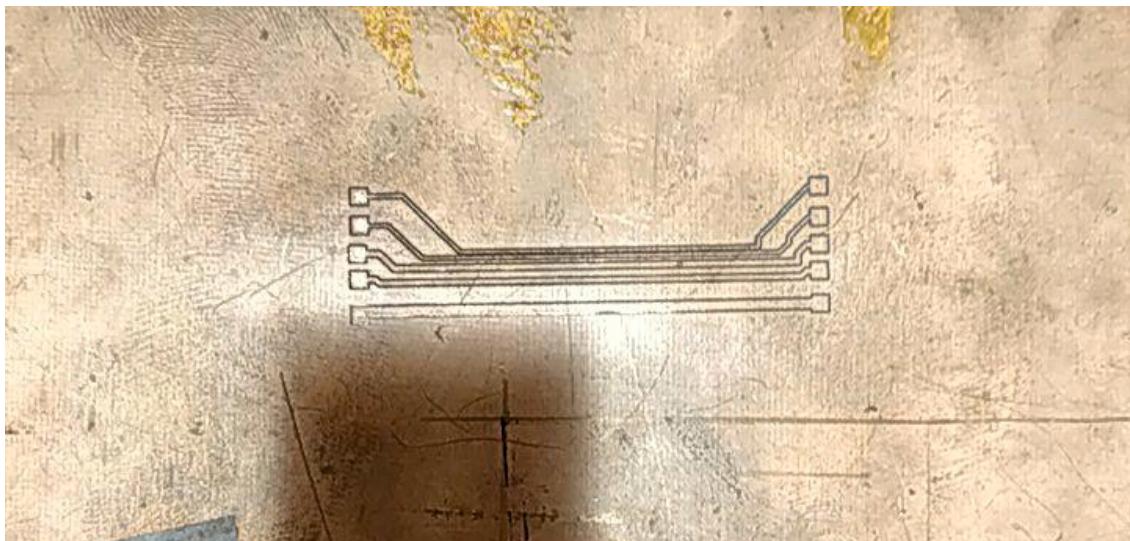
May 29 choose a way to create electronic boards

We can use Iron on Glossy paper method to create an electronic Board, this method is simple, but we have problems with the two sides it is that it is very difficult to match the holes, also we have CNC milling machine but we dosent tested it. We have solved that Sergey and Ivan will try make first motherboard by Iron on Glossy paper method. Nikita will working with CNC milling machine.

From 30 of May to 11 of June CNC milling machine

With CNC milling machine we have a lot of problems starting of setting coordinate system ending of connecting the probe to create a map of the area textolite, in this time by using Iron on Glossy paper method we make first prototype of electronic board.

First successful engraving of electronic board



13 of June first attempt of making motherboard by using CNC Milling Machine

First attempt was failed , some of the ways was broken, to avoid of wasting pcb we decided to change technology we decide to increase width of the track in this time prototype of motherboard that was made by Iron on Glossy paper method was made and now was soldering .



19 of June by using laser cutting we was make plywood part of the robot

We have some problem not compliance motherboard with plywood parts, for the first time we can play with them, but in the future we have to rewrite. We started assembly robot prototype , connect modules with prototype of motherboard.

25 of June end assembly of first prototype

We had problem with motherboard, but first prototype exactly ride, we understand that we need increase quality of transfer print circular board. In the photo we can found first prototype in game.



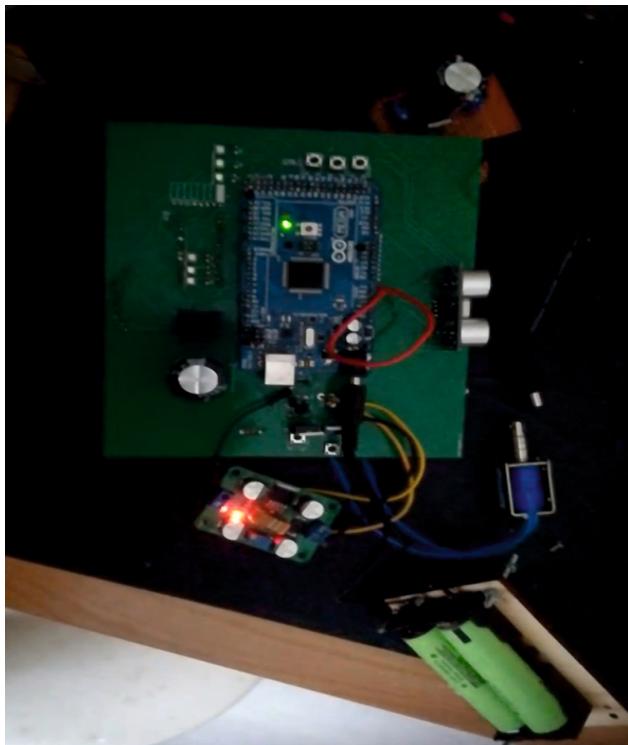
12 of July order motherboard

We decided that we can't increase quality of transfer PCB their own, because of this we decide to order motherboard in JLCPCB company, Ivan improve quality of drawings of electronic board.



22 of August Ivan is soldering motherboard

Motherboard, that we order, came. Ivan was soldering them. In photo we can found motherboard in work.



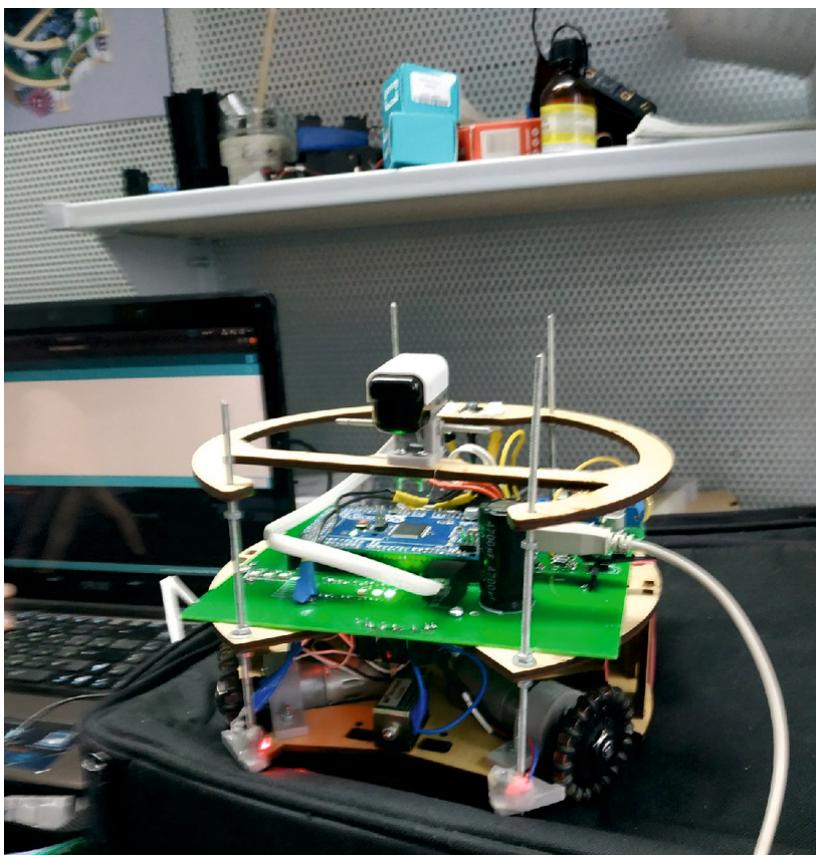
26 of August we resume work

Cut robot with according to the new drawings. In photo we can found new version of the robot.



29 of August end of making second prototype

We have made second prototype and now we write code that will be ride for the ball.

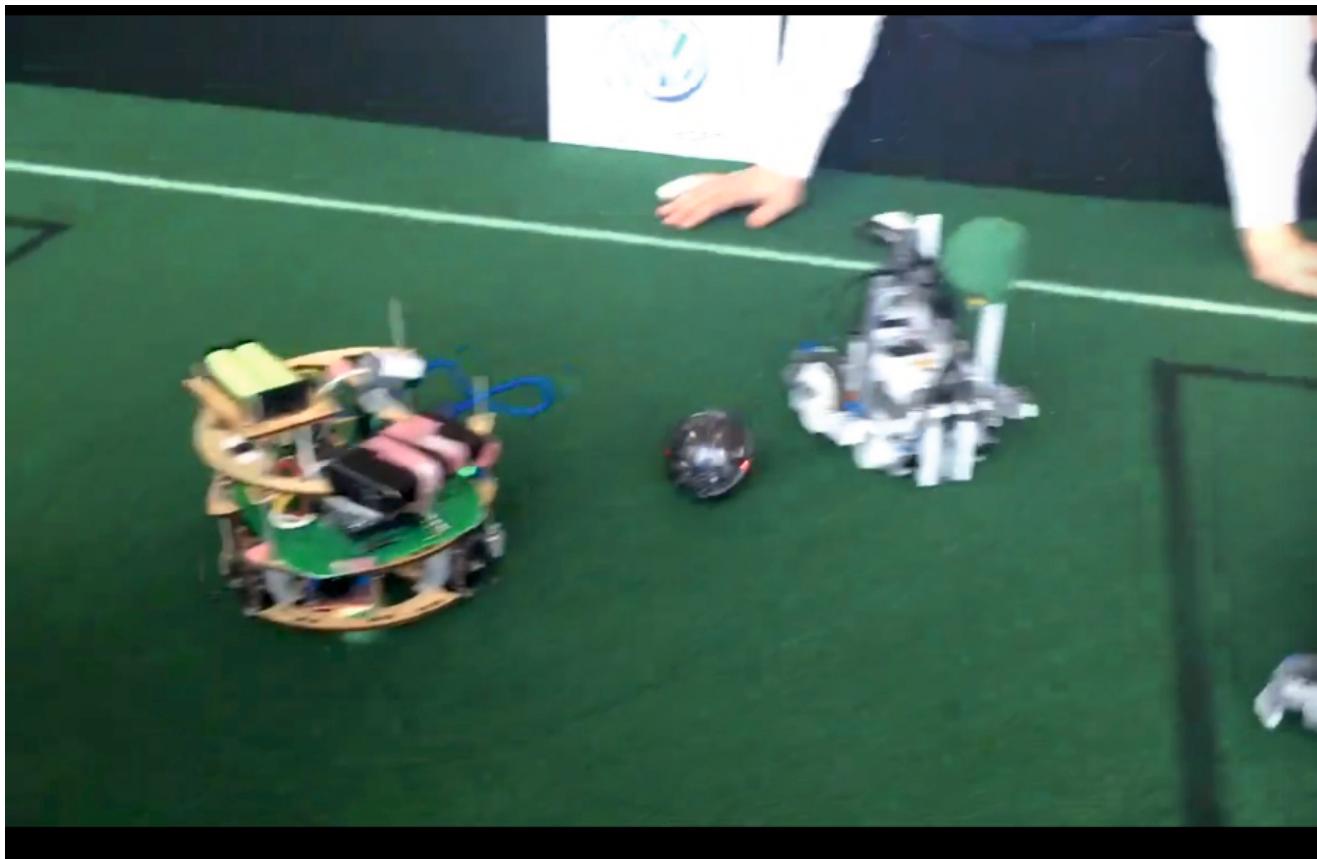


4 of September light sensor electronic boards came.

Electronic boards, that we order, came . Now we soldering and connect them.

14 of September friendly match

After assemblies second prototype we played friendly match with our team and other team from our liceum as a result of that we win but we find some construction deffects and some electronic components was damaged.

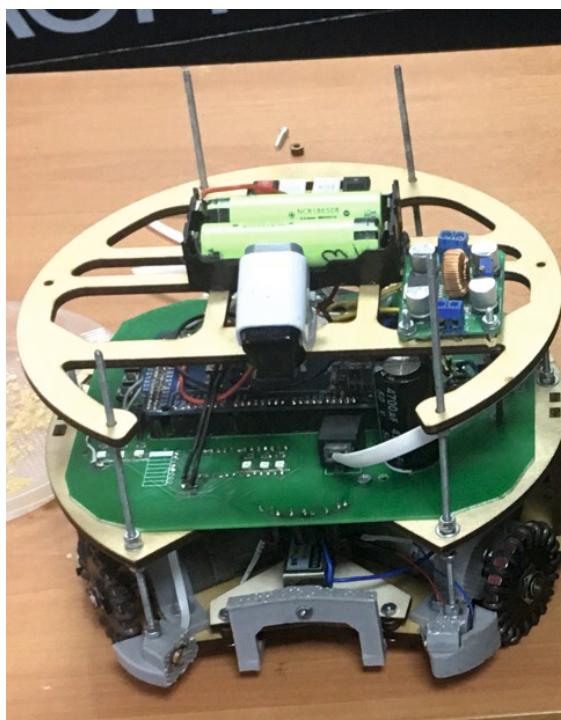


16 of September start of remaking robot

After friendly game we started remaking robot. Nikita was making new drawings.

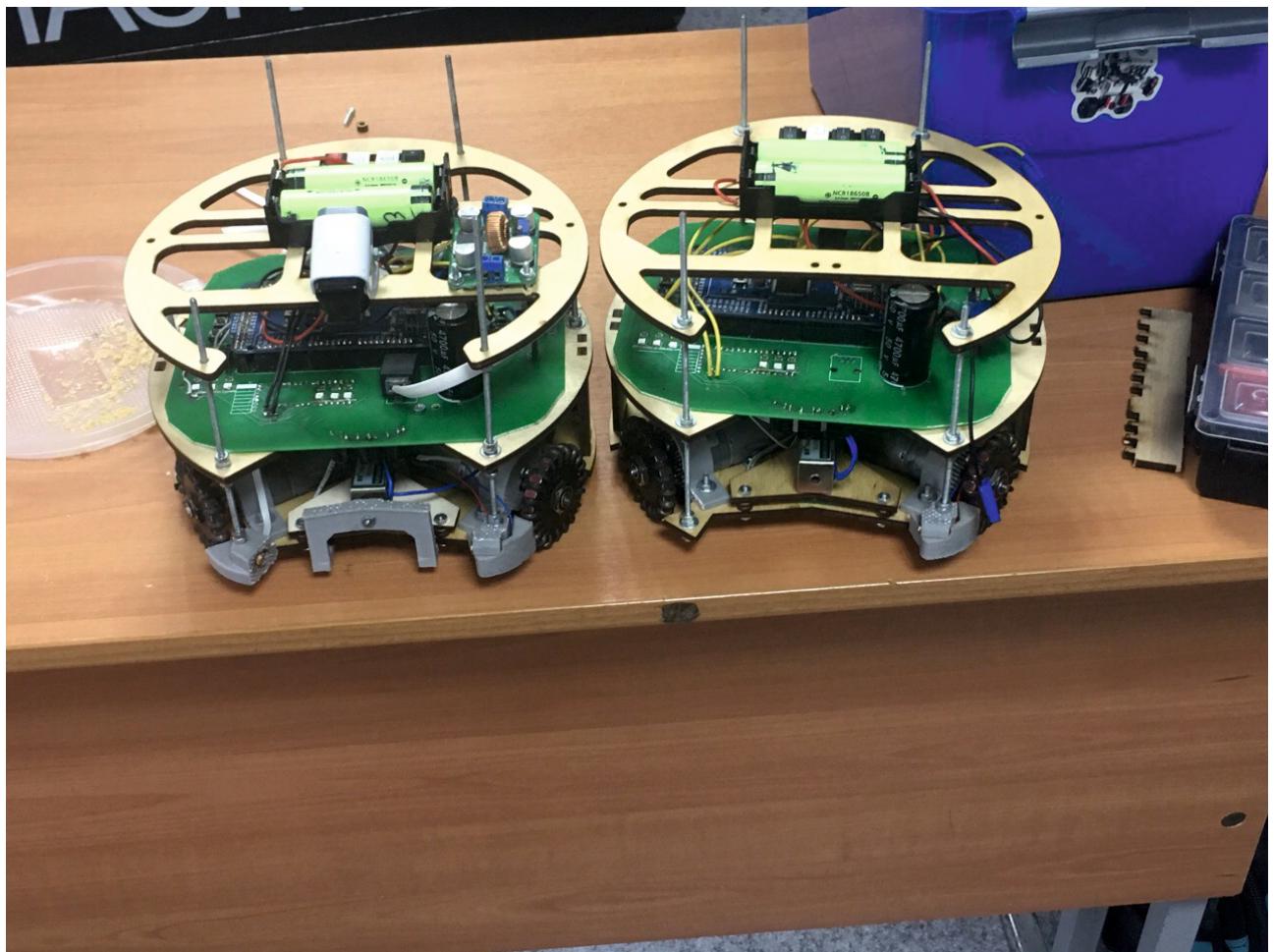
20 of September end of remaking

We made first robot, now we are writing program for him. Sergey was making second robot.



28 of September we made the second robot

We made two robots and now we will debug them .



Thanks

Our team thanks: Research and Production Enterprise “Tomsk Energy Company” for sponsor activity, members “Ruthless” team German Mostipan and Semenov Semen for help with gyroscale sensor and robot kinematics. Special we express to administration of Tomsk region.