0.1 Team meetings (10.11 - 03.12)

Description: The following section contains a consequence of team meetings with short descriptions. The purpose of this is to present the elaboration of the robot in it's progress. You can find the full information about modules and program in sections "specifications for modules"and "specifications for programs"correspondingly.
Days inside section:

0.1.1 12.11.2015

Time frame: 17:00-21:30

Today it was created the carriage (figure 1). There were applied 7 cm standard wheels with gear ratio 2:1 (speed about $2 \times 7 \times 2 \times Pi = 88$cm/sec). Next motors were connected to motor controllers and an NXT brick (as we didn't have new control system) and it was realised a simple program to test the wheel base. Source code is available in the section "specifications for programs".

The prototype had no problem with movement on the field. However, it's clearance was too narrow and it couldn't climb to the inclined plane. So, it was decided to rebuild wheel base with 10 cm wheels.

It was also created the prototype of the gripper for debris (figure 2).

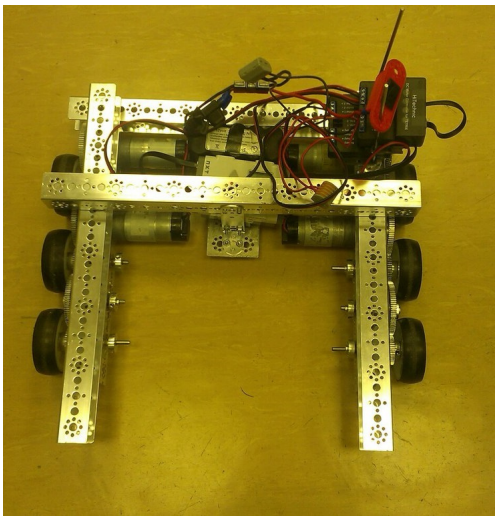

Рис. 1: Prototype of the wheel base

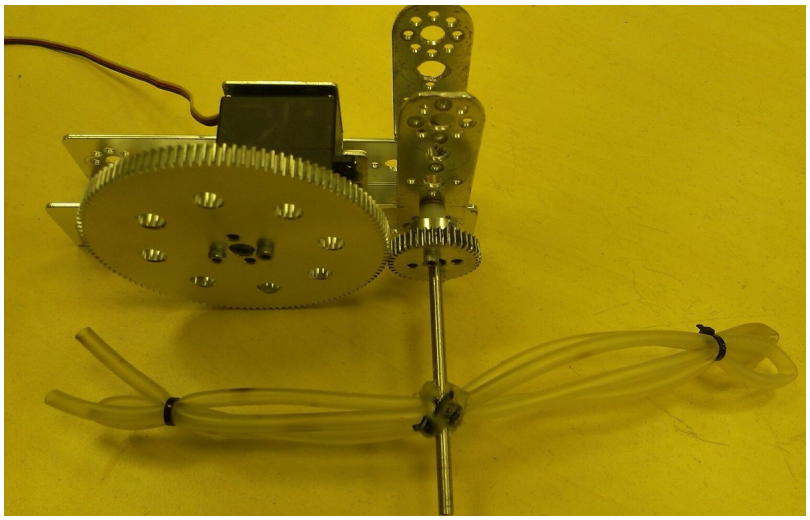

Рис. 2: Prototype of the gripper

0.1.2 14.11.2015

Time frame: 17:00-21:30
This day there was tested the improved version of program. It included movement by left stick, choosing speed with buttons A-D (12%, 24%, 48% or 96%) and accurate turns and straight movement (for alignment) with buttons L1, L2, R1, R2. Source code ia available in the section "specifications for programs".

0.1.3 16.11.2015

Time frame: 17:00-21:30

Today the gripper was mounted to the carriage (figure 3). Brushes for debris were not installed yet.

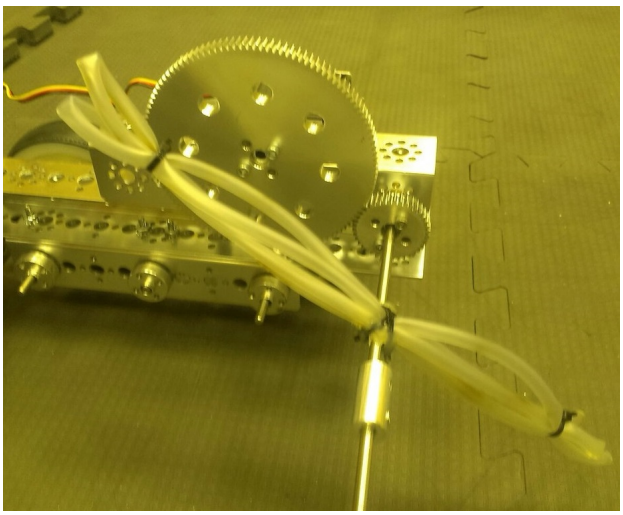

Рис. 3: Gripper on the carriage

0.1.4 17.11.2015

Time frame: 17:00-21:30

It was started the creating of a mechanism for shifting the bucket (figure 8). This mechanism is used for delivering the bucket to the box at hte horison direction.

It was also created a mechanism for scoring alpinists in autonomus period (figure 4, 5, 6).

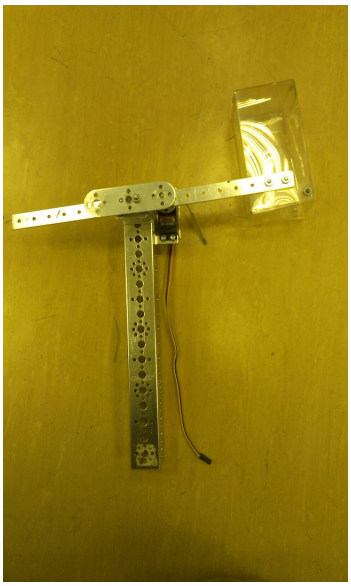

Рис. 4: Mechanism for scoring alpinists

Рис. 5: Mechanism closed

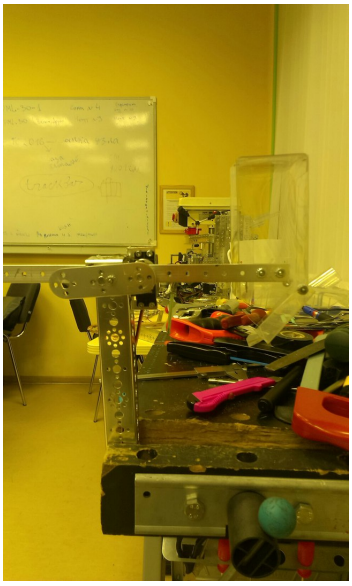

Рис. 6: Mechanism opened

0.1.5 18.11.2015

Time frame: 19:00-21:30

It was started the recreating of the wheel base. The left side was rebuilt with 10 cm wheels (figure 7). The gear ratio was changed to 1:1 (speed about $1 \times 10 \times 2 \times Pi = 63$cm/sec).

0.1.6 19.11.2015

Time frame: 17:00-21:30
The recreating of the wheel base was finished (figure 7). There was written the new version of the program. An only thing that has been changed since the previous version are the settings of the stick. Operating area of the stick was divided into 6 sectors with one option in each. The previous version had 8 sectors, so it was more difficult to choose the right one by the thumb.

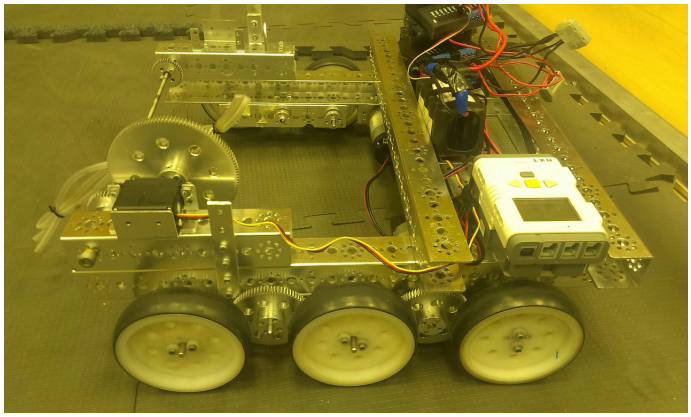

Рис. 7: Wheel base with 10cm wheels

0.1.7 21.11.2015

Time frame: 17:00-21:30

The mechanism for shifting the bucket was finished (figure 8).

The gripper was recreated due to the increasing of the height of the robot after installing 10 cm wheels (figure 9). The axis was moved to the demanded height. After that there was created the brush. It was made of silicone tubes tied to the axis by plastic clamps.

Next, the gripper was tested. The brush was capable of collecting debris. As for continious rotation servo, it was too slow and didn't have enough torque for acceptable collecing of the debris.

One more problem was that the gripper was staggering, because it was made of two axes connected by the sleeve. To avoid this, it was decided to install one tetrix tube instead of axes.

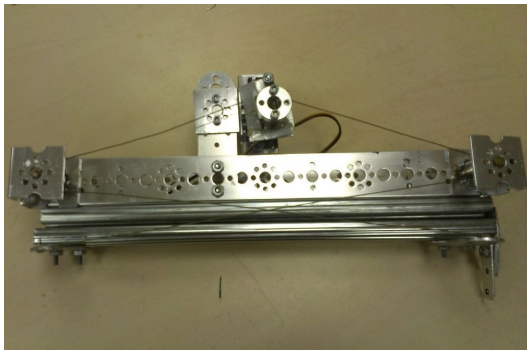

Рис. 8: Mechanism for shifting the bucket

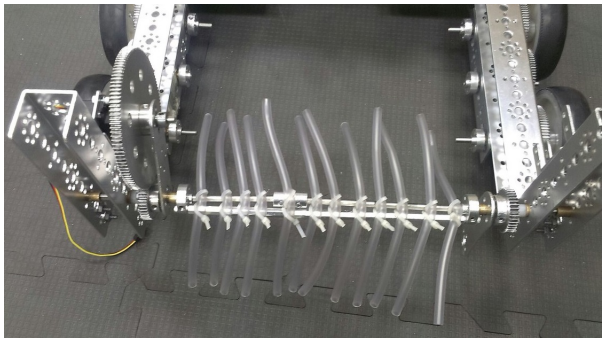

Рис. 9: Gripper with the brush

0.1.8 23.11.2015

Time frame: 17:00-21:30

It was created a prototype of the winch for elevator (figure 10). This constriction had gear ratio 1:2.

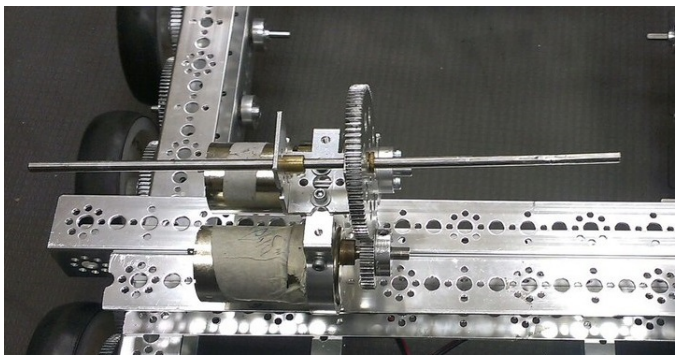

Рис. 10: Prototype of the winch

0.1.9 24.11.2015

Time frame: 17:00-21:30

The mechanism for scoring alpinists was recreated (figure 11). The beam for countraweight was removed, as the calculations clarified that it is not nessesary. The mechanicm became more compact.

Рис. 11: New version of the mechanism for scoring alpinists

0.1.10 25.11.2015

Time frame: 19:00-21:30

The aluminium profile for the elevator was cut into segments (figure 12). These segments were prepaired for installation onto the slats.

On the rails there were found coincident holes for connecting them (figure 13).

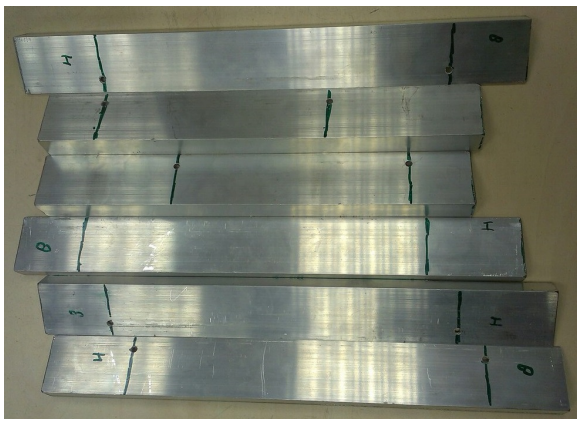

Рис. 12: Aluminium profile was cut

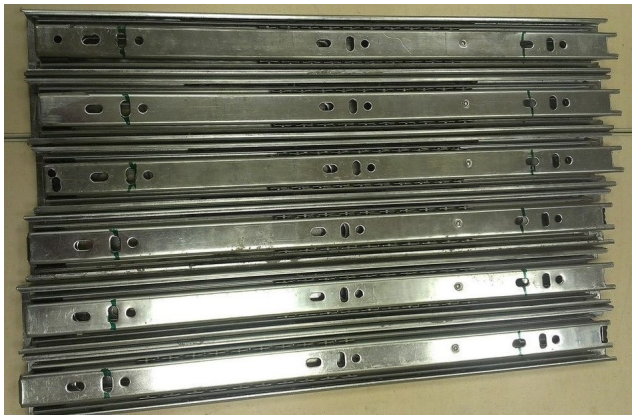

Рис. 13: Furniture rails were marked up

0.1.11 26.11.2015

Time frame: 17:00-21:30

Today we received the parcel with the original field. We started assembling it.

The slats were assembled of 3 35cm furniture rails each and installed onto the carriage (figure 15, 16). The angle between direction of extracting of the rails and the surface amounted to 22.5°

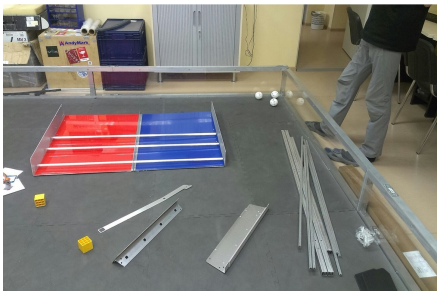

Рис. 14: Assembling of the field

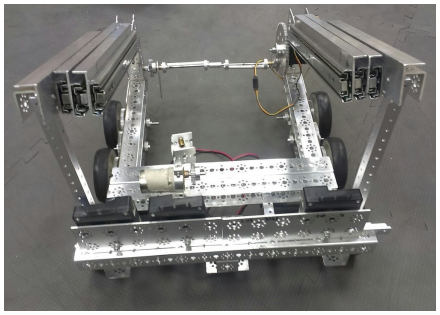

Рис. 15: Elevator installed onto the carriage

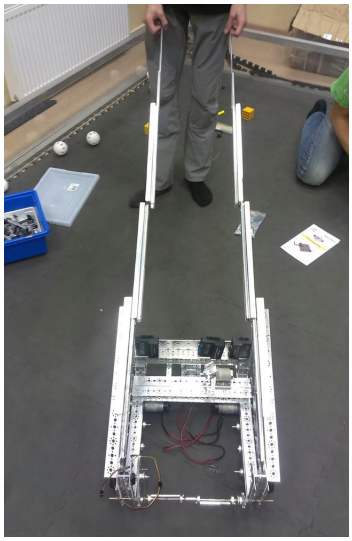

Рис. 16: Length of the slats

0.1.12 27.11.2015

Time frame: 17:00-21:30

The work piece of the bucket for debris was cut out of the pet (figure 17). It was no time to craft the bucket at this meeting.

There were installed angles onto the elevator (figure 18). These angles will be used for installing blocks.

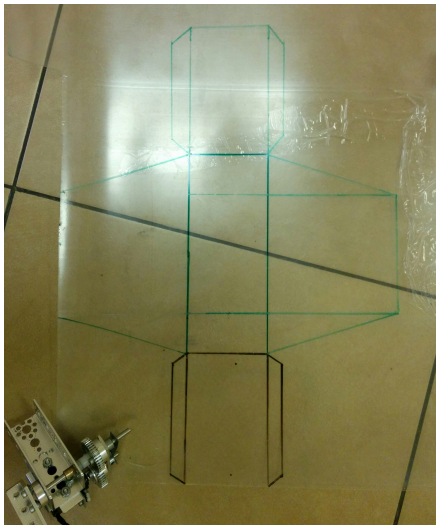

Рис. 17: The work piece of the bucket

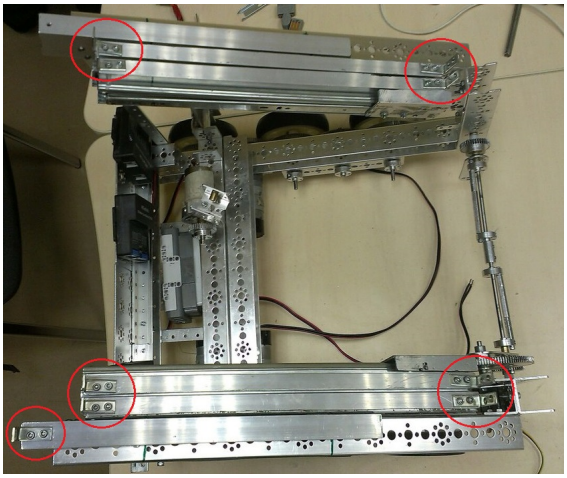

Рис. 18: Angles on the elevator

0.1.13 28.11.2015

Time frame: 17:00-21:30

Blocks were installed onto the angles on the elevator (figure 19, 20).

The concept of the winch was changed. It was decided to apply 3 standard DC motors with gear ratio 1:1. 3 standard TETRIX motors with torque 10 kg/cm and speed 2 r/pm are able to pull up robot of 10 kg with a speed $3 \cdot 2\pi \cdot 2 = 38$ cm/s. Incliding safety coefficient 1.5 the speed will amount to 25 cm/s. Since the overal length of the cable required for pulling up from 1-st zone is about 1m, the robot will be able to pull up in 4 seconds. The time of the full extracting of the elevator would be the same.

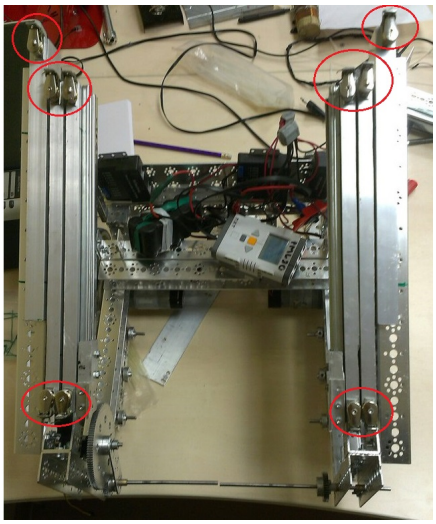

Рис. 19: Blocks on the elevator

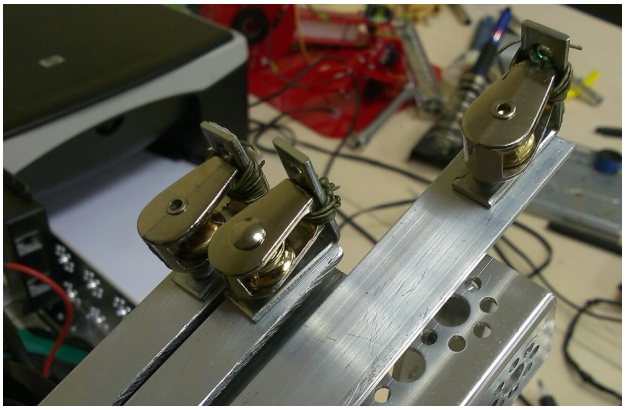

Рис. 20: Blocks

0.1.14 29.11.2015

Time frame: 17:00-22:00

The carriage was reshaped in order to provide more space for installation of the winch (figure 21).

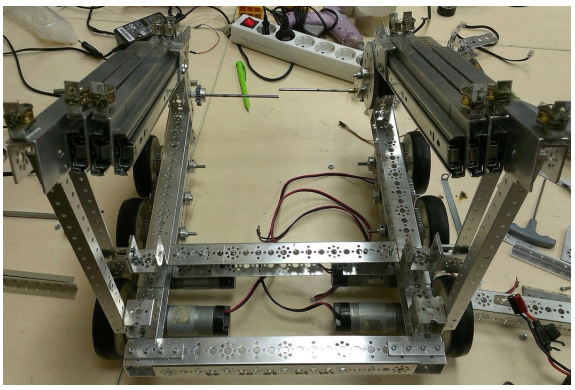

Рис. 21: Carriage reshaped

0.1.15 30.11.2015

Time frame: 17:00-22:00

The winch was assembled (figure 22).

It was also created the bucket for debris (figure 23, 24).

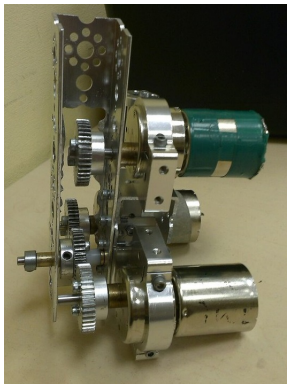

Рис. 22: Winch

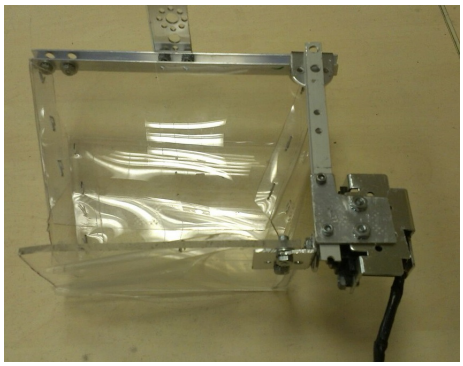

Рис. 23: Bucket (front)

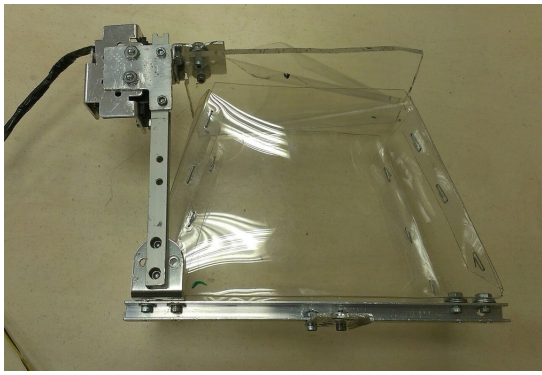

Рис. 24: Bucket (back)

0.1.16 01.12.2015

Time frame: 16:00-22:00

The winch was installed onto the robot. The 8mm axis will be connected with the winch. It will keep the coils for rope. There were drilled all the needed holes for fixing coils on the axis (figure 25, 26).

The gripper was reassembled with the tetrix tube. For powering the gripper it was installed a standard DC motor with gear ratio 2:1.

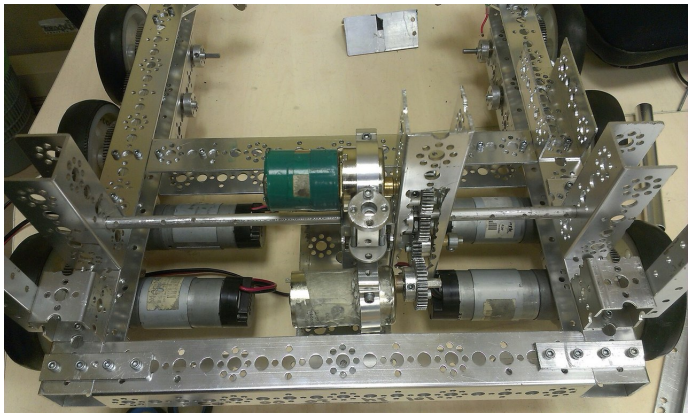

Рис. 25: Winch installed onto the carriage

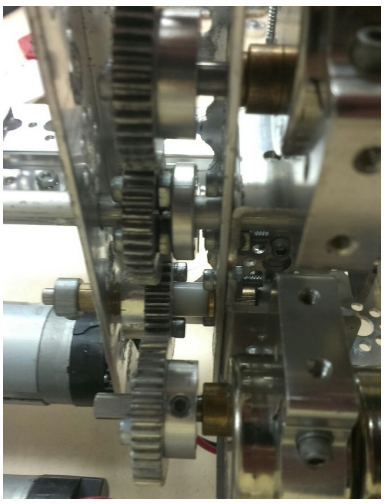

Рис. 26: The construction of the winch

0.1.17 02.12.2015

Time frame: 16:00-22:40

Coils were installed onto the axis connected to the winch (figure 27).

NXT brick, battery and 6 controllers (4 motor controllers, 2 servo controllers) were installed onto the robot (figure 28, 29).

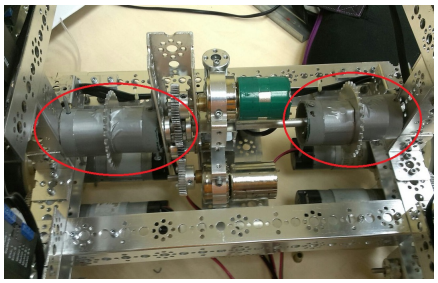

Рис. 27: Reels for the ropes

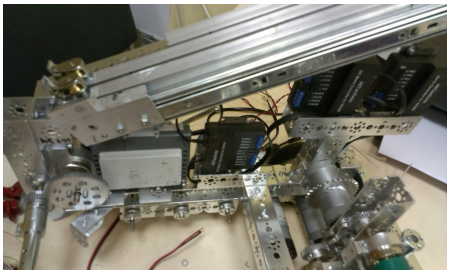

Рис. 28: Controllers and NXT on the right side

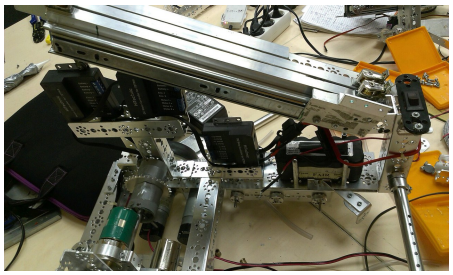

Рис. 29: Controllers and battery on the left side

0.1.18 03.12.2015

Time frame: 17:00-21:30

Today the mechanism for shifting the bucket was installed onto the robot. It was mounted to the top pair of slats (figure 30, 31).

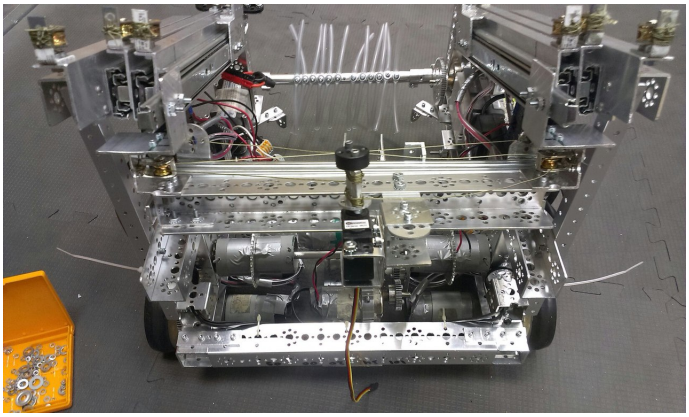

Рис. 30: Mechanism for shifting the bucket 1

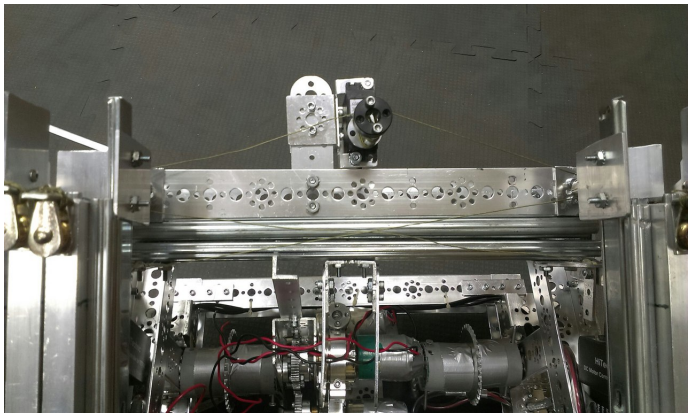

Рис. 31: Mechanism for shifting the bucket 2

There were also created brushes for collecting debris on the gripper (figure 32).
The bucket was installed onto the mechanism for shifting bucket (figure 88).

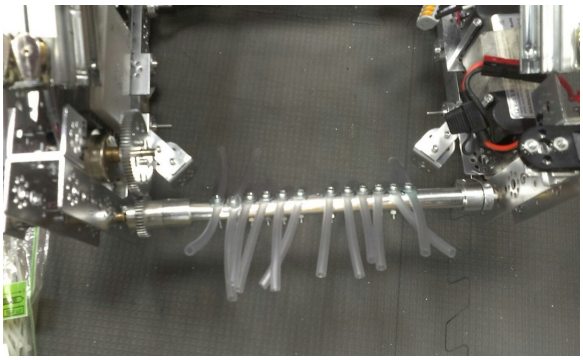

Рис. 32: Brushes

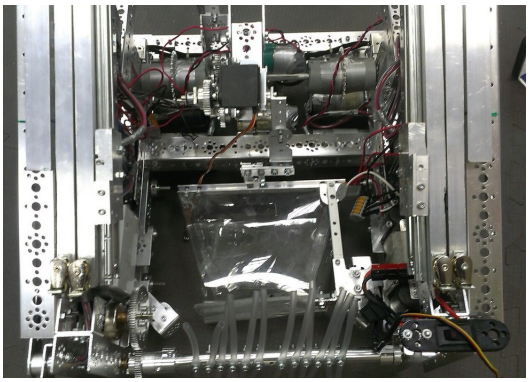

Рис. 33: Bucket installed to the elevator

To connect servos which are installed on the elevator there were manufactured special wires (figure 34). They were made of telephone wire by soldering servo connectors. Unfortunately, it was investigated that these wires have too high resistance (9 Ohmes each), so it was impossoble to power standard servos by them. However, continious rotation servos worked with these wires with no problem (possibly because of higher inner resistance).

Рис. 34: Special wires

0.1.19 04.12.2015 (Competition)

Time frame: 8:00-22:00

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0.1.20 05.12.2015 (Competition)

Time frame: 8:00-23:00

Today there were qualification matches. Our team managed to reach the 2-nd place.
After that there were final matches. There were less than 20 teams in the competition, so the final alliances were consisting of 2 teams each. We chose team PML30-x. Due to nice teamwork our alliance won the competition.

During the matches it was found out, that the robot has a very high center of mass, so it's easy for it to be overturned while climbing the mountain (figure 35, 36). So, the robot should be operated more carefully.

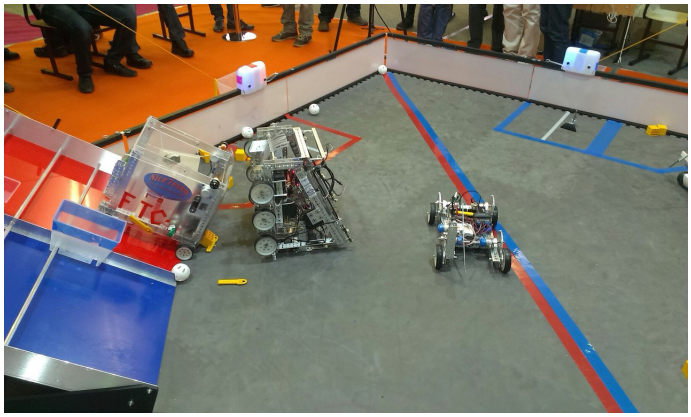

Рис. 35: Robot is overturned 1

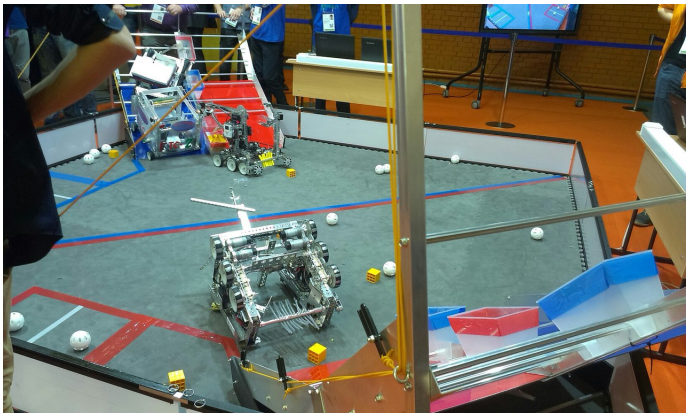

Рис. 36: Robot is overturned 2

The elevator didn't work because of no winch, so it was decided to temporarily remove bucket and install the beam, that will be used for scoring alpinists into the shelter and releasing the bottom alpinist at the mountain (figure 37, 38).

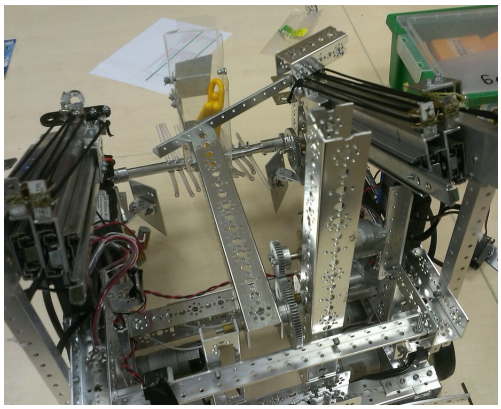

Рис. 37: Beam for operating the climbers (closed)

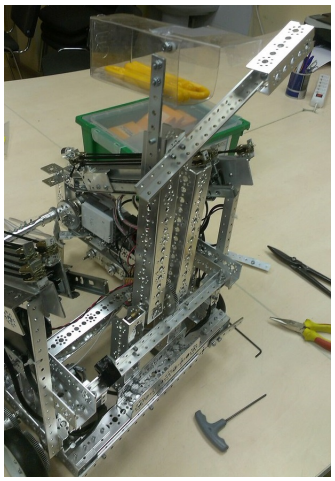

Рис. 38: Beam for operating the climbers (opened)

0.1.21 08.12.2015 (Discussion)

Time frame: 18:00-21:30

Today we were discussing the experience we got at the competition. We thought out what problems does our robot has and how we can improve it.

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0.1.22 09.12.2015

Time frame: 17:30-21:00

All the electric components were removed. The beam for scoring climbers was also removed.

After that the slats were moved down on 9.6 cm with preserving the former angle 22.5° of incline (figure 39, 40).

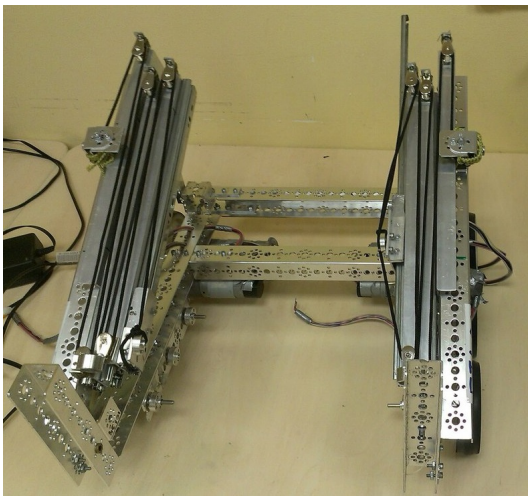

Рис. 39: The slats were moved down 1

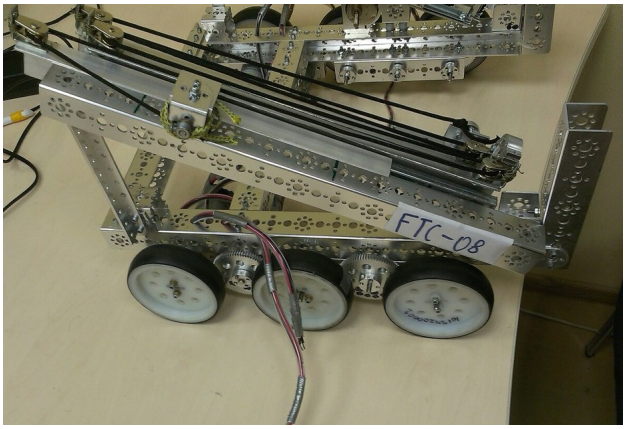

Рис. 40: The slats were moved down 2

0.1.23 10.12.2015

Time frame: 17:00-22:00

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0.1.24 12.12.2015

Time frame: 16:00-22:00

The opposite pairs of slats on the elevator were connected by the ribs. It strengthened the elevator and made it more stable as from now on both sides will move dependently (figure 41, 42).

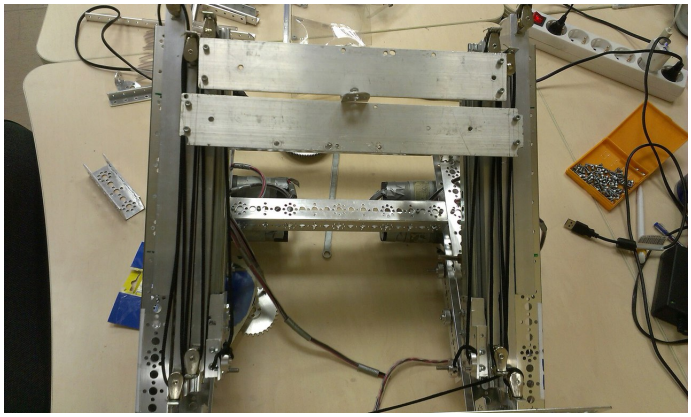


Рис. 41: Slats connected by the ribs 1

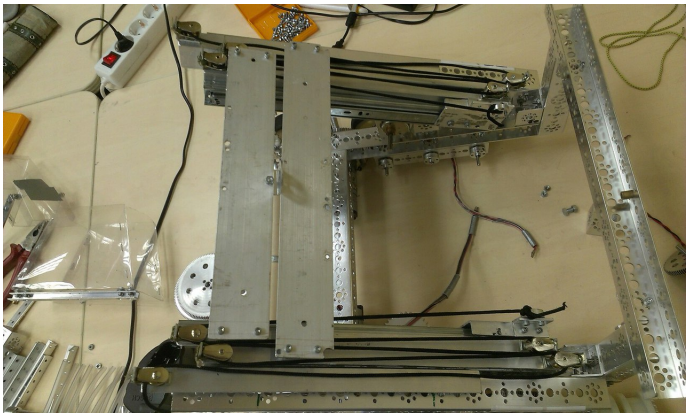


Рис. 42: Slats connected by the ribs 2

In addition, it was started the assembling of the winch for extracting lift. It will include two distinct reels for two ropes from both sides of the lift (figure 43).

At first, it was an idea to make each coil from two middle-sized gears with screws between them, but this construction was too bulky. So, it was decided to apply wheels from TETRIX caterpillar tracks as coils.

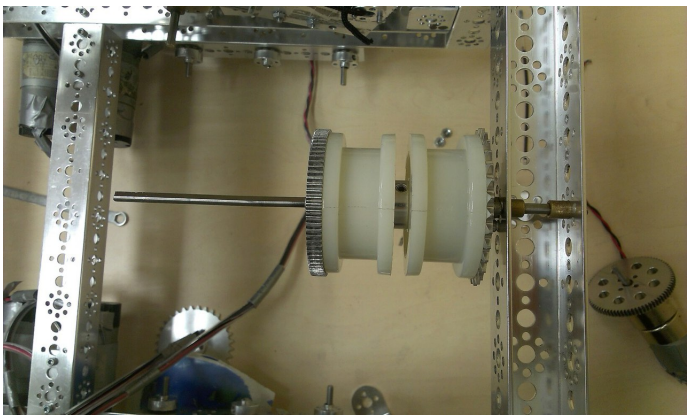


Рис. 43: Winch was created

0.1.25 14.12.2015

Time frame: 17:00-21:00

The winch for extracting the lift was reliably fixed on the robot's base (figure 44).

It was installed the axis of a second brush of the gripper (figure 45).

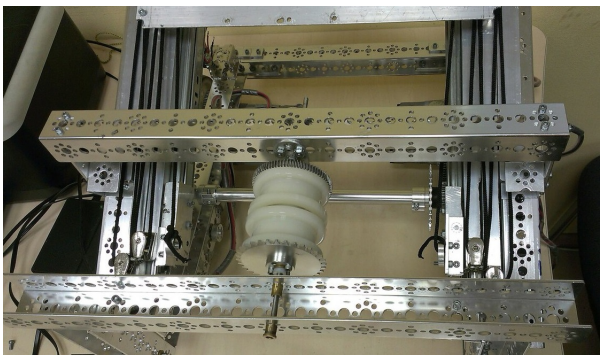


Рис. 44: Winch was reliably installed

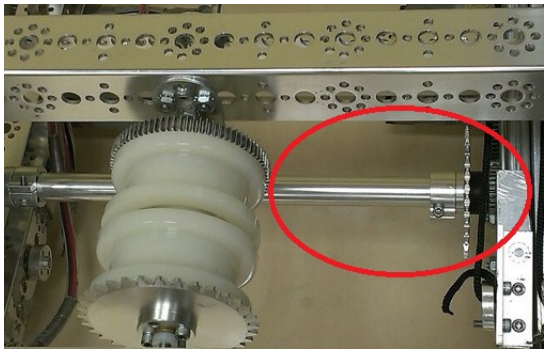


Рис. 45: Axis of a second brush

0.1.26 15.12.2015

Time frame: 17:00-21:30

There were installed a pair of blocks for leading cables from the elevator to the winch (figure 47).

Next, 2 standard TETRIX motors for powering the winch were installed onto the robot (figure 46).

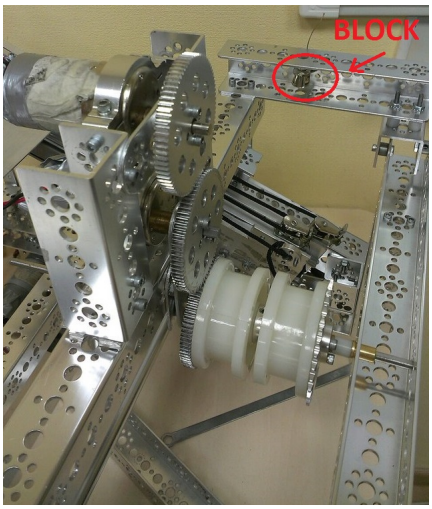


Рис. 46: Motors for powering the winch

Рис. 47: Block for cable

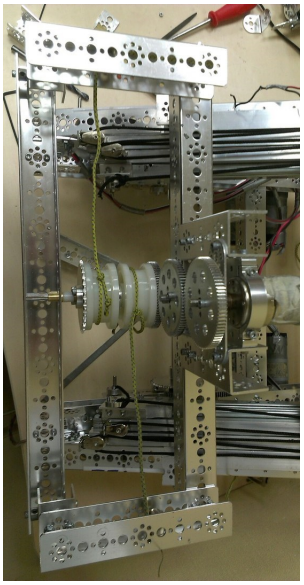


Рис. 48: How the cables chould go

0.1.27 16.12.2015

Time frame: 19:00-22:00

The mechanism for shifting the bucket was recreated with relation to the lastest version. In contrast, in the new version there were applied longer slats (40 cm), that will provide enough offset of the bucket. Also, the mount of the mechanism was made of aluminium profile instead of tetrix parts to save weight (figure 49, 50, 51).

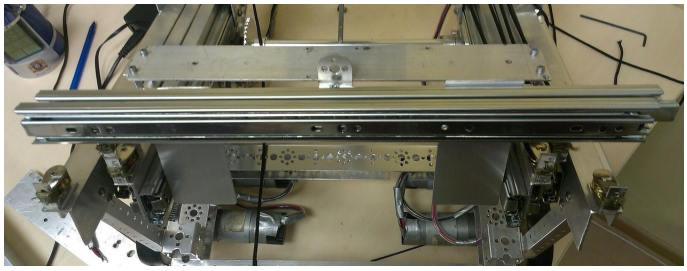


Рис. 49: Mechanism for shifting the bucket

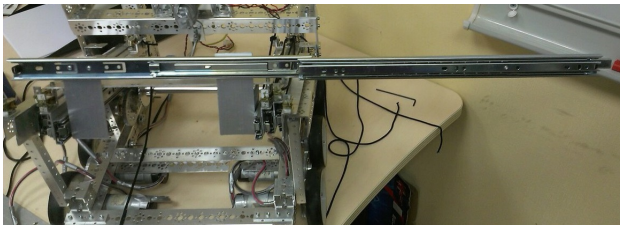


Рис. 50: Extracted to the right

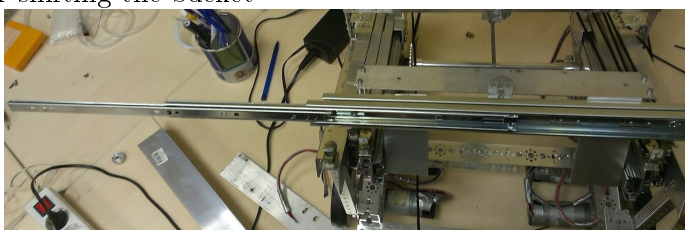


Рис. 51: Extracted to the left

0.1.28 17.12.2015

Time frame: 17:00-21:00

There was installed a servo for powering the mechanism for shifting the bucket. Next, there were held the cables (figure 52, 53). Then, the mechanism was tested. It worked ok.

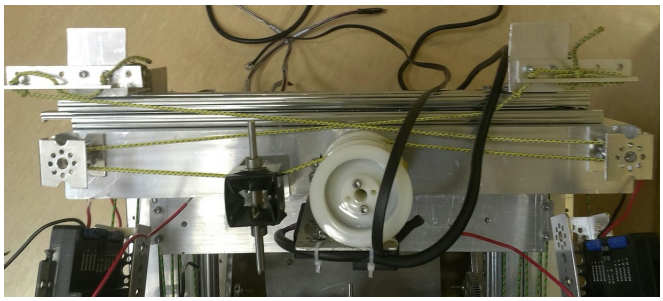


Рис. 52: Servo and cables installed 1

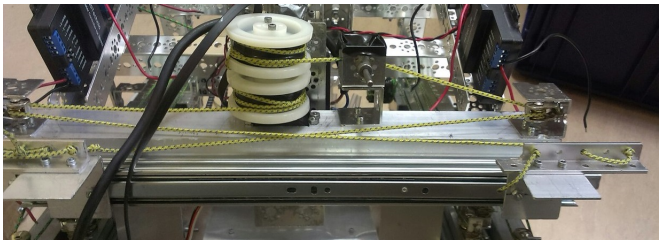


Рис. 53: Servo and cables installed 2

The cables for the extracting of the elevator were held (figure 54, 55).

Рис. 54: How the cables are tied to the coils

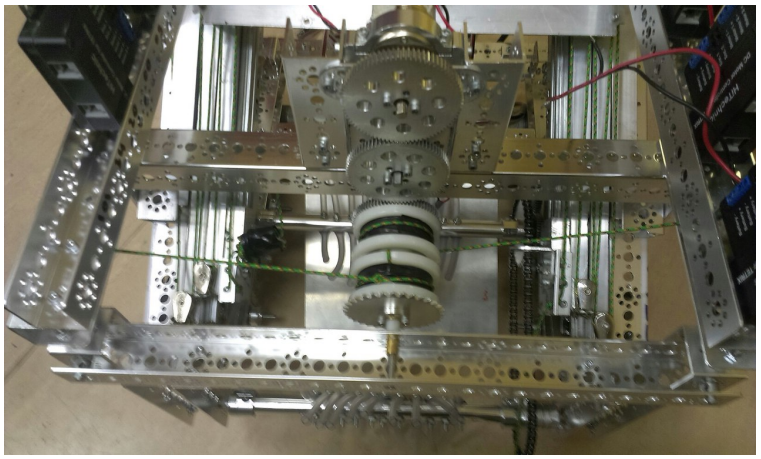


Рис. 55: How do the cables go

There was installed a ramp for debris. The brushes were finished (figure 56).
There were installed motor controllers and a servo controller. The wiring wasn't finished yet (figure 57).

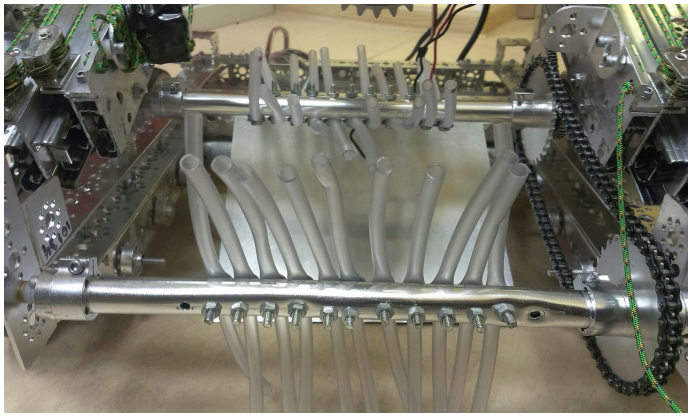


Рис. 56: Ramp and brushes for collecting debris

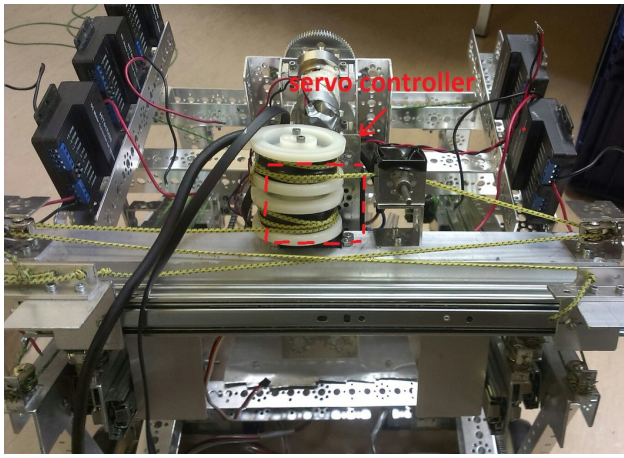


Рис. 57: Controllers installed

0.1.29 19.12.2015 (Competition)

Time frame: 10:00-22:00
//////////////////////////////////////

0.1.30 20.12.2015 (Competition)

Time frame: 10:00-22:00
////////////////////////////

0.1.31 22.12.2015 (Discussion)

Time frame: 17:00-21:00
Today it was a consideration on results of the competition. The conclusion of this meeting was a list of tasks:

0.1.32 23.12.2015

Time frame: 19:00-22:00

The winch was recreated with a chain to avoid overshoots of the gears (figure 58).

Рис. 58: Winch with chain

The wiring was held in a more safe way (figure 59).

The mount for battery was installed (figure 60).

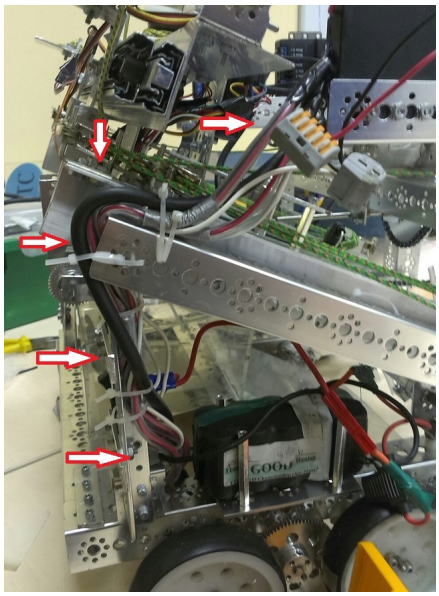


Рис. 59: Wiring

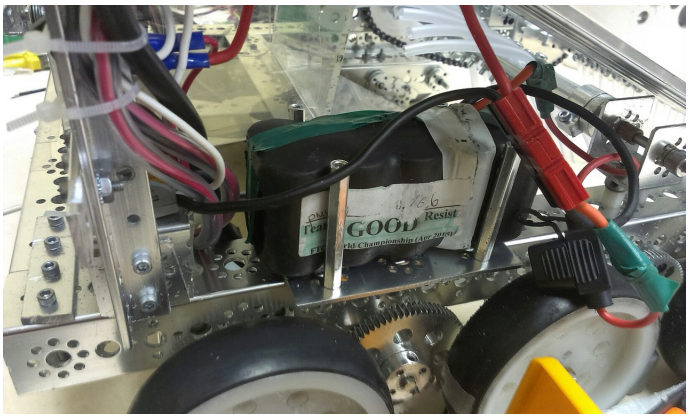


Рис. 60: Mount for battery

0.1.33 24.12.2015

Time frame: 17:00-22:00

The elevator was tested while the robot was standing on the horisontal surface (figure 61). It worked ok. The full extraction took 4.5 seconds.

The length of cables on the elevator were adjusted so as make the same tension on both of them. It will help to avoid the bend of the elevator while extracting.

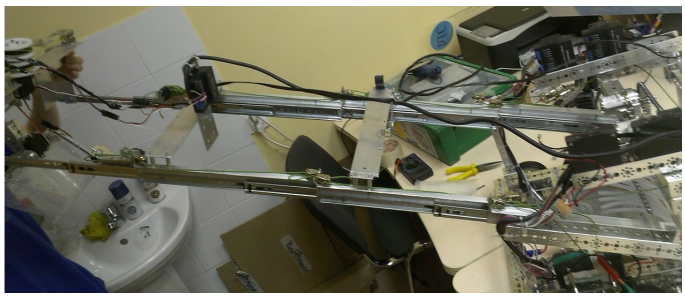


Рис. 61: Testing of the elevator

The wiring to the top section of the elevator (to the bucket and mechanism for shifting the bucket) was held (figure 62, 63).

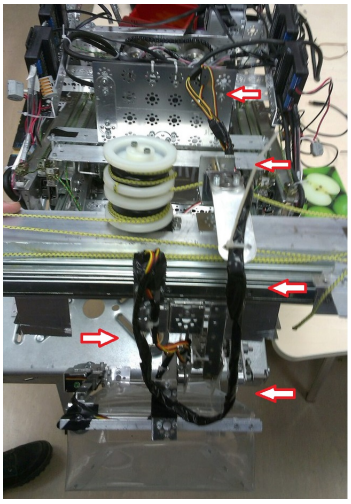


Рис. 62: Wiring to the bucket

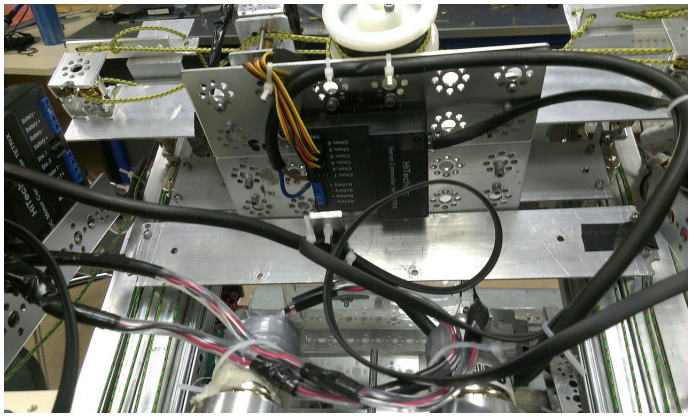


Рис. 63: The servo controller

It was investigated that the beams at the sides, to which the blocks attached, are narrowing because of the tension forse of the cable. To prevent this bending of beams there was installed another beam between them (figure 64).

There were also installed shores for cables that will prevent them from tangling (only for one cable this day).

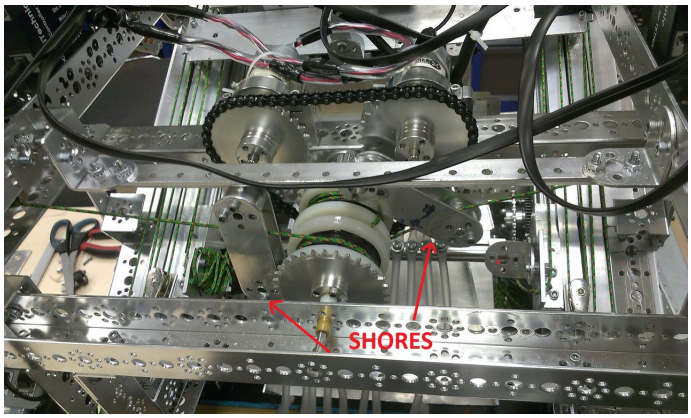


Рис. 64: Beam with shores (the current image was taken after all the shores were installed)

0.1.34 26.12.2015

Time frame: 16:00-22:00

A second pair of shores for the prevention of the entanglement of the cables on the winch coil was installed.

On the ramp for debris there were installed special borders for leading scoring elements to the entrance of the bucket (figure 65).

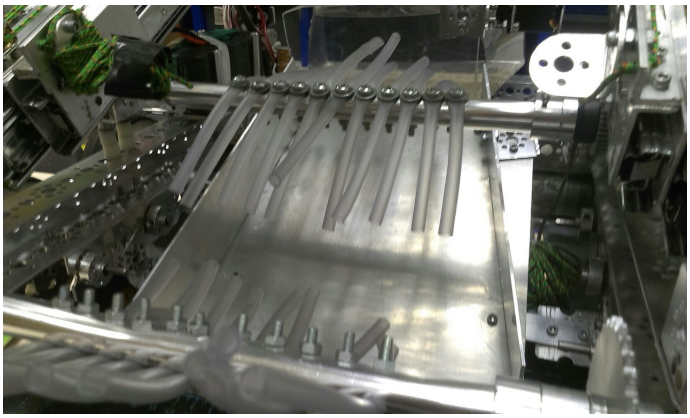


Рис. 65: Borders for debris

There used to be a problem that slats, on which the bucket is mounted, bend a lot under it's weight. This day it was found a solution to this problem: it is possible to install a special plate, that will be fixed on the top slat and slide along the surface to which the bottom slat is attached. This plate will rest in the surface and prevent construction from bending.

Today it was created a prototype of this construction (figure 66, 67).

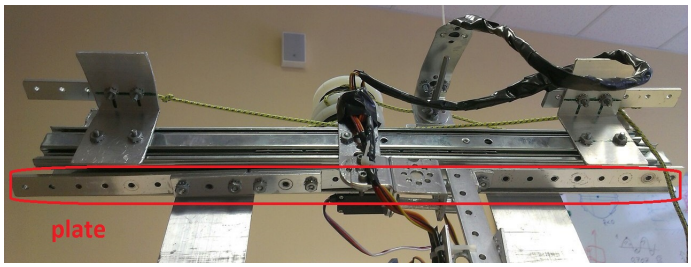


Рис. 66: Special plate

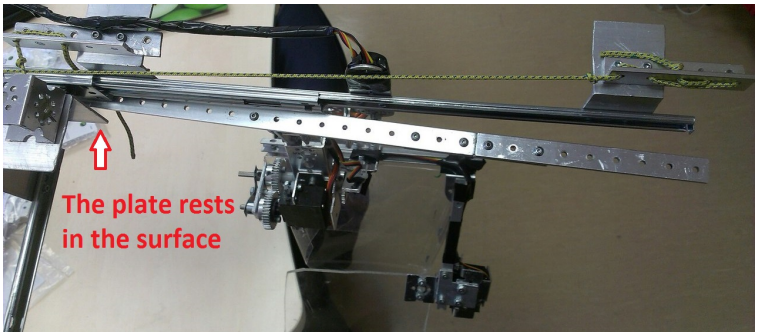


Рис. 67: How does it work

0.1.35 28.12.2015

Time frame: 16:00-22:00

Today the operators were practicing in drivind the robot.

During the trainings it was found out that the ramp for debris scrabs the field. So, it was moved up.

It was also investigated that the robot will not overturn while climbing to the mountain if the elevator is extracted on about 30 cm or more. However, after the wheels stop moving, the robot slips down from the mountain. So, it was essential to make a mechanism for grasping the lower hurdle of the second zone to stay at the mountain.

It was revealed that the brushes are turning in opposite direction. So, it was decided to install once more gear to inverse the direction of rotation of the first brush.

The mechanism for shifting the bucket and the servos for overturning the bucket and opening the cover were tested. Both of these systems worked ok.

It was investigated that the power of 2 standard TETRIX DC motors is nit enough to extract the elevator to the full height. It was the reason why one of the motors broke down.

It was decided to install 3 motors instead of 2 and replace standard TETRIX motors with AndyMark motors because AndyMark motors are more reliable concerning to stalling.

0.1.36 29.12.2015 (Discussion)

Time frame: 16:00-22:00

//////////////////////////

0.1.37 04.01.2016

Time frame: 12:00-21:00

The mechanism for shifting the bucket was recreated (figure 68). In the new version of this mechanism the shaft of the servo doesn't suffer from bending because the coil that is fixed on it is now attached to the axis at it's other side.

This mechanism is not finished yet.

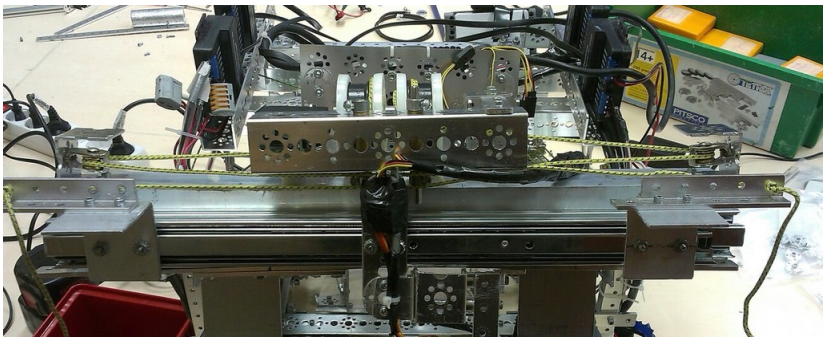


Рис. 68: Servo for shifting the bucket is fixed more reliably

0.1.38 05.01.2016

Time frame: 17:00-21:30

The mechanism for shifting the bucket was finished.

The assembling of the new version of the mechanism for scoring autonomus alpinists was started (figure 69, 70, 71).

Рис. 69: New mechanism for scoring alpinists

Рис. 70: How does it work 1

Рис. 71: How does it work 2

2 standard TETRIX motors at the winch were replaced with 3 NeveRest AndyMark motors (figure 64). Firstly, it 2 times increased torque at the coil (3 AndyMarks give torque of $3 \cdot 25 = 75 kg \cdot cm$, while 2 standard

- only $2 \cdot 20 = 40kg \cdot cm$). Secondly, it raised the reliability of the construction, as the AndyMark motors can cope with stalling for a long time (about 2 minutes), so they will not break down if the movement of the elevator is blocked.

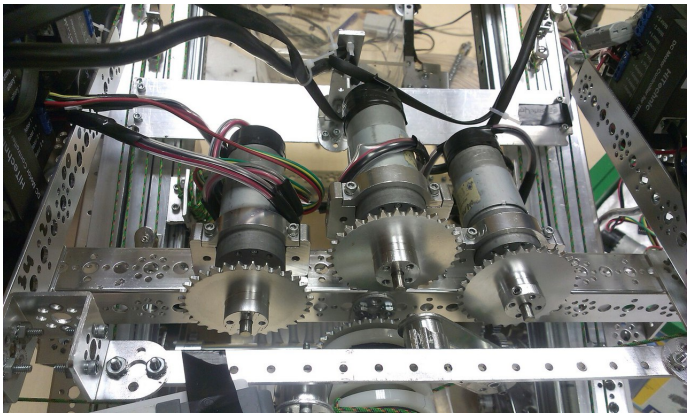


Рис. 72: Three motors for powering the winch are installed

0.1.39 06.01.2016

Time frame: 14:00-22:00

Today it was created the working version of a device for preventing the bending of slats for shifting the bucket (figure 73, 74). After that, the device was tested. It worked ok.

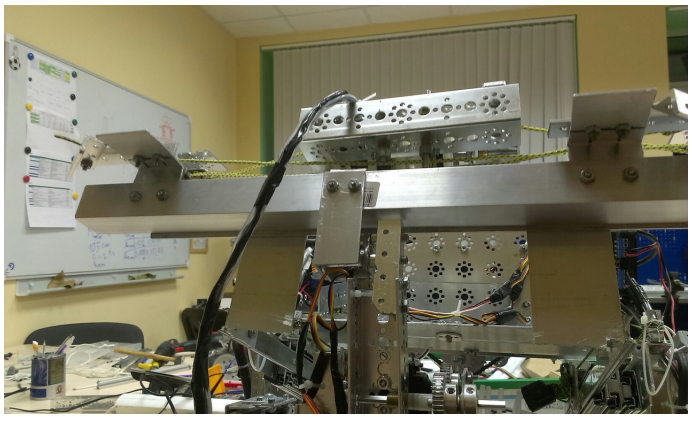


Рис. 73: Device for the prevention of bending of the slats

Рис. 74: How does it work

The chain at the winch was installed (figure 75).

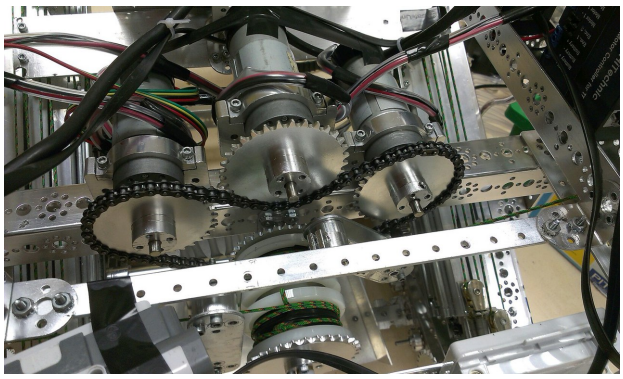


Рис. 75: Chain is installed

Today it was also continued the development or the mechanism for scoring autonomus alpinists. It was created a mechanism for releasing the climbers (figure 76, 77, 78).

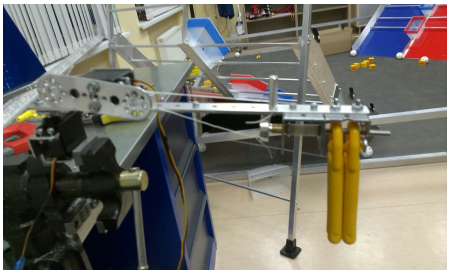


Рис. 76: Releasing alpinists 1

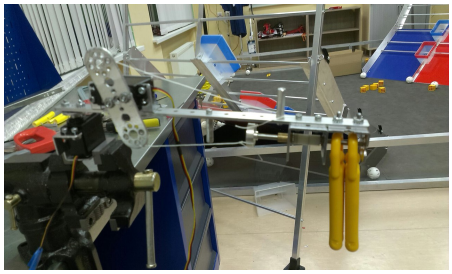


Рис. 77: Releasing alpinists 2

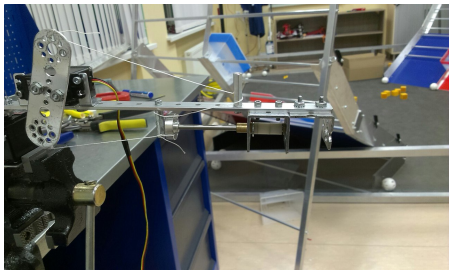


Рис. 78: Releasing alpinists 3

The elevator was tested.

Firstly, it was found out, that one pair of blocks is fixed not reliable enough. The problem was that due to the cable was not in a plane of the block, it was pulled up by the cable. To compensate this pressure there were installed two plastic clamps (figure 79). However, it was a temporary solution.

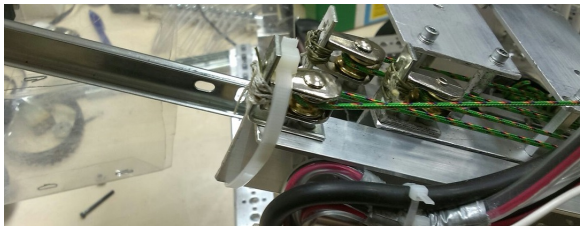


Рис. 79: Clamp at the block

Secondly, the power of 3 motors still was not enough to extract the elevator to the full. The problem was that the second sectoin (with respect to the bottom) required more power for extraction than the first one and the third section required the most power. So, it was assumed, that the problem caused by overloading the friction of the blocks: in the current system one cable at each side was held through all the blocks (figure 80) and a large part of power was wasting on friction.

In this case, to reduce the power that spends on fighting the friction, it was decided to use another system of helding the cables (figure 81). The new construction required 3 blocks instead of 5 at a side and the cable from the winch went only through one of them. However, this construction required three times higher torque and three times less length of the cable to reel for extracting. So, the diameter of the coils chould be changed correcpondingly.

Рис. 80: Current system of using blocks

Рис. 81: New system of using blocks

0.1.40 08.01.2016

Time frame: 15:00-22:00

The mechanism for scoring the autonomus alpinists was installed onto the robot.

After some tests it was investigated that it should be moved a bit higher and the axis of the servo that turns the module should be strethened.

0.1.41 10.01.2016 (Discussion)

Time frame: 16:00-20:00

Today the cables at the elevator were held in a new way (figure 82). As the construction couldn't be tested by motors (the coils weren't recreated yet), it was tried by the arms. There were not noticed any problems.

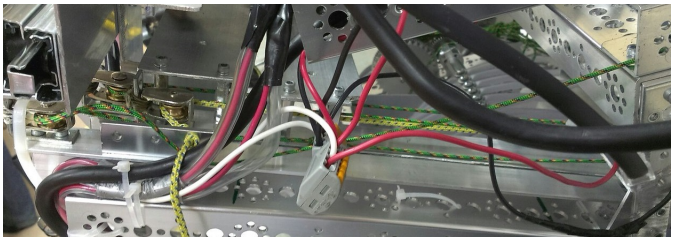


Рис. 82: Cables are held in a new way

The bucket was detached from the elevator to provide separate development of the bucket and the elevator.

0.1.42 12.01.2016

Time frame: 17:00-21:00

The mechanism for scoring autonomus alpinists was improved (figure 103). The axis if the servo was strethened by the U-shaped detail.

There were created hooks for grasping the low hurdle of the second zone of the ramp (figure 84).

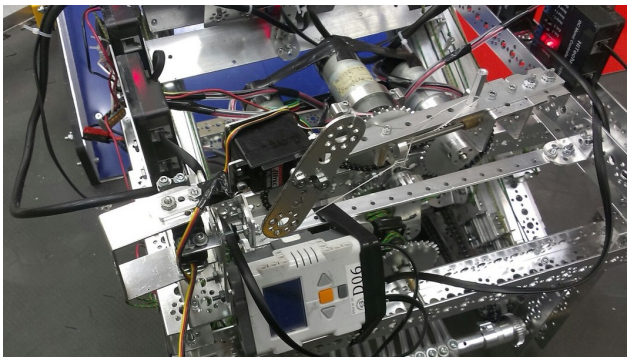


Рис. 83: Mechanism for scoring alpinists

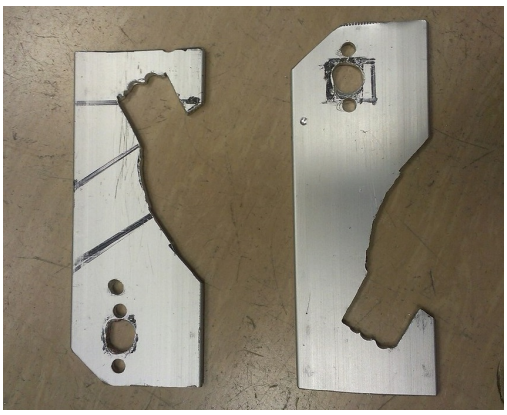


Рис. 84: Hooks

0.1.43 13.01.2016

Time frame: 17:00-22:00

Today the coils were recreated. Their diameter was reduced (figure 85).

Next, the elevator was tested. It worked, but the power was not enough for the full extracting. The reasons of this problem were not found.

Рис. 85: Coils of new diameter

0.1.44 14.01.2016

Time frame: 19:00-21:00

There were found two reasons of the problem of the elevator.

Firstly, the battery at the previous test was low.

Secondly, the ribs that connect two sides of the elevator caused a bend. it was because the cables at both sides were not the same length, so the sides of elevator were extracting differently.

To solve this problem, it was decided to make the mounts of the ribs mobile. So if there appear some bend, the ribs will merely slide along the movable mount (a kind of small slat).

0.1.45 16.01.2016

Time frame: 16:00-21:30

There was created a moving mount for one of the ribs at the elevator (figure 86).

It was also developed a prototype of a mechanism for grasping the hurdle at the ramp. The construction of the transfer between the servo and the hooks will prevent the servo from breaking down (figure 87).

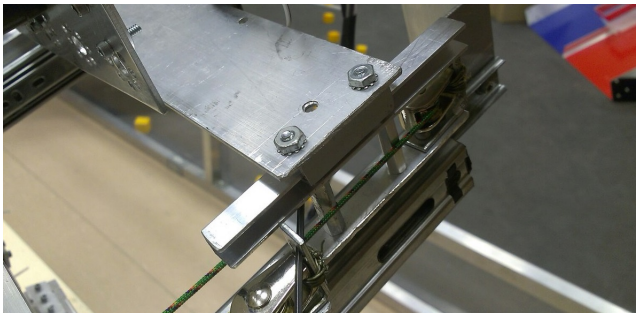


Рис. 86: Moving mount of a rib

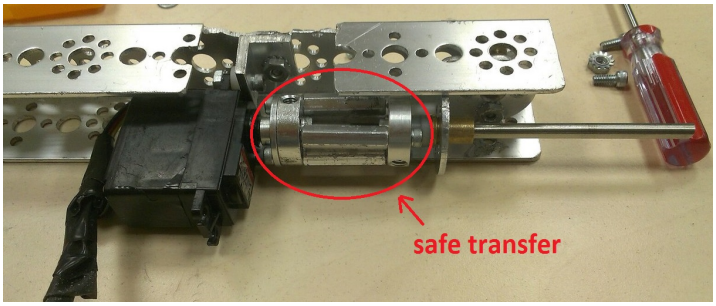


Рис. 87: A prototype of the mechanism for grasping the hurdle

0.1.46 18.01.2016

Time frame: 18:00-22:00

The new mount of the servo for overturning the bucket was created (figure 88).

In the new construction the servo was fixed on the bucket, which made construction more compact. With new construction, the mount of the bucket will not touch the rails while shifting, so it will have the free movement.

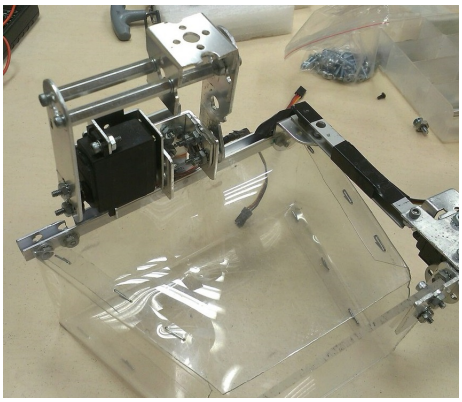


Рис. 88: New mount of the servo for overturning the bucket

0.1.47 19.01.2016

Time frame: 17:00-22:00

There was crafted the moving mount for the second rib on the elevator (figure 89).

It was also started the assebling of the mechanism for grasping the hurdle (figure 90).

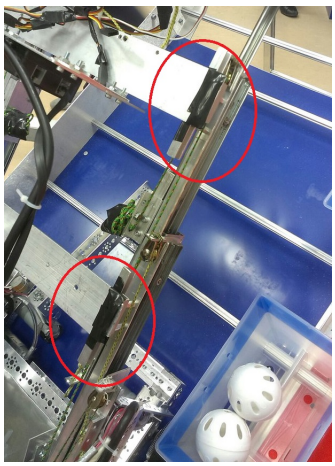


Рис. 89: Ribs with movable mounts

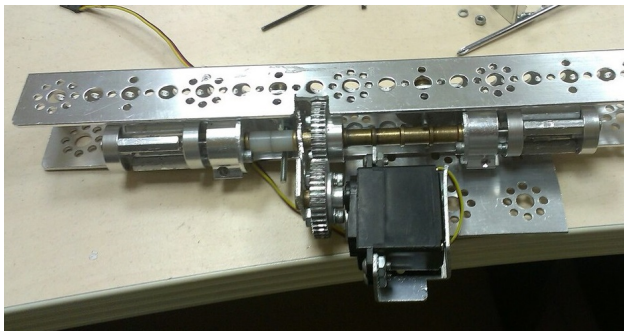


Рис. 90: Mechanism for grasping the hurdle

0.1.48 20.01.2016

Time frame: 19:00-21:30
The assembling of the mechanism for grasping the hurdle was finished (figure 91, 92). The hooks were not installed on it yet.

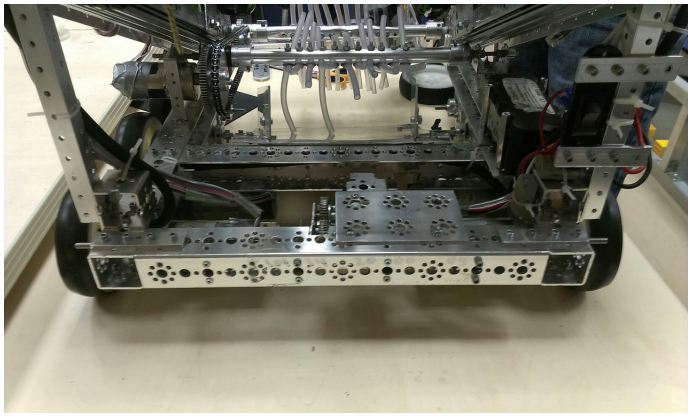


Рис. 91: Mechanism for grasping the hurdle 1

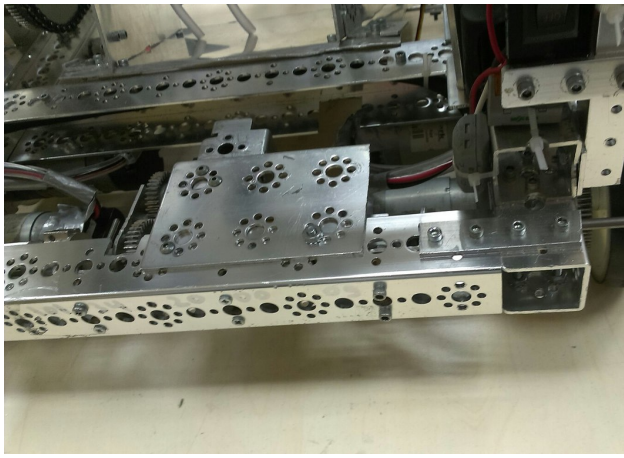


Рис. 92: Mechanism for grasping the hurdle 2

0.1.49 21.01.2016

Time frame: 16:30-22:00
The hooks were installed onto a mechanism for grasping the hurdle (figure 93, 94, 95).

Next, it was tested without powering the servo. The construction worked ok.

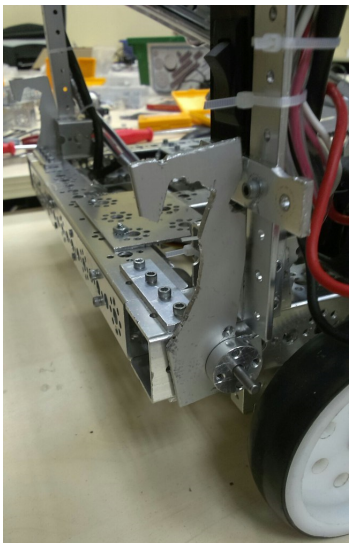


Рис. 93: Hooks rised up

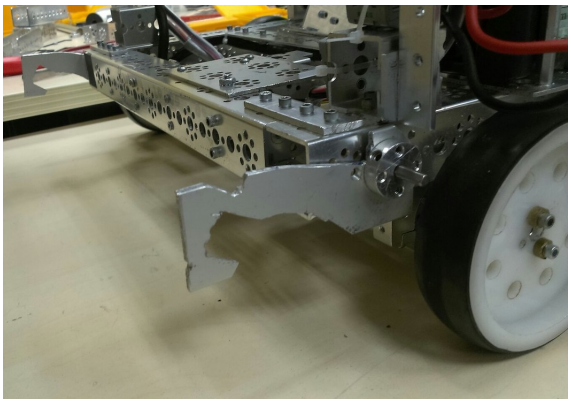


Рис. 94: Hooks turned down

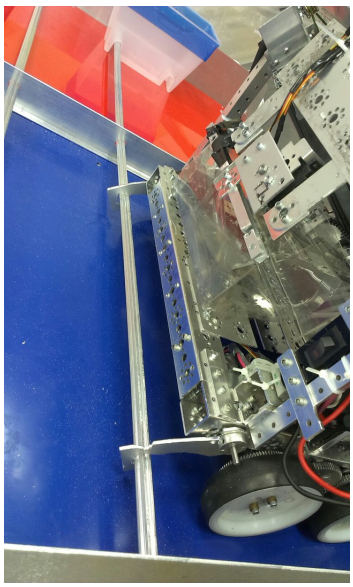


Рис. 95: How does the module works

There was found a problem in the wheel base. The holes for middle wheels were drilled out because of friction with the wheels' fixations (figure 96).

The wasted beams were replaced with new ones. In order to prevent the appearance of this problem in future, there were installed bronze collars into the holes, in which the axles of middle wheels rotate (figure 97).

Рис. 96: Drilled out holes

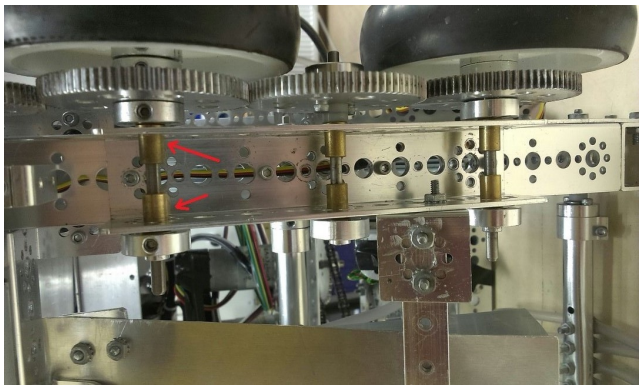


Рис. 97: The bronze collars were installed

The bucket was installed onto the robot and it's servos were connected to the controller (figure 98).

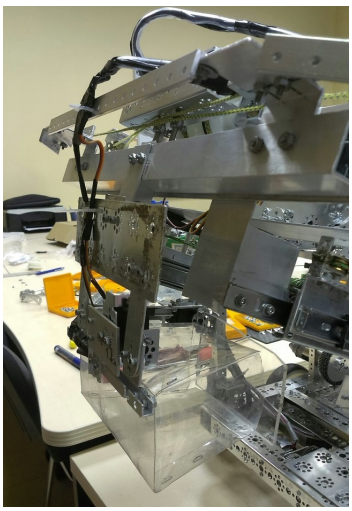


Рис. 98: Winch installed onto the carriage

0.1.50 23.01.2016

Time frame: 17:00-22:30

This day our community organised a private competition on our own field. There were 3 teams including ours. There were held several matches 2 vs 1, which were played according to the entire game rules. This event provided teams with an experience of a true gameplay and allowed to test all the systems of the robots. It also was a source to find mistakes in construction and understand what should be improved in it.

During the competition, there were introduced some changes of the construction.

Firstly, the servo on the mechanism for grasping the hurdle was changed from standard to continious rotation. This was made to increase it's reliability. The continious rotation servo doesn't keep the angle, so it doesn't break down if the external force changes this angle. It is important feature, because, when the hooks are adjusting to the hurdle, the servo can be turned by the outer force.

Secondly, the ends of the hooks were wrapped by the tape to prevent the damage of the field or other robots by the sharp corners.

Into the driving-control program there was added a function for operating the mechanism for scoring alpinists inti the shelter. During the matches, this mechanism was tested.

It was decided to put the brushes on the gripper into a position, when they rotate in the same phases to find out, if this will be more effective, or not. The practice showed, that this position of brushes is unconvenient.

During the games it was found out, that the robot has plenty of areas, where the debris can get stuck, increasing our posession of it. These areas were aside the ramp for debris and under the bucket. The second area was temporarily covered by plates so as to prevent cubes from getting stuck in it.

At the mechanism for shifting the bucket it was revealed, that the cables, which pull the moving part, often get behind the pins, which causes the inability of shifting the trolley to the corner. This problem should be solved.

It was found out, that it is nit possible to collect more than 4 cubes into a bucket in game conditions. The problem was that cubes didn't settle down in a bucket as it was expected.

0.1.51 25.01.2016 (Discussion)

Time frame: 18:00-21:00

//////////////////////////////

0.1.52 26.01.2016

Time frame: 17:00-21:00

The moving mounts for ribs on the elevator were recreated (figure 99, 100). There were applied white collars, which were sliding along the 10 cm axes. This construction had less friction and was more reliable. These details were not finished during the current meeting.

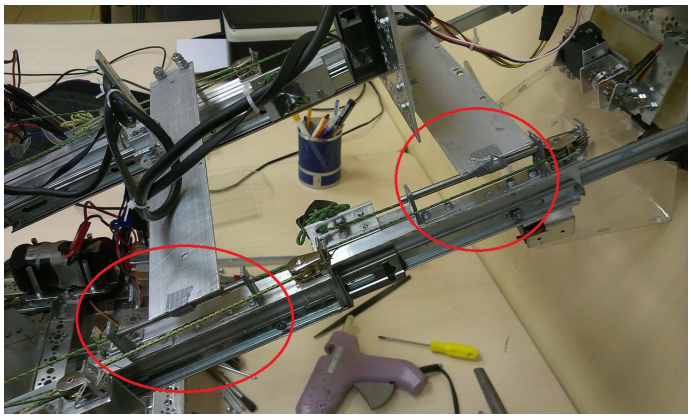


Рис. 99: Convenient movable mounts of the ribs

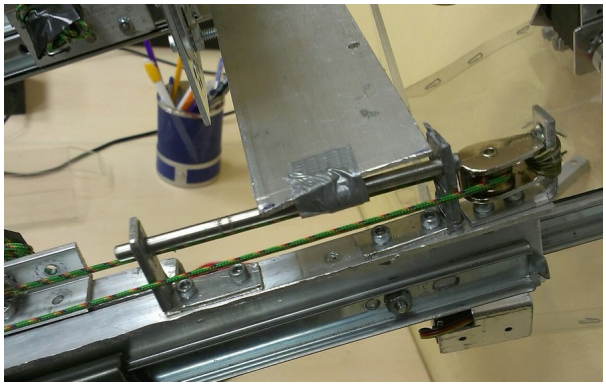


Рис. 100: The mount of the rib

After a number of tests, the brushes on the gripper were set in the most effective position.

It was created a protection from debris at the back of the robot (figure 101).

The protection of the area under the bucket from debris was recreated with a layer of PET (figure 102).

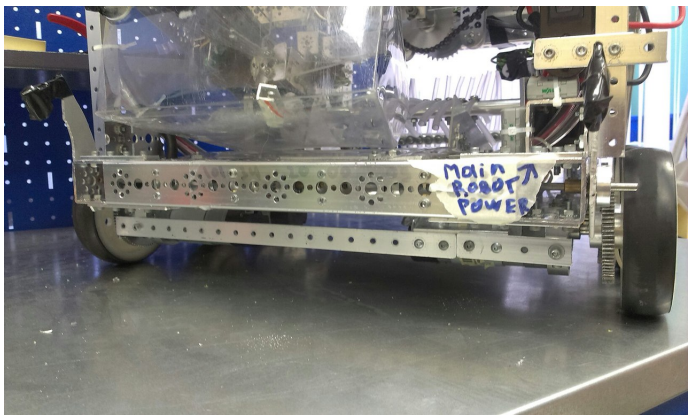


Рис. 101: Protection from debris 1

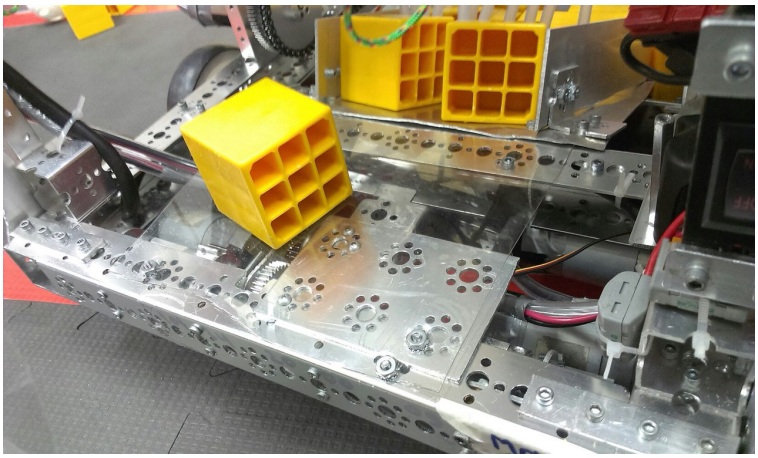


Рис. 102: Protection from debris 2

0.1.53 27.01.2016

Time frame: 19:00-21:00

It was created a surface for pushing the button on the beacon (figure 103, 104).

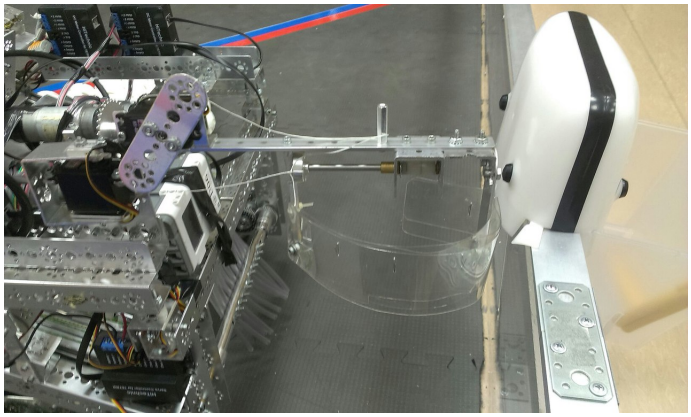


Рис. 103: The surface for pushing the button

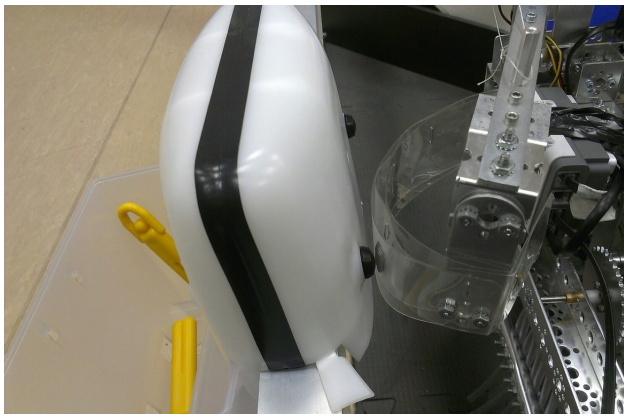


Рис. 104: How does it works

0.1.54 28.01.2016

Time frame: 17:00-22:00

It was started the development of the protection of the servos' wires on the bucket from grasping the elements of construction while shifting (figure 105).

It was also created a protection from the engagement of the cable with the axis at the mechanism for shifting the bucket (figure 106).

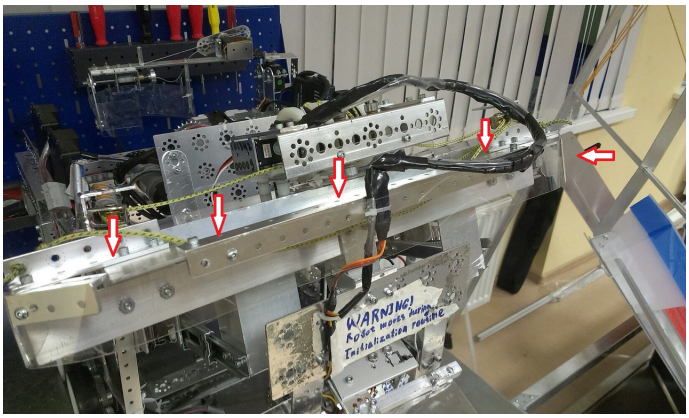


Рис. 105: Protection for wire

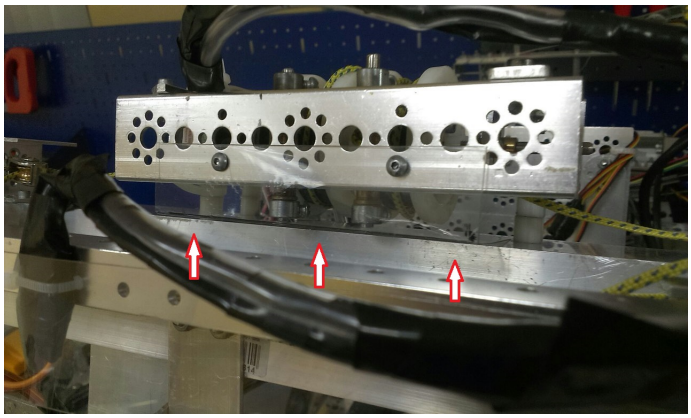


Рис. 106: Protection for cables

The mount of the second block on the elevator was strethened.

It was started the creating of the borders at the sides of a gripper, that will prevent debris from getting into the areas beyond these borders. There were taken all the needed measurements. After that, a part of these borders was cut out from PET.

0.1.55 30.01.2016

Time frame: 16:00-21:30

The borders for debris were installed at both sides of the gripper (figure 107, 108). The extension of these borders was installed at both sides of the bucket (figure 109).

The moving mounts of the ribs were finished (figure 110).

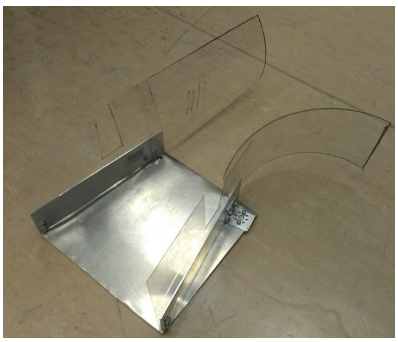


Рис. 107: Borders for debris

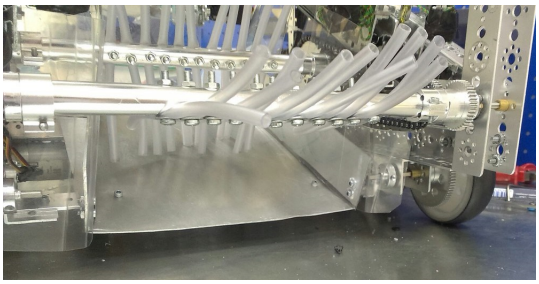


Рис. 108: Borders for debris (front)

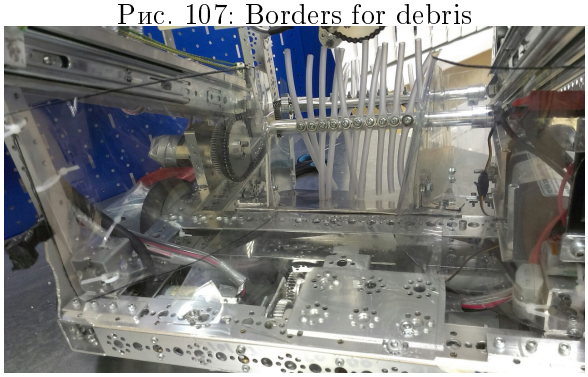


Рис. 109: Borders for debris (back)

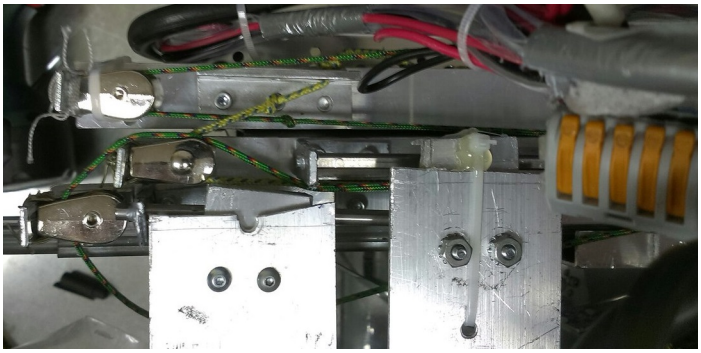


Рис. 110: The moving mounts of the ribs

The protection of the servos' wires on the bucket from grasping the elements of construction was finished. This protection will prevent wires from getting to the areas where it can get stuck (figure 111, 112).

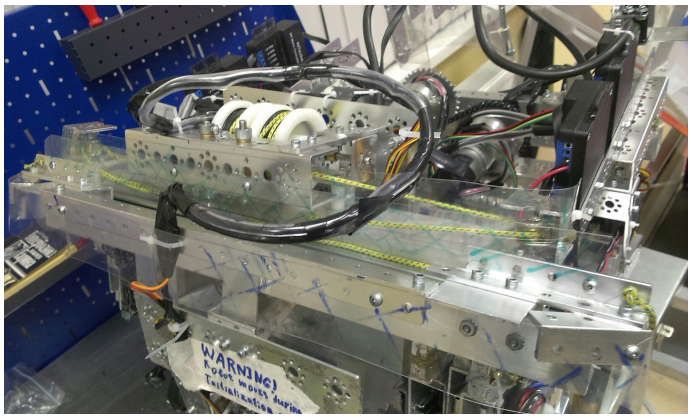


Рис. 111: Protection for wire

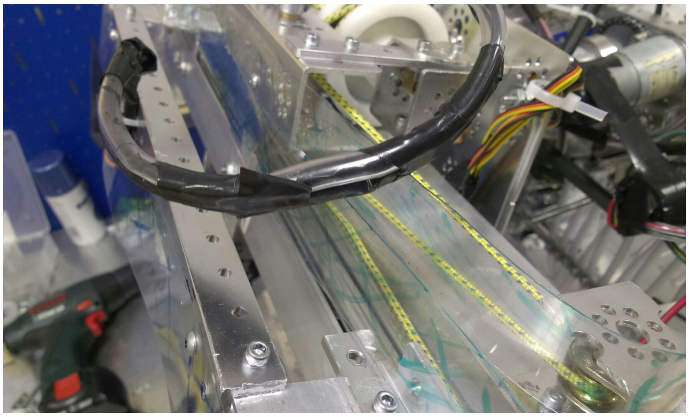
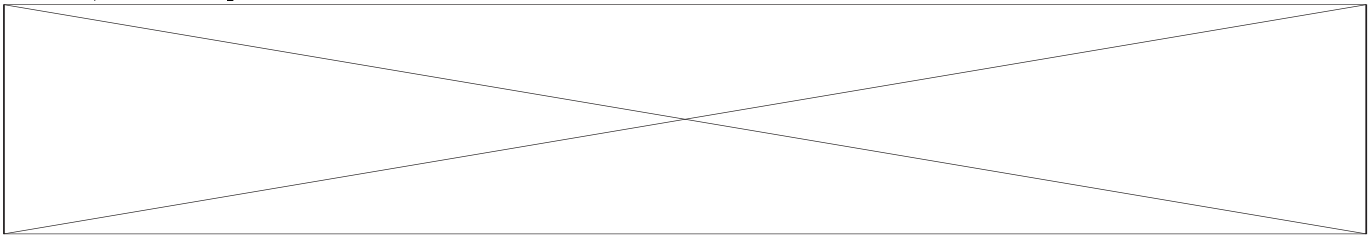


Рис. 112: How does the protection works

It was created a new bucket for debris. It's shape allowed to collect 5 cubes at once, but was more convenient, than the previous.



0.2 Specifications for modules

Description: This section contains detailed information the process of elaboration of each module in particular.

0.2.1 Elevator

Engineering tasks included in this module:

1. Lifting mechanism
    1.1. According to the technical plan our team created beforehand, the lifting mechanism was to consist of several construction beams connected to each other with special parts. To create these parts, we first thought through the concept and 3d-modeled them in Creo Parameteric 3.0. These parts are something akin to a brace and will stabilize one beam in relation to another. There are two types of braces: for the central gaps, and side gaps of the beams. Let us consider the simplest way to connect the two beams with these braces. Beam A will be fixed in place to the base of the robot, and beam B will be fixed relative to beam A. Then we can can connect the first three braces to the top of beam A and the second three braces to the bottom of beam B, allowing for maximum freedom of movement for one of the beams against the other. For greater stability we use two groups of three on each end of the beams.
    1.2. We must find such a height and length of the lifting mechanism that there would be an angle of tilt that would allow the robot to throw debris into the highest and middle bucket goals from the low zone, and grab the pull-up bar from the middle zone.
    1.3. Knowing that the individual beams are 350mm long, we calculated that in order to reach this height, we need four beams.
    1.4. Lifting four beams requires a block system - e.g. we need to add blocks with twine that, when reeled in, would lift the system.
    1.5. In order to fasten the braces we need to add caps on the end faces of the beams. I came to the conclusion that I needed to change the caps: drill a hole through their legs, so that the twine could be put through them, and grind off the heads somewhat in order to make a trough, through which to pass the line. This allowed me to avoid adding additional blocks on the beams.
2. Turning mechanism
    2.1. The turning mechanism consists of a servomotor attached to the base of the robot, a worm on the axis, and a gear on the first beam of the lifting mechanism. The servomotor turns the worm, which, in turn, rotates the gear, and the lifting mechanism tilts.
3. Reeling mechanism (winch)
    3.1. The reeling mechanism is a system of two coils powered by 2-4 motors. It is both used for extracting elevator and pulling up. The principle of work is folowing: one coil pulls the cable and extracts the elevator when the another coil releases strong cable used for pulling up. When the elevator is fully put forward, so does the pullup cable. Next, when the coil rotates backwards, it pulls the pullup cable and releases elevator's cable causing it to fold back.

At the 25^{th} December it was decided to stop the development of the current construction of elevator. The reason was that the first competition was taking place in a week, and nothing was ready yet. Firstly, the plastic details for connecting the profiles to each other were not created in material as there was nowhere to make them. Secondly, this system was never made before, so it could have some latent problems.

It was decided to use the furniture rails instead of construction profiles because our team had used them in 2 previous FTC seasons and we have an experience in developing the elevator with furniture slats.

0.2.2 Bucket

1. The main requirements for the module were:

   - Maximum capacity: five cubes and three spheres
   - A mechanical limiter on the amount of debris in the bucket
   - A closing mechanism for the bucket
   - Delivery mechanism for putting the debris into the goals. содержимое...

2. The first stage of development was creating the general concept of the module, its structure and method of operation. In result, was decided on the following mechanism: The bucket is shifted outside of the robot and turned 90 degrees around an axis parallel to the axis of shift; both movements are done by one servo. This allows to place the bucket opening to be parallel to the ground and increase the accuracy of debris delivery. Movement in two planes at once is accomplished through sloped guide rails, which turn the beams with the bucket during their sideways movement. To prevent premature release of debris from the bucket, the bucket opening will be closed.

3. The next step was developing the closing mechanism. To minimize the load on the servo completing the turning movement, the center of mass of the module has to be situated as close as possible to the mounting point on the lifting mechanism. Thus, the following system was developed:

   - On the beam which is mounted to the lifting mechanism, is installed a reel with twine.
   - The twine is fixed in such a way that when the reel turns in one direction, one of the ends is pulled taut while the other slacks, and vice versa.
   - The twine wraps around several fixed blocks along all the beams which support the bucket.
   - Above the bucket opening there is another axis with another reel identical to the first, and the surface which blocks the opening.

   This allows to open and close the bucket without adding any additional significant load on the servo which turns it. To make sure that such a mechanism for transmitting rotational movement indeed works, a simplified model was assembled. The results of our tests showed that this transmission is operable, but the angle between the extreme positions is slightly more than 135 degrees, rather than 180 degrees, but this is still enough to complete the task.

4. After that the parameters of the guiding rails (slope relative to the vertical direction, maximum height) were calculated depending on where they are mounted: The bucket, mounted on the beams, which in

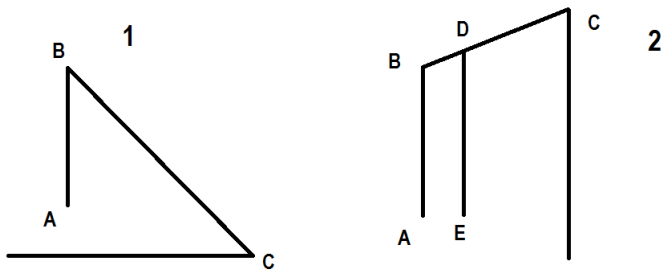


Рис. 113: Side view of beams onto which the bucket is mounted

turn are mounted on the slats are in point A and move together. CB can rotate around point B. DE is the maximum height of the guiding rails. Position 1: the bucket is lying on the ground and collecting debris. Position 2: the bucket is perpendicular to the ground and can deliver the debris to the goals. The needed ratios can be found from the easily derived formula: $< C = /(DE - BA)$.

5. At the time the above process was completed, the qualification rounds were not far away, and so was decided to temporarily use two servos for shifting and turning the bucket, since the structure of the module would become significantly simpler and would require less time to complete. Were connected two slats in such a way that their uppermost part could move in both directions. After that on one of the ends of the slats were added limiters that depending on their position do not let one of the slats move. This does not prevent the robot from working properly, as we know our alliance before the match and thus in which direction we need to extend the bucket. This means we can adjust the limiters before the match. (Note: in the figure both limiters are set to the closed position, in which neither slat can

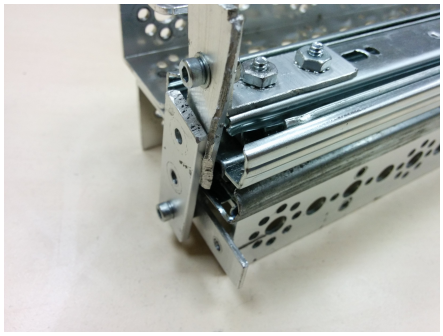


Рис. 114: Structure of limiters

move; during the game itself one of the limiters will be set in the open position).

6. Then the servo with a reel for the twine moving the slats was fixed on. Blocks were attached to the ends of the fixed beams and wound the twine around them; the ends of the twine are tied to the ends of the slats, which allows them to move as needed. The servo direction of rotation defines the direction of movement of the slats and the bucket.

7. After that was come up, tested and made another, less complicated, trapezoidal bucket with the opened part smaller than closed. The construction of the guides on the top of bucket would make debris fall in sequence 2-2-1 from the bottom, that way the scoring goals will hold maximum number of debris.

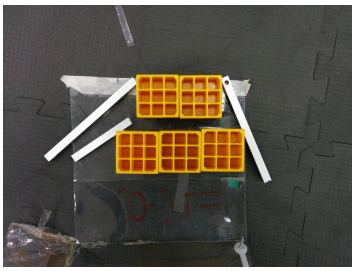


Рис. 115: Structure of guides

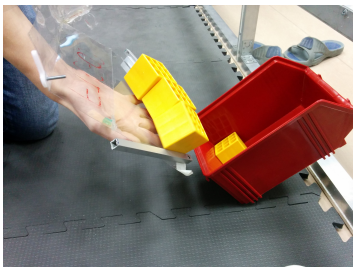


Рис. 116: Process of guides testing

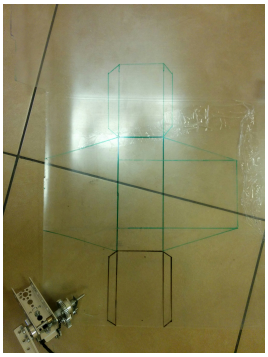


Рис. 117: Marking of bucket

Tests showed that guides work well, so was decided to use them in construction of bucket. The pair of front makes debris fall to the scoring goals more accurately, the assymetric guide slows one debri to make all the debris fall as 2-2-1, not 2-3.

8. After that was streched the line to move the slats. Servos for moving the slats and turning the bucket were placed on the slats.

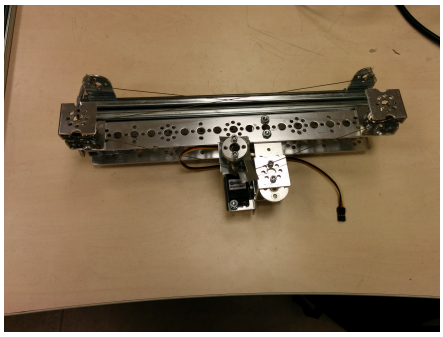


Рис. 118: Construction of line and pulling it servo

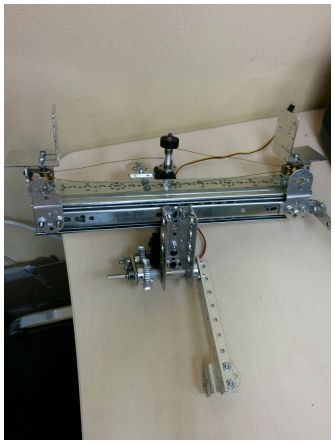


Рис. 119: Final construction of the slats

9. Next done part of module is closing mechanism. The difficalty in it is that axis of servo has to be as close as possible to the front-top edge of bucket.

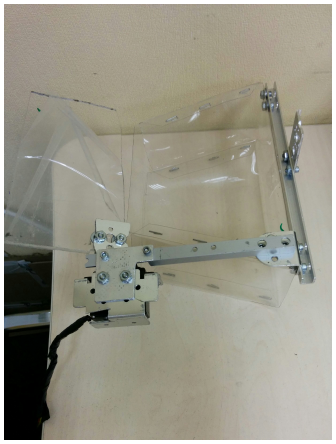


Рис. 120: Final construction of the bucket with closing mechanism

10. After that bucket was installed on bracings on the slats. Then all the module was mounted on the lifting mechanism. It was done in the way to make the bucket turning axis as low as possible. It would make the volume, used by bucket less, because with that place of the bucket it was necessary to turn it while lifting because otherwise bucket intersected with other parts of robot while lifting. So the lower axis made the radius of bucket turning less and reduced the capacity on the servo by shortening the shoulder of buckets weight. By the time it was done, the first competitions had almost started so the slats weren't mounted on the lift because of time troubles.

11. After the end of competitions slats were replaced by longer ones (40 cm instead of 35) to make bucket shifting completely out of robot teoreticaly possible. Also the shifting servo was changed to faster and more powerful servo in order to make bucket shifting faster and more reliability. Then possible work process of bucket was estimated and it turned that fast lifting was impossible. It was so because the bucket was to be turned in case not to intersect with other parts of robot to be lifted. And generally bucket was close to catch parts of robot while moving from front of robot to its end during the lifting. To solve these problems was decided to place the bucket int end of the robot above two beams. It would make lifting easier because bucket would move inside robots projection much less time than before, also it is easier to transport debris throw the robot than to transport the bucket.

12. Then the slats were mounted on this lift in the way to place bucket in the end of robot. The next problem was not much space so the beam, on which the bucket was mounted intersected with lifts slats while shifting. So the mount of the bucket was changed. With that construction servo was turning with the bucket. It made the non-intersection beam possible. After that bucket was mounted on the sift mechanism without any intersections, so the problem was solved.

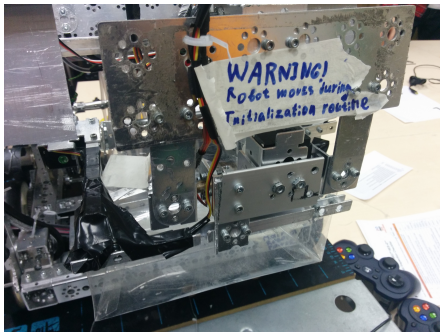


Рис. 121: Construction of bucket

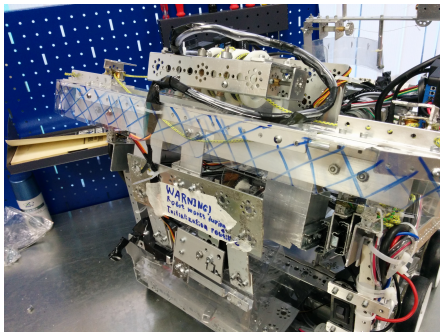


Рис. 122: The bucket mounted on robot

13. The next step was testing bucket and the whole robot. In the process of it was found two problems: the closing mechanism was able to work only when the bucked was a bit lifted and bucket couldn't hold 5 cubes, caught by grab mechanism. First problem was solved by cutting sides of partition, closing bucket. The second problem weren't solved by adding guides to move first cube sideways (grab couldn't move the cube so). Because of it was decided to change the shape of bucket.

14. After that the new shape was devised.

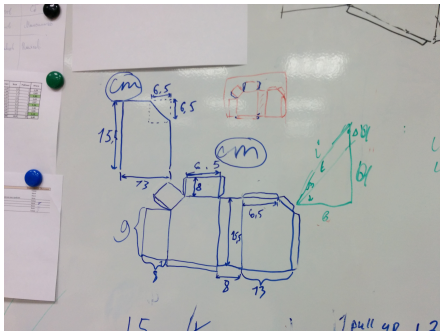


Рис. 123: Shape and scan of the bucket

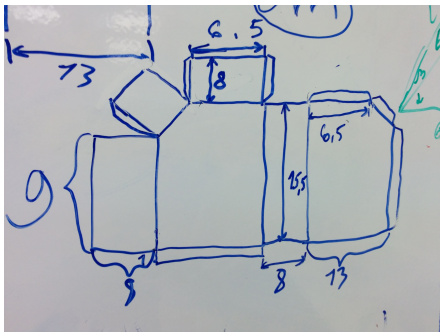


Рис. 124: Closer view of the scan

This shape was chosen because:

- It was easier to fill by the grab mechanism
- It was big enough to hold 5 cubes
- It was not enough spacious for 6 cubes
- It has output hole with width of 2 cubes and that made cube falling vore direct and allows to score cubes.

15. Then the new bucket was marked and cut from a sheet of plastic (the same was used for the first bucket). Next, bucket was assembled and tested (not on robot). Tests showed that bucket was able to hold 5 cubes and score them directly to the high scoring bucket.

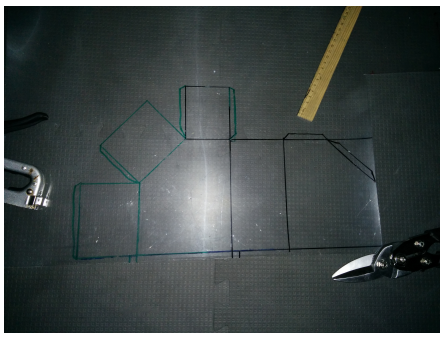


Рис. 125: Marking of bucket on the plastic sheet

Рис. 126: Fully assembled bucket with cubes inside

16. After that was made protection for wires that could get into slats and break there. Also was made protection for rope of shifting mechanism that could catch on parts of robot because of which shifting stopped. Both protections are plastic strips.

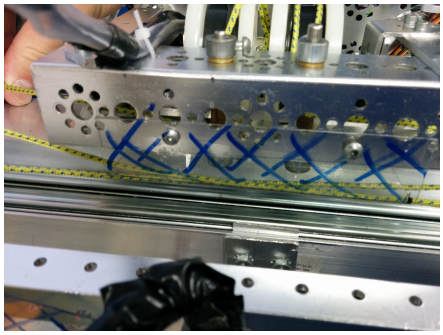


Рис. 127: Protection of rope

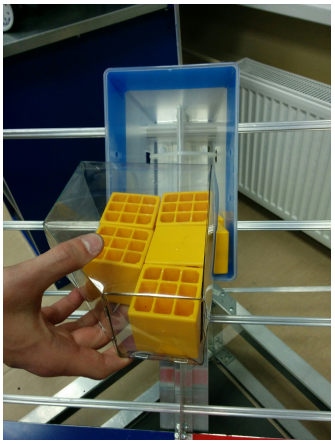


Рис. 128: Test of new bucket

0.2.3 Mechanism for scoring alpinists

Engineering tasks included in this module:

1. The first step was find all the sizes of climbers and elements of field that essential for creating module. The size of the box for climbers is the same to the box for debris: 14.6 x 5.75 . The height of the border is about 30 cm. The parameters of the climber 11.6 x 2 x 3 cm. It's weight is approximately 10-20g .
2. After that it was invented the image of the mechanism for scoring climbers into the box. The lever with a container for climbers turns around the axis, which is placed higher than the edge of the border. The container is closed by a cover with a latch, that is tied to the mount of the axis by thread. When the container overturns, the thread stretches and releases the latch. It allows to throw climbers verticallywith high accuracy and prevent them from accidental falling out of the container during the movement.
3. According to this idea it was created the model of the bucket in Creo Parametric. To prevent the servo from breaking down, it was provided a second lever opposite the bucket, that can be charged with contraweight. It was also created a blueprint of a bucket and a cover. These elements will be made of PET.
4. Next, the first version of the module was assembled and tested. The latch for cover was working stable. However, after the implementation in real details it was acknowledged, that the module is quite bulky

because of the lever for contraweight. So, there were held calculations of the moment on the servo to investigate whether it can operate without a countraweight or not.