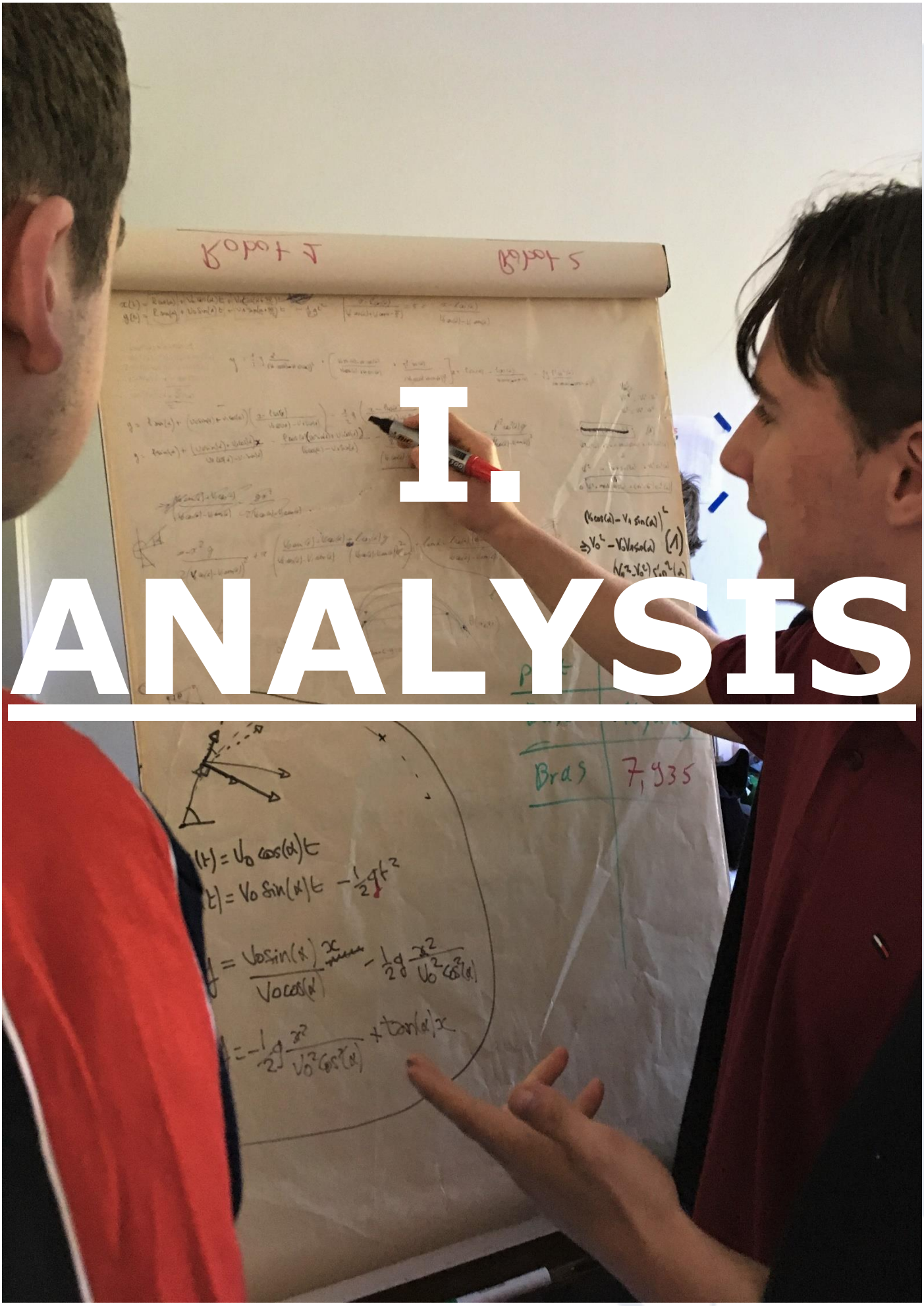

5553

ROBO'LYON

The FIRST French Team

# ANTARÈS

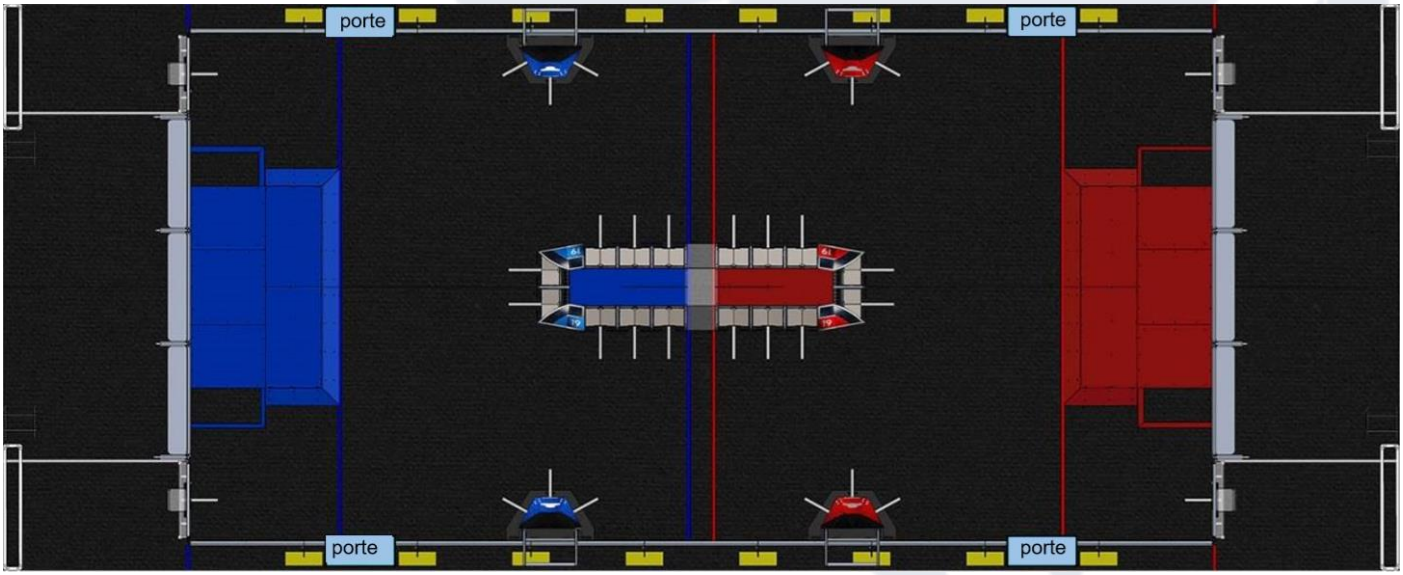



# I. ANALYSIS


# DESTINATION: DEEP SPACE

This year's game consists in taking hatch panels in loading stations and putting them in different areas: the cargo ship and the rocket. They will block the cargos (balls) we will drop in these areas. The cargo ship can contain 8 hatch panels and cargos, and the rocket can contain 6 of them at three different heights. At the end of the match, each robot which can climb on one of the three steps (6cm, 21cm, 55cm) earn additional points.

The match lasts 2min30. The first 15 seconds correspond to the sandstorm during which a curtain sets up in front of the drivers. The robot can then be autonomous or be driven by the driver with a little camera. After the sandstorm, the robot is driven by the driver until the end of the match and has 20 seconds to climb on the different steps.



- Points' values:
    - In sandstorm and tele-operated period:

| Action | Points | Difficulty /5 |
|---|---|---|
| Getting down from the first step | 3 | 1 |
| Getting down from the second step | 6 | 2 |
| Put a hatch panel on the cargo ship and on the first level of the rocket | 2 | 1 |
| Put a hatch panel on the other levels of the rocket | 2 | 4 |
| Drop a ball in the cargo ship | 3 | 2 |
| Drop a ball in the rocket | 3 | 3 |
| Climb on the first step at the end | 3 | 1 |
| Climb on the second step at the end | 6 | 3 |
| Climb on the third step at the end | 12 | 5 |

    - Ranking points:

| Action | Points | Difficulty /5 |
|---|---|---|
| Fill the rocket | 1 | 3 |
| Total 15 points or more by climbing on the steps at the end | 1 | 4 |
| Victory | 2 | Ø |
| Tie | 1 | Ø |


# STRATEGY

## Strategy 1:

- Defend from the other teams
- Climb on the third step
-

| + | - |
|---|---|
| - Simple<br>- Prevent other teams to earn points | - Dependent of the alliance about points |

## Strategy 2:

- Put the hatch panels on the cargo ship and on the first levels of the rocket
- Drop the balls everywhere
- Climb on the third step at the end

| + | - |
|---|---|
| - Earn additional ranking points | - dependent of the alliance about hatch panels |

**Strategy 3:**

- Put hatch panels on the cargo ship and on the two first levels of the rocket
- Drop the balls in the cargo ship and in the first two levels of the rocket
- Climb on the third step at the end of the match

| + | - |
|---|---|
| - Independance (vis-à-vis)the alliance<br><br>- Earn additional ranking points | - Can't fill the entire rocket<br><br>- complex |

**Strategy 4:**

- Fill the cargo ship and the entire rocket with the balls and the hatch panels
- Climb on the third step at the end of the match

| + | - |
|---|---|
| - Independance of the alliance<br><br>- Earn additional ranking points | - Very complex<br><br>- Very vulnerable to rivals' defence |

Comparing the first two strategies, we noticed that it was wiser to be able to score several points even if it means defending with a less specialized robot. Moreover, defense is useful only if one of the opposing robot is able to put hatch panels and cargos on the last level of the rocket. However, after we thought about the fourth strategy, we remarked that we would have to conceive a very complex robot which would be vulnerable to the first strategy (defense). So, we imagined a versatile strategy using a robot putting cargos and hatch panels in the two first levels of the rocket and in the cargo-ship, able to climb the third step of the habitable zone, insuring at least one ranking point, and able to defend if it has to.

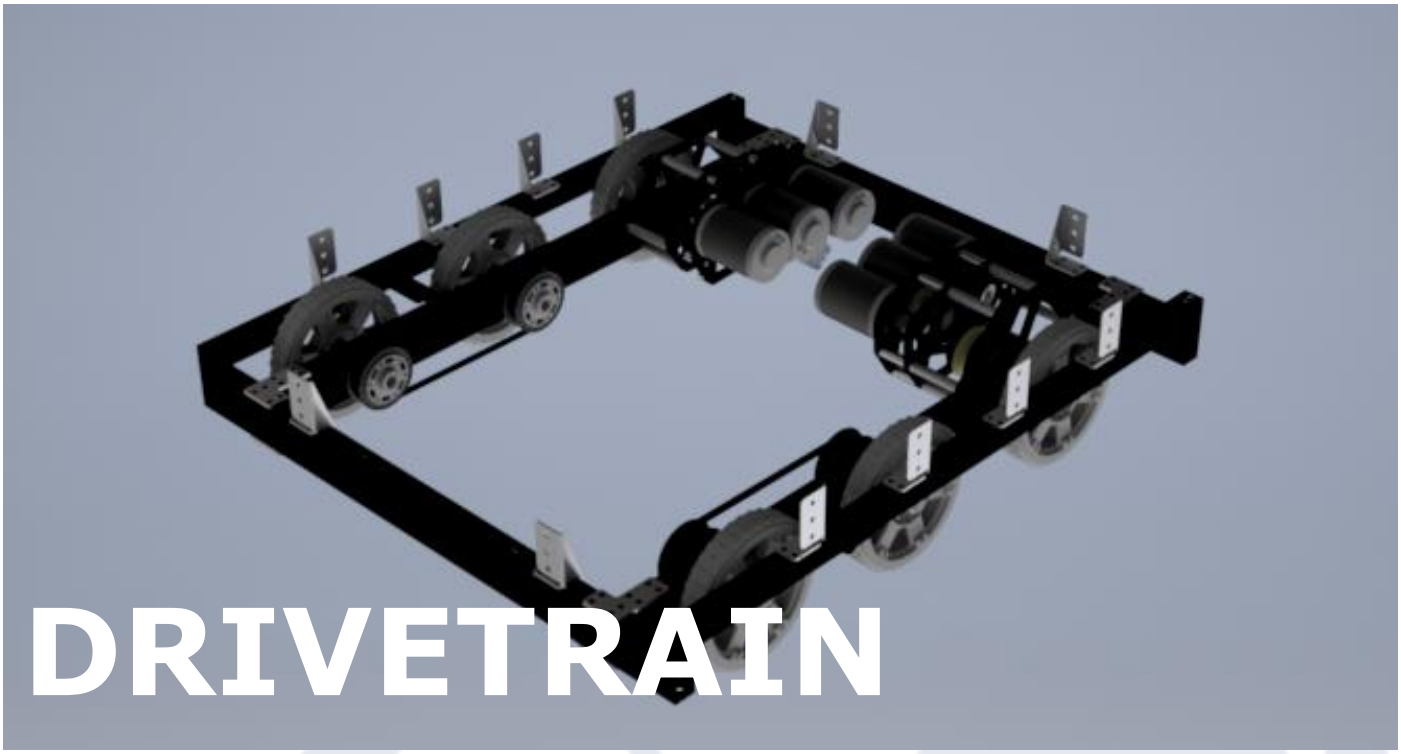

# GOALS

- Drivetrain:
  - Fast and nimble
  - Simple
  - Very movable
  - Two speeds:
    - A High speed for long trips
    - A Low Speed to defend, for short trips and for powerful accelerations
- Mechanism to manipulate the cargos (balls) and the hatch panels:
  - Able to take the balls and the hatch panels with the same mechanism
  - Able to catch the balls on the ground and in the loading station
  - Able to catch hatch panels in the loading station
  - Able to expel balls and hatch panels quickly when tilting itself
  - Reliable
  - Easy for the driver

- Climbing mechanism
  - Fast and efficient
  - Reliable

- Programming
  - Visual processing
  - Acceleration ramp
  - Precise control of the movement of the pivot
  - Efficiency

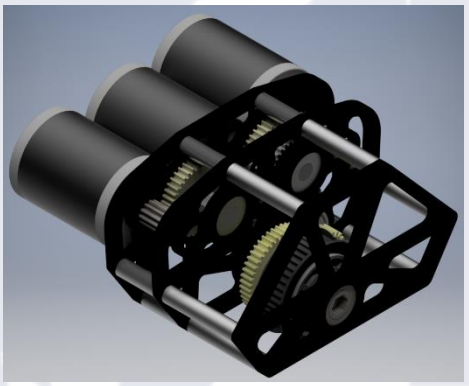
# II. DESIGN

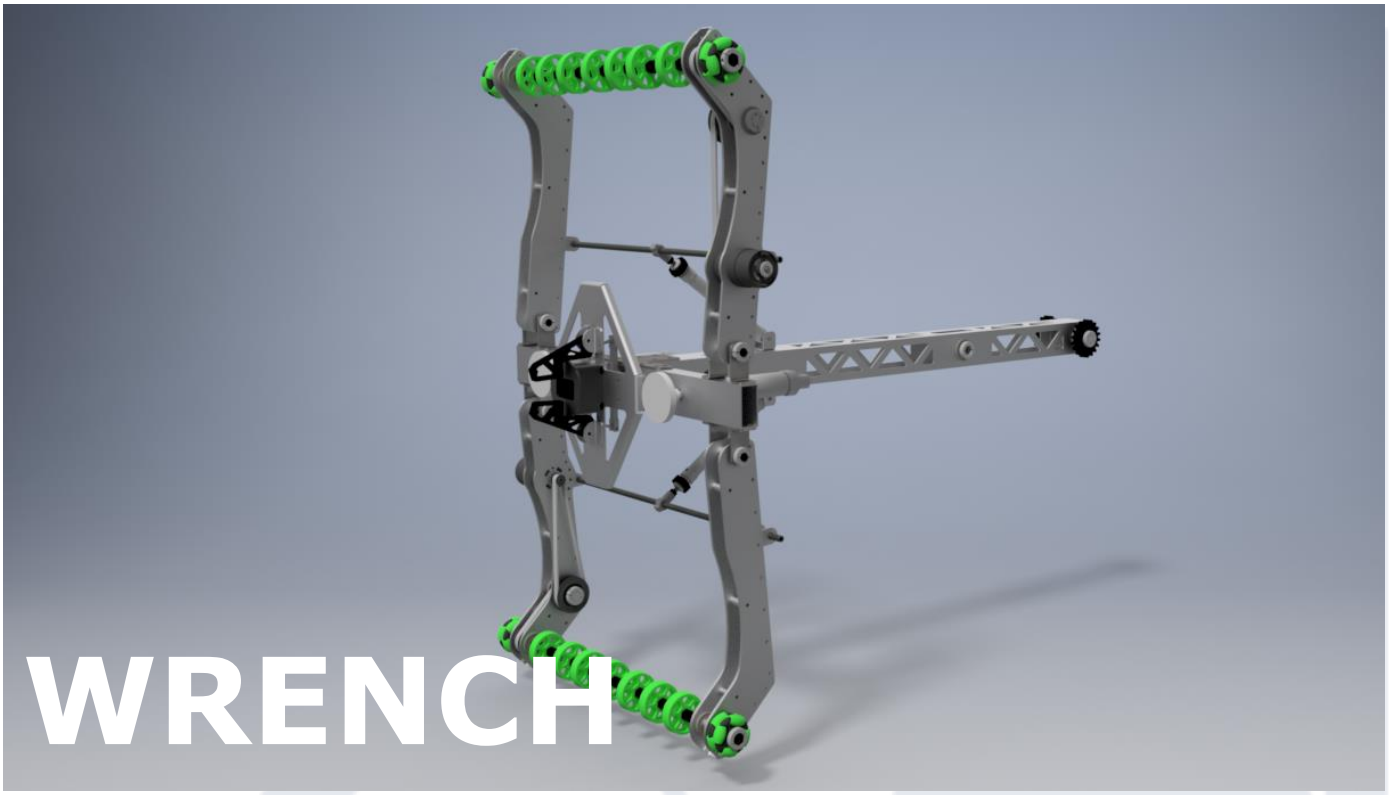


# DRIVETRAIN

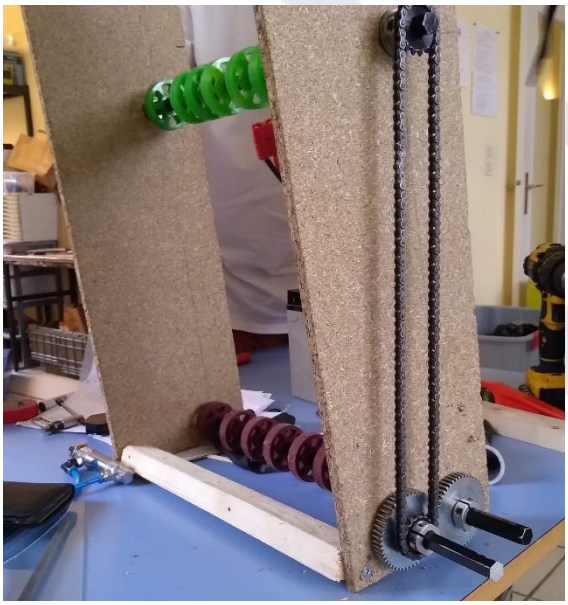
Characteristics:

- Frame
  - Aluminium profiles of 50x25x2mm
  - Simple design
- Bumpers' clamps
  - Aluminium profiles of 25x25x2mm
- Drop center of 3mm
  - Make it easier to turn
- 6in wheels for a better crossing
- 2 speeds custom gearboxe
  - 3 *miniCIMs*
  - Ballshifter
  - High gear
    - Réduction of 7 :1
    - Max speed: 19ft/s
  - Low gear
    - Réduction of 12 :1
    - Max speed: 11ft/s
- Transmission with belt and pulleys HTD 5M of 9mm





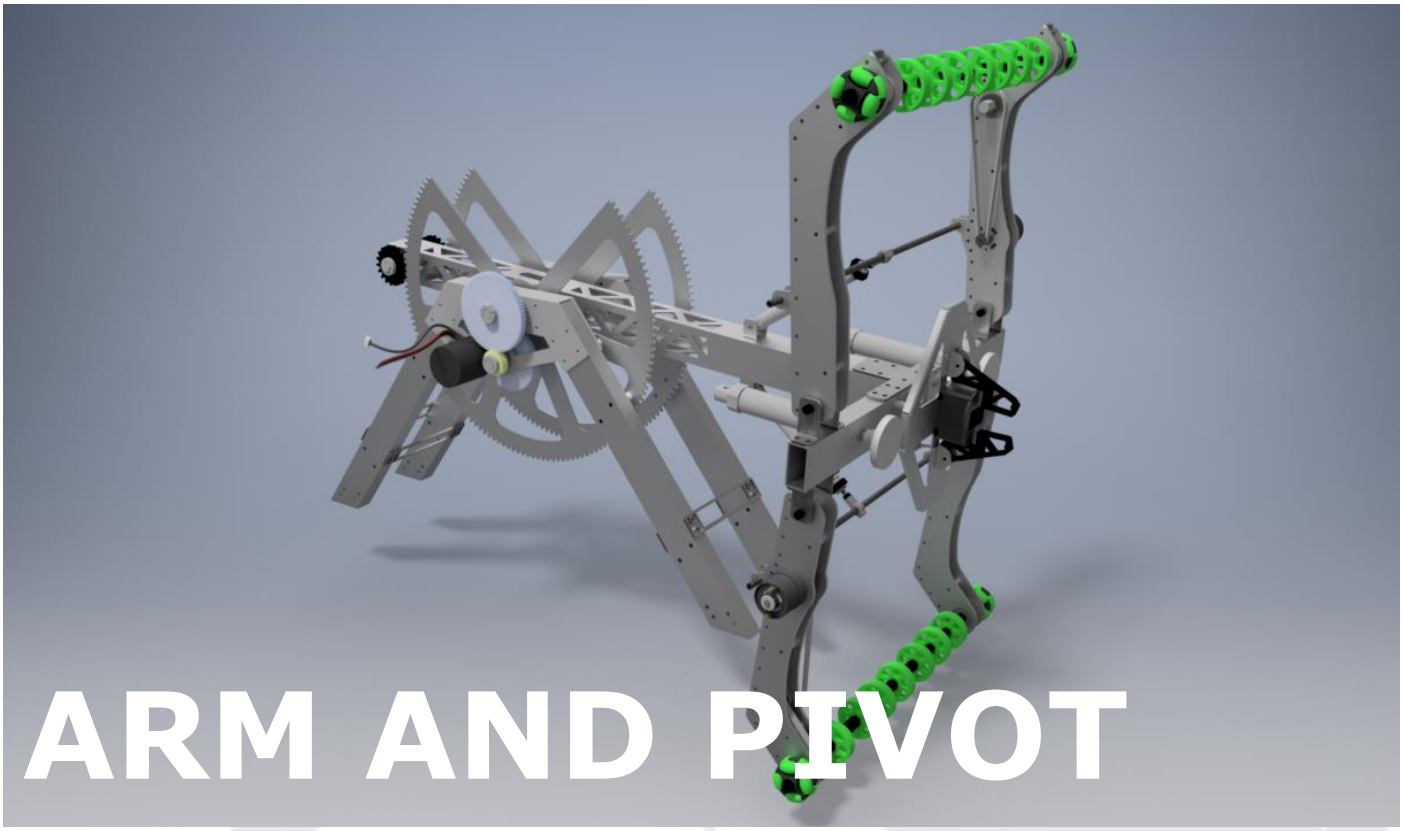

Prototype:



We BUILT a prototype of a mechanism which could catch balls. We used *ANDYMARK green and maroon compliant wheels*, motorized by a CIM motor. It allowed us to test the spacing between the wheels and to check if this kind of mechanism was working to catch and expel the balls.

Characteristics:

- 10 *ANDYMARK maroon compliant wheels* on each side of the wrench
- Integrated reduction
  - A *775 pro* on each side of the wrench
  - Reduction only with belts
    - Reduction of 6 :1
    - Linear speed of 27ft/s
    - Angular speed of 3158 rpm
- The wrench has an adaptive shape in order to catch the balls on the ground and in the loading stations
- The wrench can open to 180° in order to use the hatch system which is integrated
- The wrench and the hatch system are integrated in the same mechanism: the arm which swivel around the robot



# ARM AND PIVOT

Advantages :

- Allow to catch and drop balls and hatch panels from each side of the robot
- Simple, composed of only one articulation
- Rugged and reliable
- Compact and light

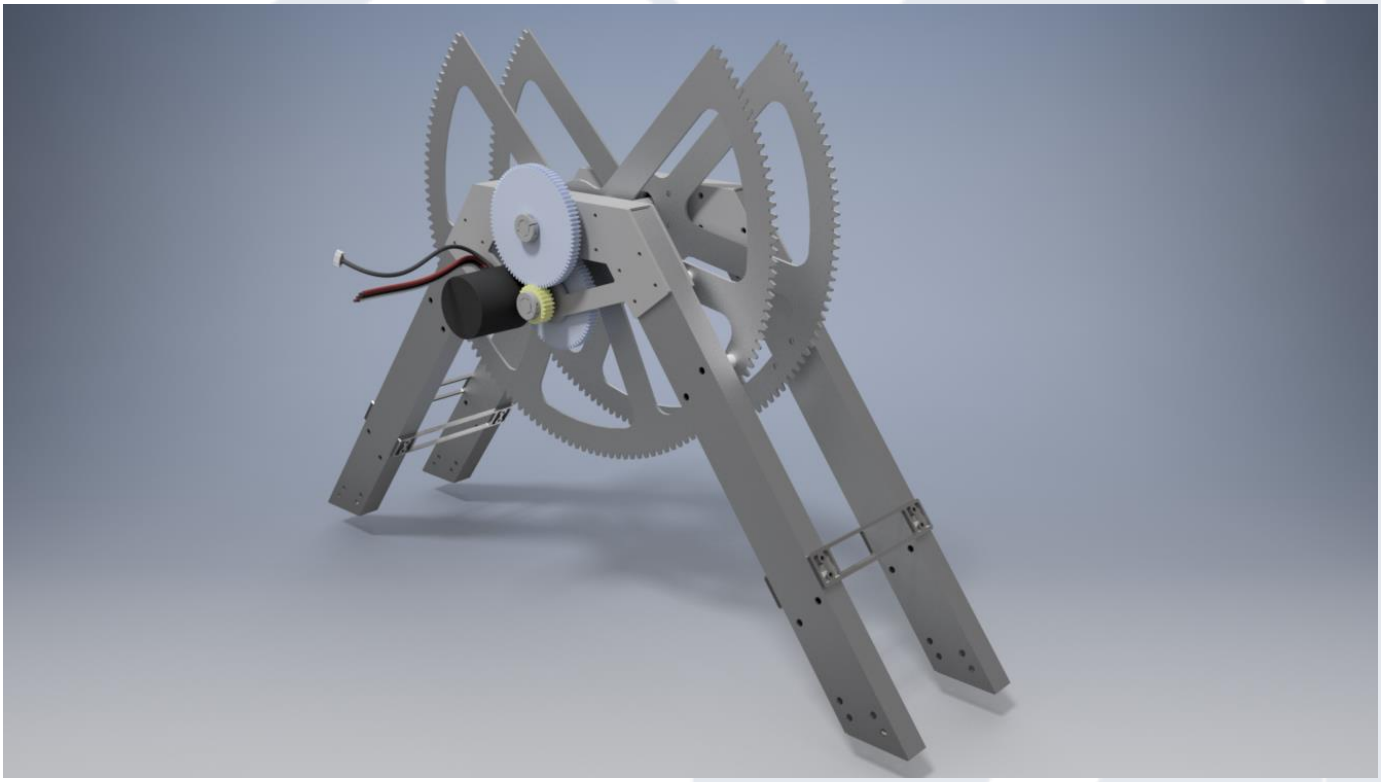
Disadvantages:

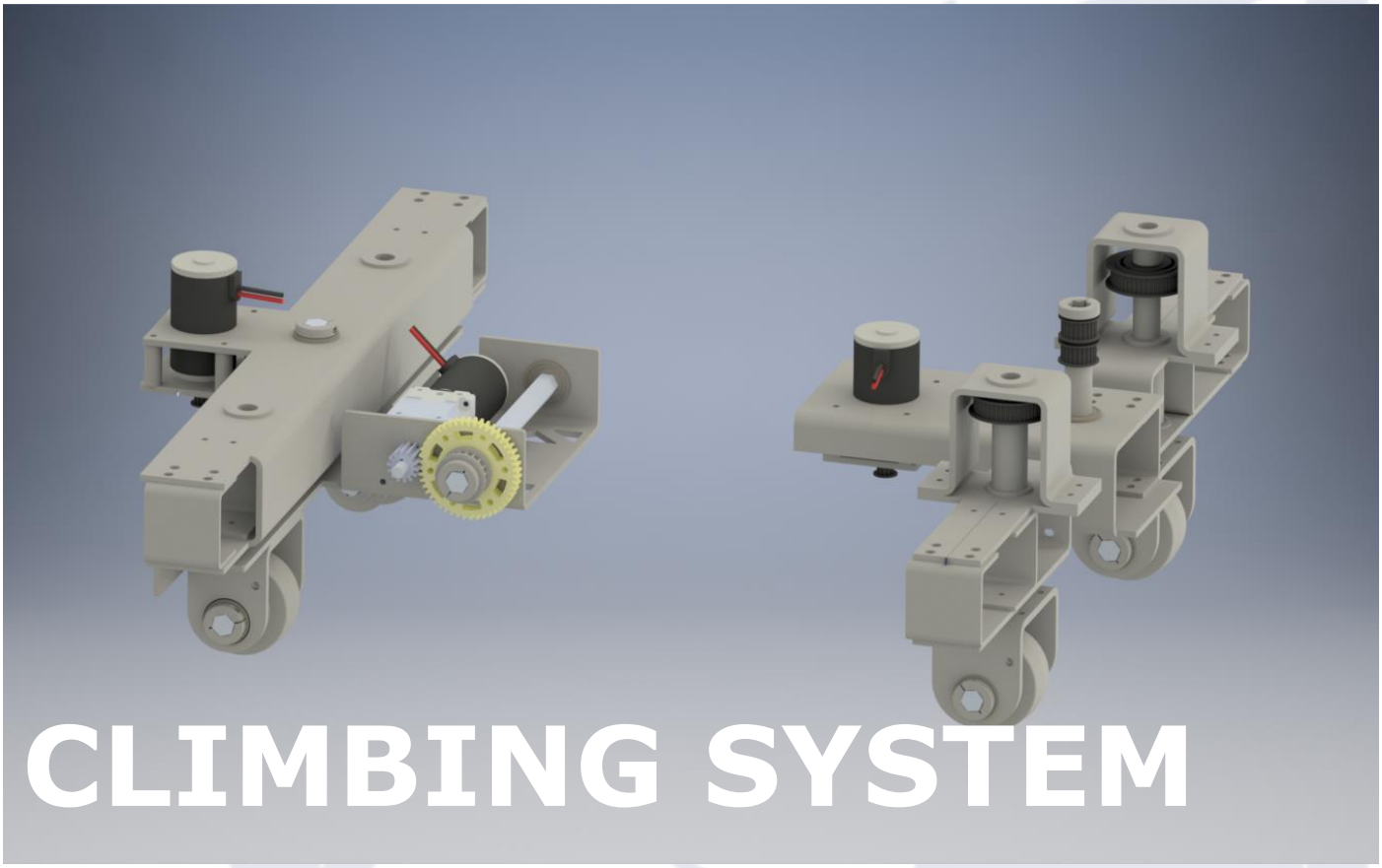
Cannot put balls and hatch panels in the third level of the rocket
Limit the space in the center of the robot

We were inspired by the mechanism of our last robot **SCORPION** which we readapt for the needs of this new game.

Characteristics :

- Motorized by 1 *NEO*
  - Gearbox integrated in the pivot's structure
  - Reduction of 175 :1
    - First level 12 :84
    - Second level 18 :54
    - Third level 18 :150
- Custom gear in steel and aluminum
- Chain inside the profile
- Simple design of the arm
  - Aluminium profile of 50x50x2mm
- Pivot's structure with aluminum profiles of 50x25x2mm.

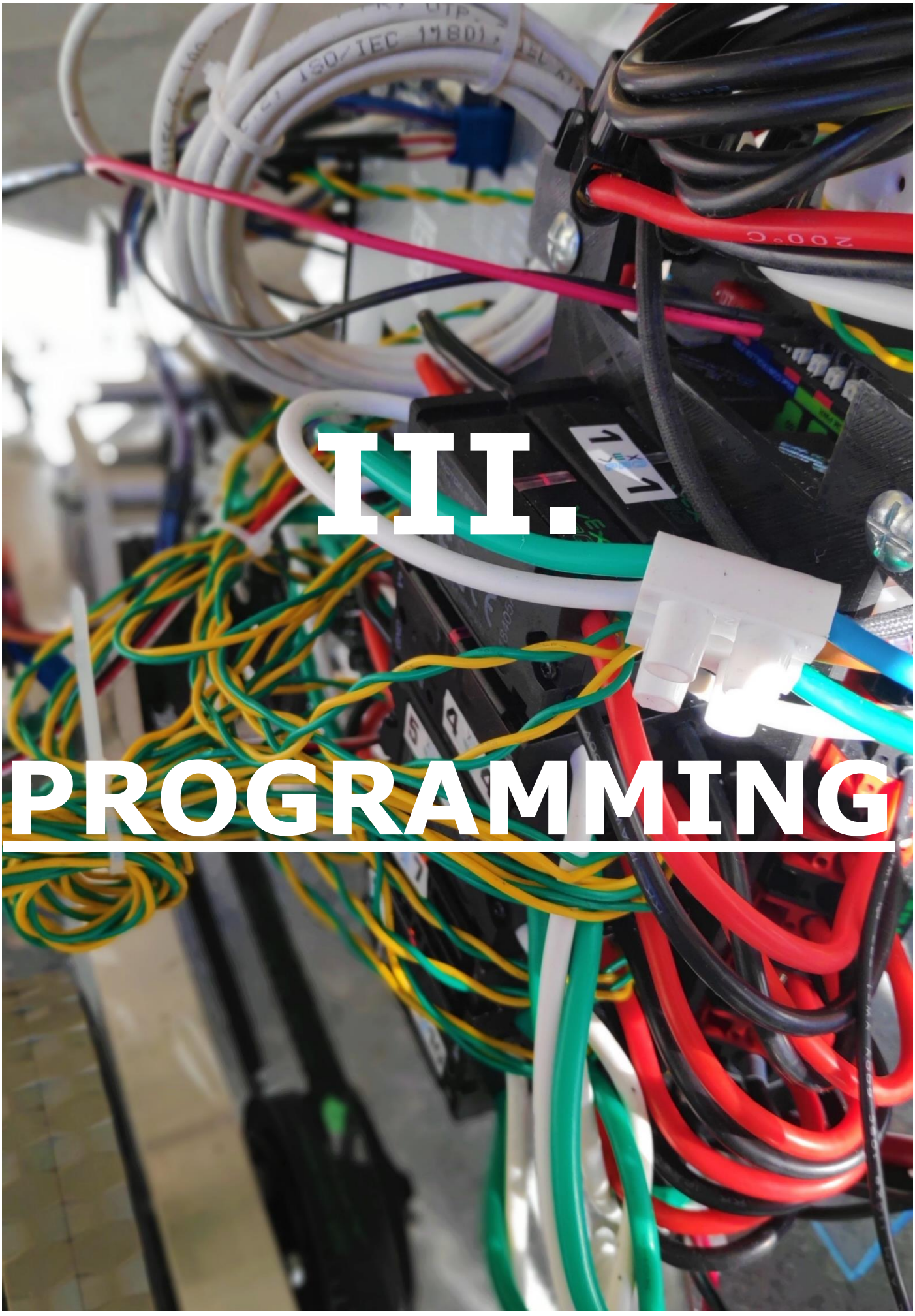




# CLIMBING SYSTEM

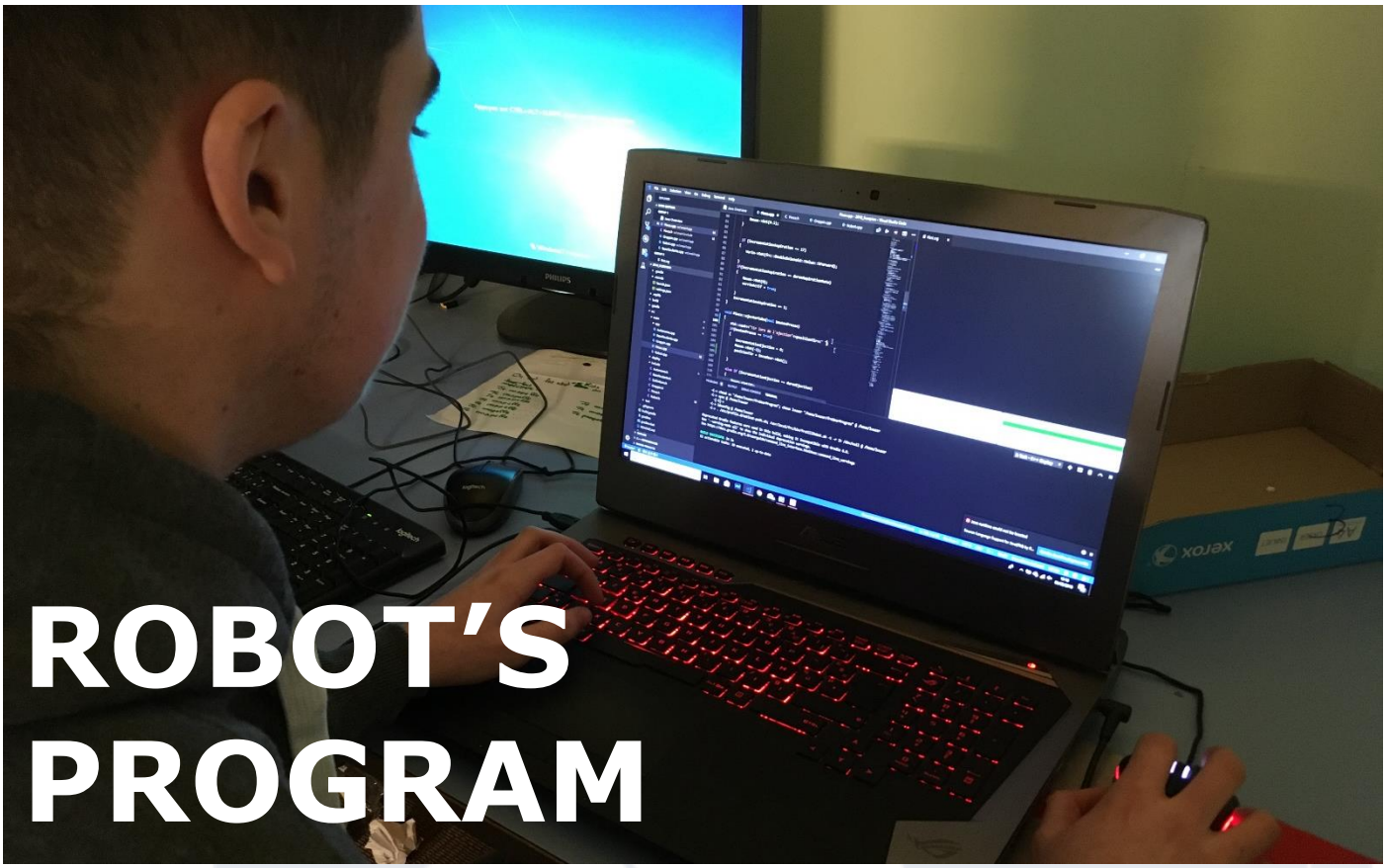
Characteristics:

- Pulley system in which is included a nut. It allows a belt to turn a screw which leads to raise the robot on four wheels
    - Modules' motorization: a *BAG* per module
        - Climbing motorization
            - Gear system
            - Reduction of 4 :1
            - Climbing in 5.7 seconds
        - Wheels motorization
            - Planetary system
            - Reduction of 450 :1
            - Speed : 0.65ft/s



# III.

# PROGRAMMING



# ROBOT'S PROGRAM

- Command-Based programming :
  - more flexibility
  - better organization
  - object-oriented programming

- Use of Pathfinder lib to generate splines to follow during the sandstorm period: fast and precise trajectories.

- Use of *CIMcoders* in the drivetrain to count the distance

- Use of PID controller to enslave the pivot of the robot

# VISUAL PROCESSING

- Use of the Open CV library for image processing
- Use of the library Network table to communicate with the robo rio
- The program is operating with a raspberry pi 3b+ to gain performances. It is divided in different stages:

1. Converting the image from RGB to HSV
2. Filtering each pixel according to its color
3. Image processing with canny filter
4. Contour’s detection

5. Contour’s filtering (according to their properties)

6. Contour’s coupling, creating a new target

7. Tracking the optimal trajectory to reach the detected target thanks to the use of odometry and motion control