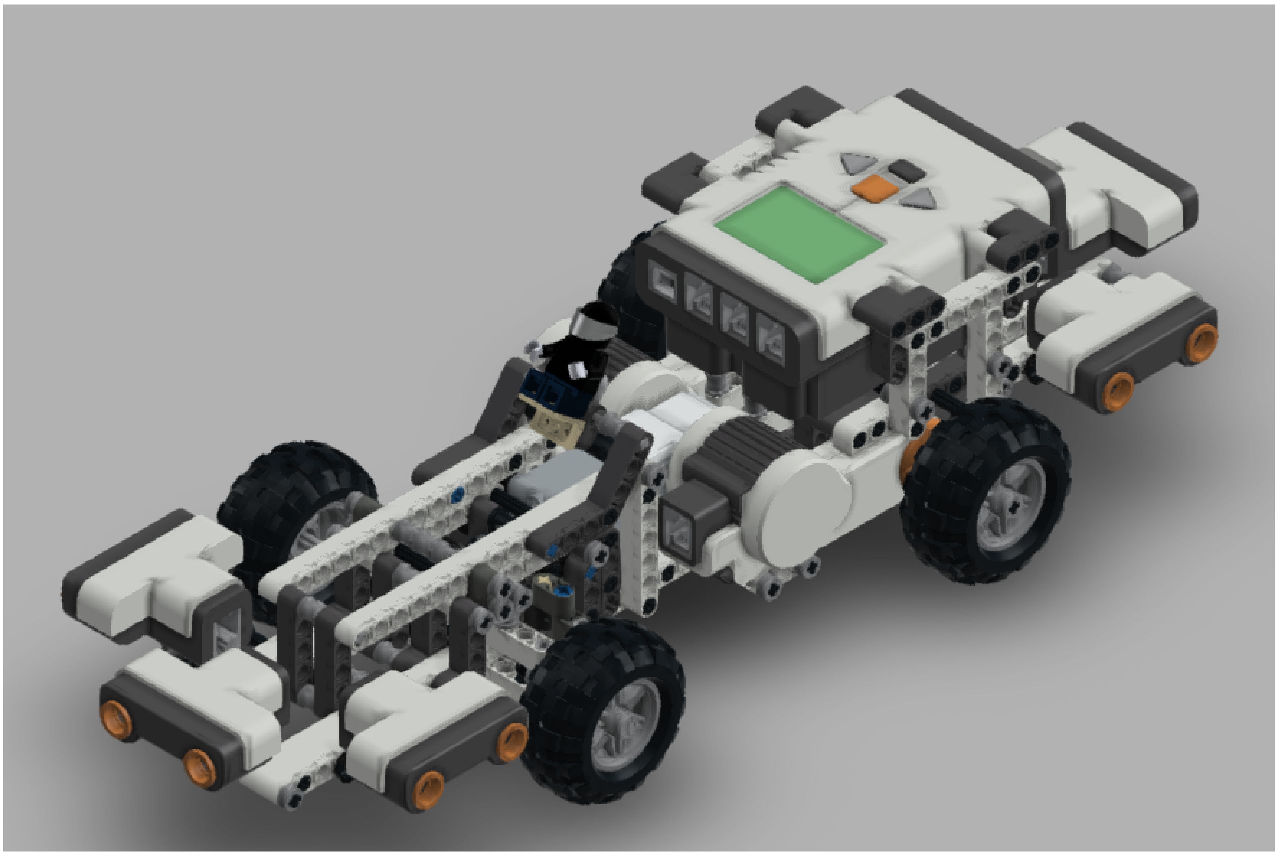
Autonomous Parking System

Project constructed as an assignment for the summer semester of 2021

Scientific Article

Authors: Mechanic group: Bartosz Bobak, Jarosław Klary, Filip Kaczor, Grzegorz Sidorowicz



1. INTRODUCTION

In the summer semester of the academic year 2020/2021 for the mechatronic classes in the University of Science and Technology, we were supposed to create from scratch one project. It could be chosen from the list of projects provided by our supervisors or our own invention. After dividing into groups we have decided to choose an Autonomous parking system installed on a car. If it was not the pandemic situation in our country we would prepare the projects manually in the university, but due to inability to let us enter the buildings we were supposed to prepare the project remotely. Our group is designated to take care of the mechanical aspects of our project. In this article we will show our solutions to the problems we encountered and what final solutions we came up with. Mechanical group is responsible for building the car itself, we have to get everything from software and electronic groups all together and connect it in a way that will make the car serve its purpose, run as effectively as possible and also look as much like a car as possible. Our whole team was divided into groups with the same amount of people. We chose the groups basing on our personal preferences

2. PURPOSE AND SCOPE OF WORK

The main purpose of our work is to create the mechanical parts of an autonomous car which includes a main body and steering axle, a chassis etc. The scope of our work will be divided into each complex mechanical part in this vehicle describing its previous iterations, reasoning behind our choices, its general purpose and how well it synchronizes with the rest of the parts whether mechanical or not, to create a synchronous device. The reason why we came up with such an idea was that nowadays this technology is very widely spread. This is one of the features that the future will provide us from now on. We think that getting the grips with this module is crucial in the perspective of what awaits us in the future.We were aware that this project would be quite problematic in case of complexibility of the issue but we were up to the challenge to pull this out.

Generally speaking we had to settle for one idea out of many of how we could prepare this project. We could choose various methods of construction. Due to the base that we had initially for our project build in real life we had to choose an option with no steering axle but with 4 separate engines one for each wheel. This resulted in the car behaving somewhat like a tank. After some adjustments we overcame this inconvenience and managed to build a real life model equipped with a steering axle. In a model created in Autodesk Fusion 360 programme we could make a project with a working steering axle with no problems from the very beginning and that is what we did.

After many discussions over how many sensors we would need or how many engines. We settled for using six sensors: one on each corner of the base and two on both sides. We are going to provide many screenshots with almost step by step descriptions that will be provided in chapter 4. The whole project was prepared very carefully in separate groups, also simultaneously just to save some time for testing. Our autonomous car will be controlled remotely with a telephone that is equipped with a bluetooth module. That is another variation that was one of our ideas in pulling off the whole project. In our first evaluations that way to control the car was the most suitable.

3. OVERVIEW OF EXISTING SOLUTIONS

This idea is commonly used in manufacturers like Tesla where the car after driving closely to a possible parking spot and park the car parallely or perpendicularly. All you have to do is simply enable the parking mode and take your hands off the steering wheel. The car shortly starts seeking for the best spot using sensors at the sides of the car. When it finds the spot it starts to swerve to adjust the position of the car to the parking spot after it drives in between two other vehicles it enables two sensors that determine the distance between the car and other vehicles around. The manufacturers that use similar solutions are numerous nowadays. It helps to automatize the vehicles which is the target that every motor company wants to achieve. The precursors are from Japan which was the first country to use self parking mode in their cars e.g. Toyota. Then America started to lead the research over this particular area of development which resulted in many Ford cars also equipped with this module. In these times self-parking is really desired as the owners usually want to take the burden off them while parking cars in such narrow and overcrowded parking places as they are nowadays.

Figure 1. - Ford F-150[1]

Also, these days new systems are being developed. This new concept's main assumption is driverless parking. This requires remotely controlling a car while in the special parking lot and the car automatically finds its way to park. That is a very convenient method because it does not involve a driver while parking. This eliminates any possibility of human error. Currently only one company is a precursor in these researches, namely, Mercedes-Benz

Figure 2. - Manual control of car parking [2]

4. MODEL AND SIMULATIONS

a) The first step was to make a steering axle

Our first solution to the problem is shown in Figure 3 and 4.

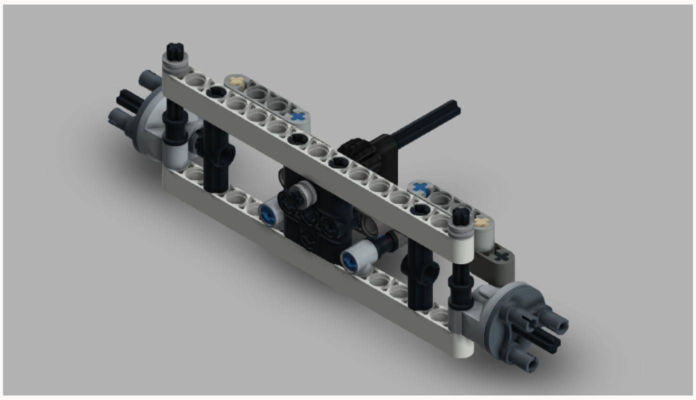


Figure 3 - version 1.0 of steering axle, front view

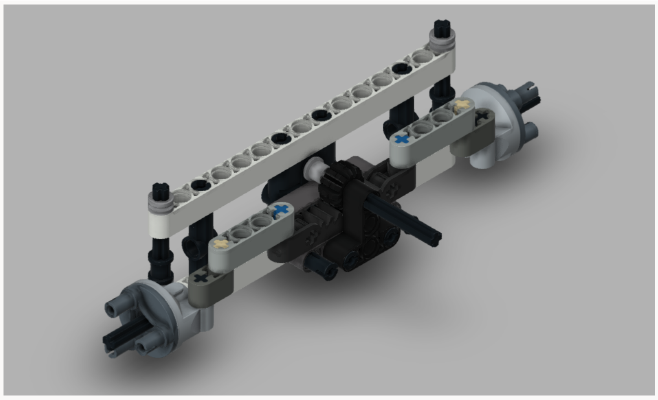


Figure 4 - version 1.0 of steering axle, back view

However the lack of lego bricks forced us to change our plan of action. We ended up with a steering axle shown in Figure 5 and 6.

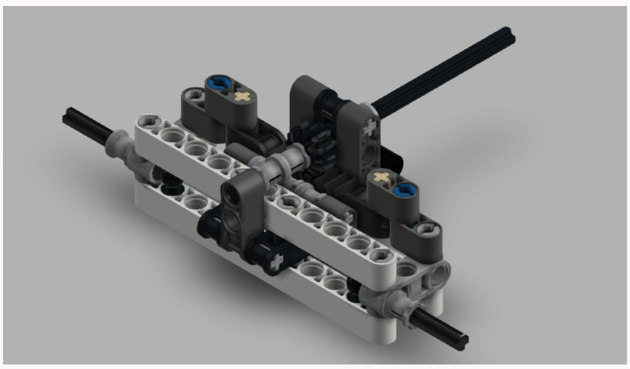


Figure 5 - version 2.0 of steering axle, front view

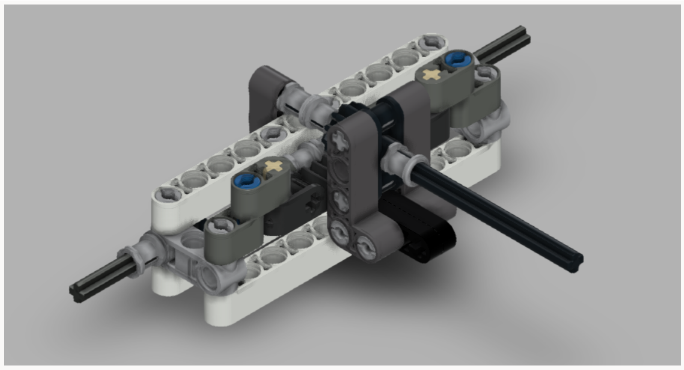


Figure 6 - version 2.0 of steering axle, back view

b) Major breakthrough is shown on figures 7 - 10.

After settling down on using the steering axle shown above, we had to connect motors and main hardware to our car. We connected the steering axle to the servo motor and two motors to the rear axle. The main hardware is located above the rear of the autonomous car.

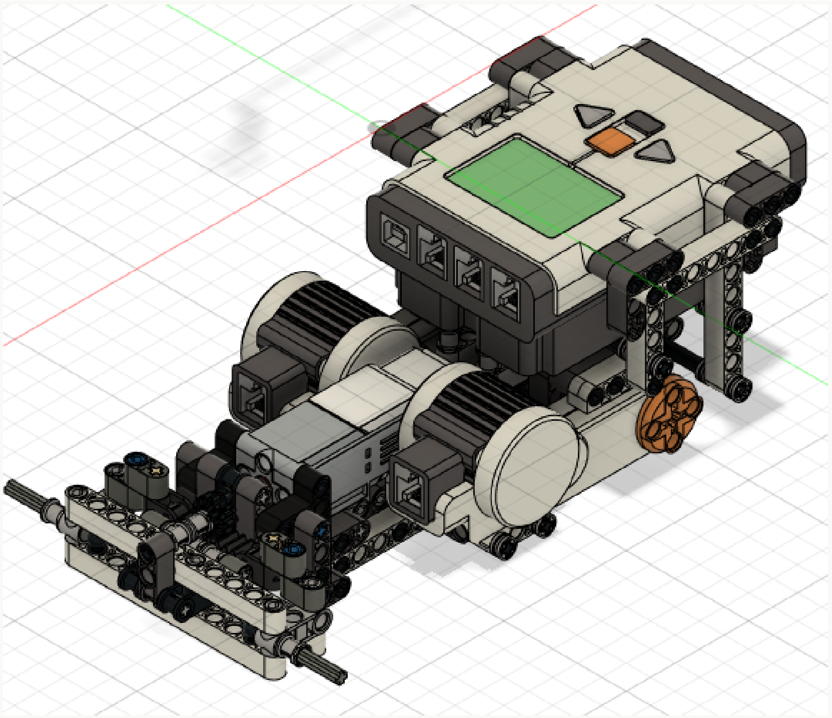


Figure 7. - steering axle connected with engines and central computer

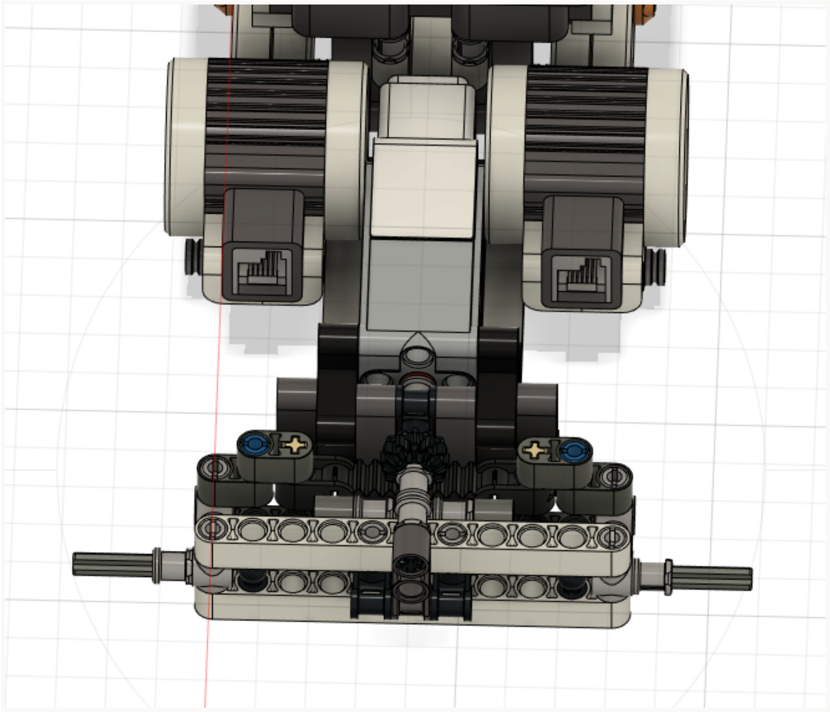


Figure 8. - close-up from the top

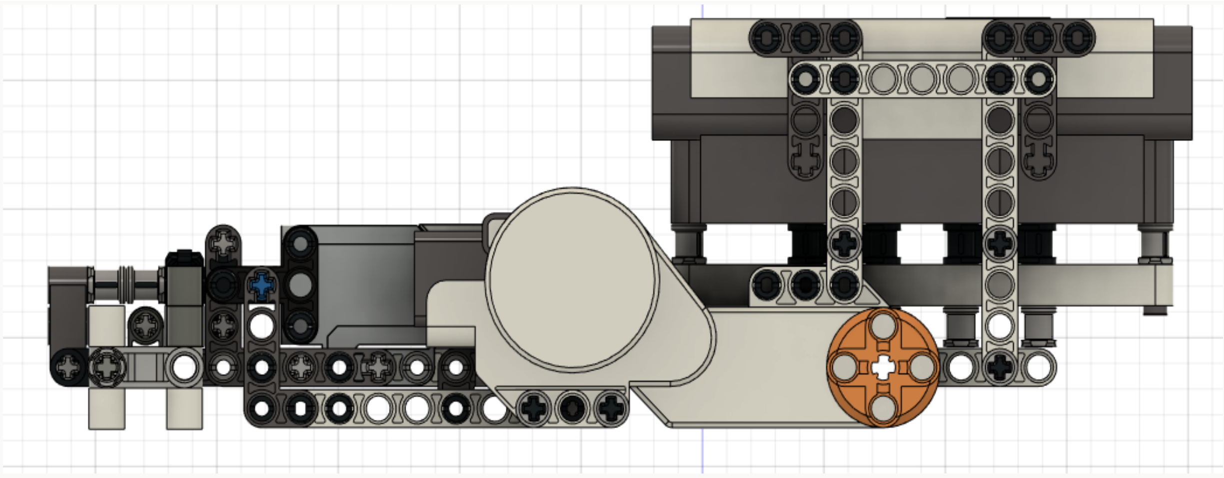


Figure 9. - view from the right side

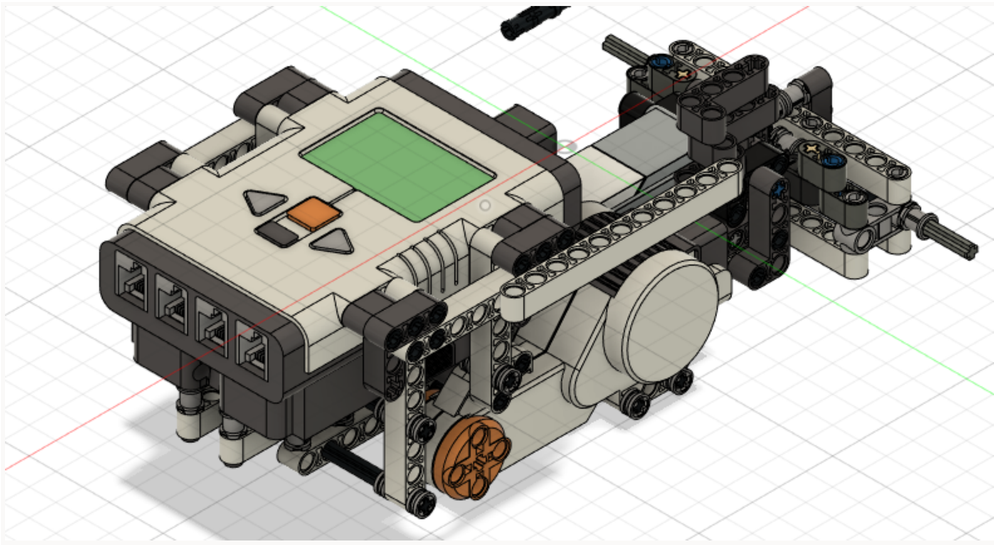


Figure 10. - Focus on the rear axle

c) Final project is shown on the figures 11-13

To finish our project, all we had to do was to implement sensors and connect them to the chassis. Result of our work is shown below.

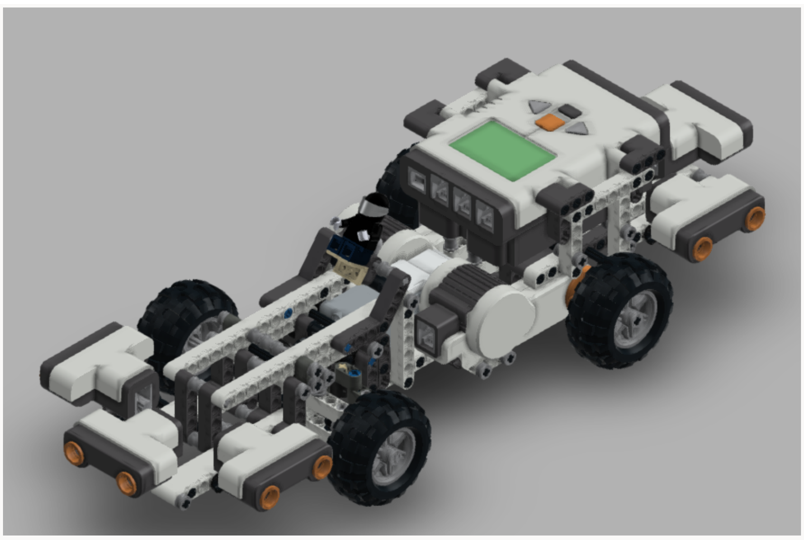


Figure 11. - general view

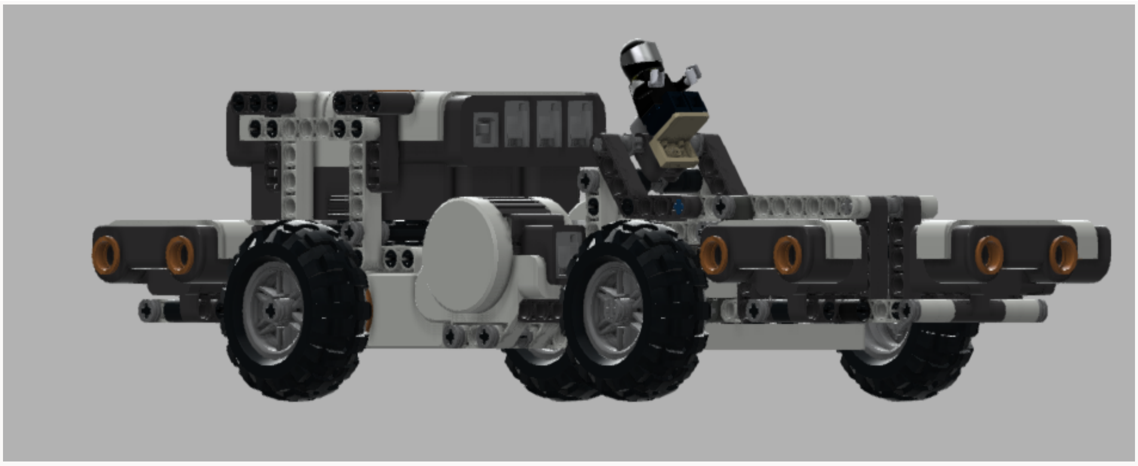


Figure 12. - close-up on the placement of the sensors

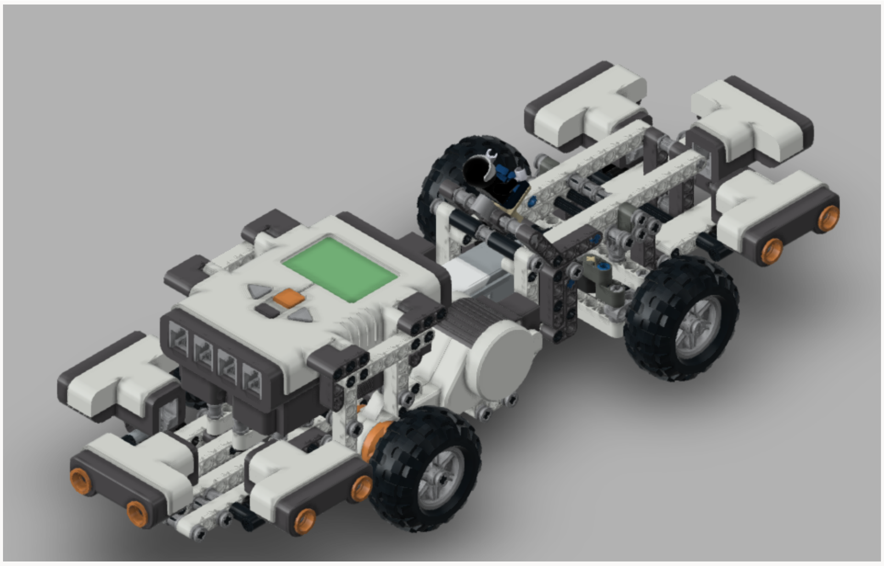


Figure 13. - general view from the back

The whole 3D model is under this link

Part that turned out to be irreplaceable:

-8 toothed belt that was used to make rack and pinion gear for our steering axle:

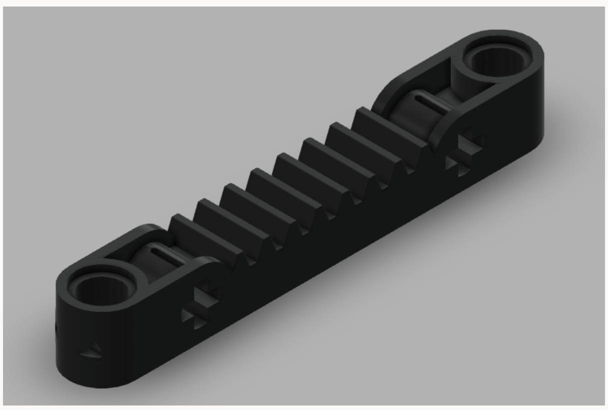


Figure 14 - rack and pinion lego

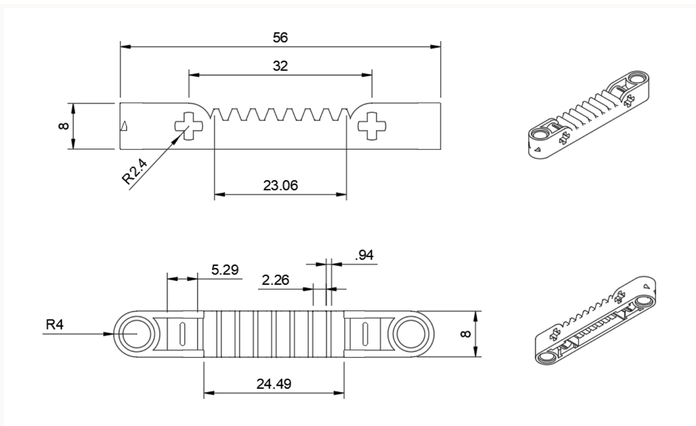


Figure 15 - rack and pinion measurement

5. PROTOTYPE AND TEST

a) **The first real component we built was a steering axle, one of the most important parts from a mechanical point of view in our project. We can see it in Figure 16 and 17.**

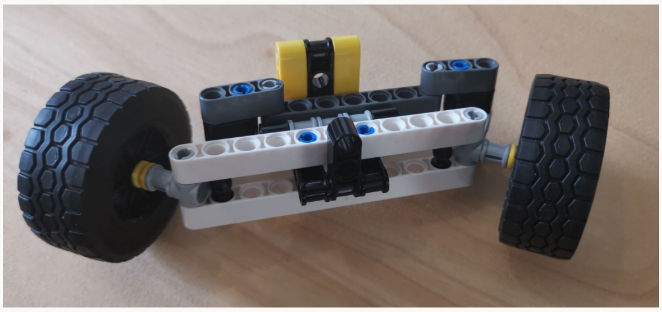


Figure 16 - v. 2.0 of steering axle build in real life, front view

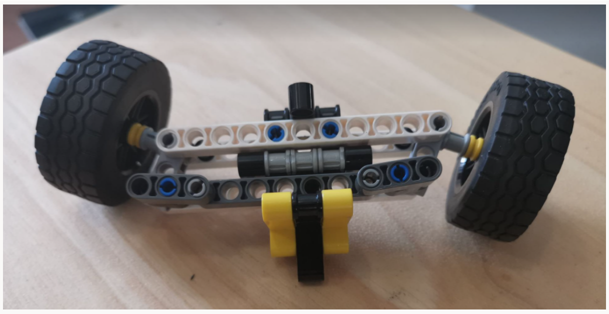


Figure 17 - v. 2.0 of steering axle build in real life, back view

b) **We can see the final project on the figures 18-20.**

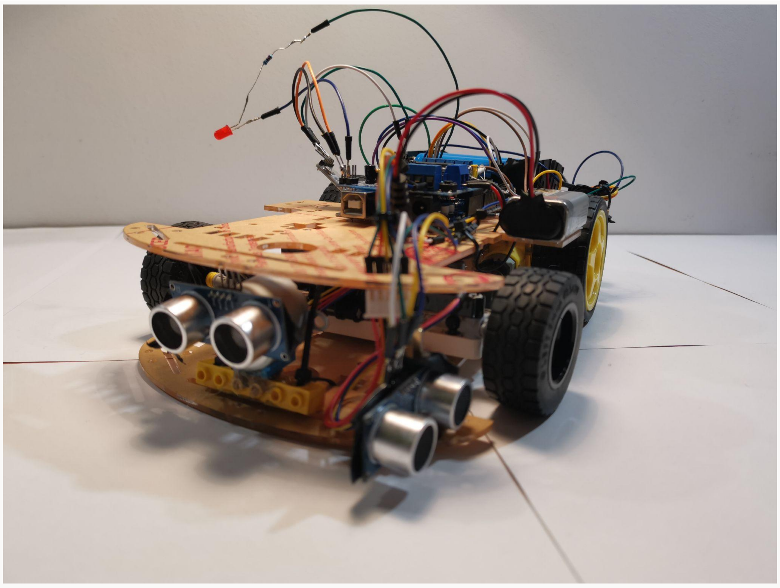


Figure 18. - view from the front

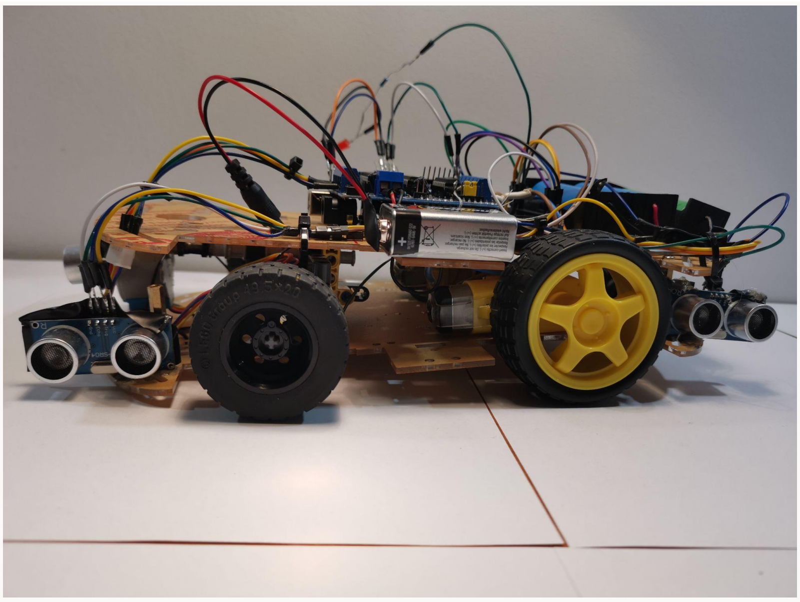


Figure 19. - view from the right

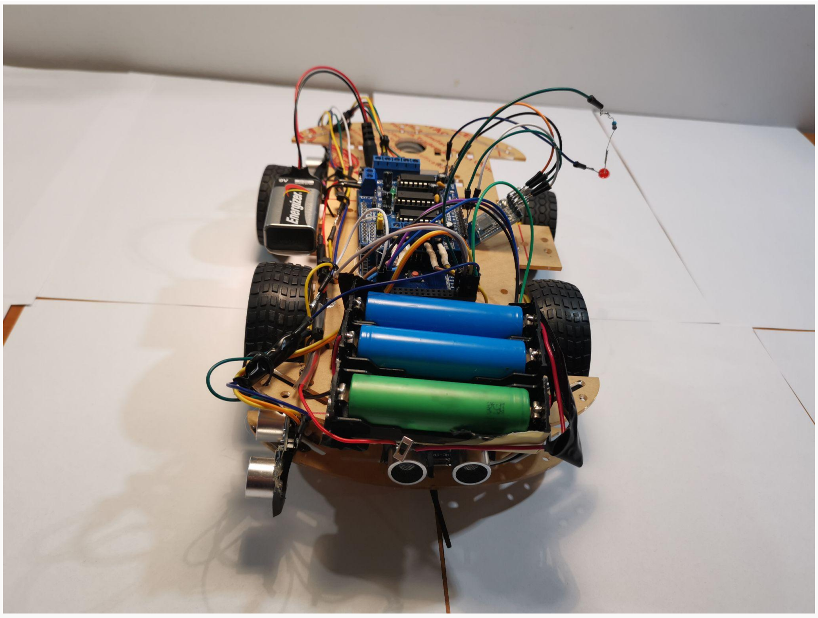


Figure 20 - view from the back

6. MEASUREMENTS AND ANALYSIS

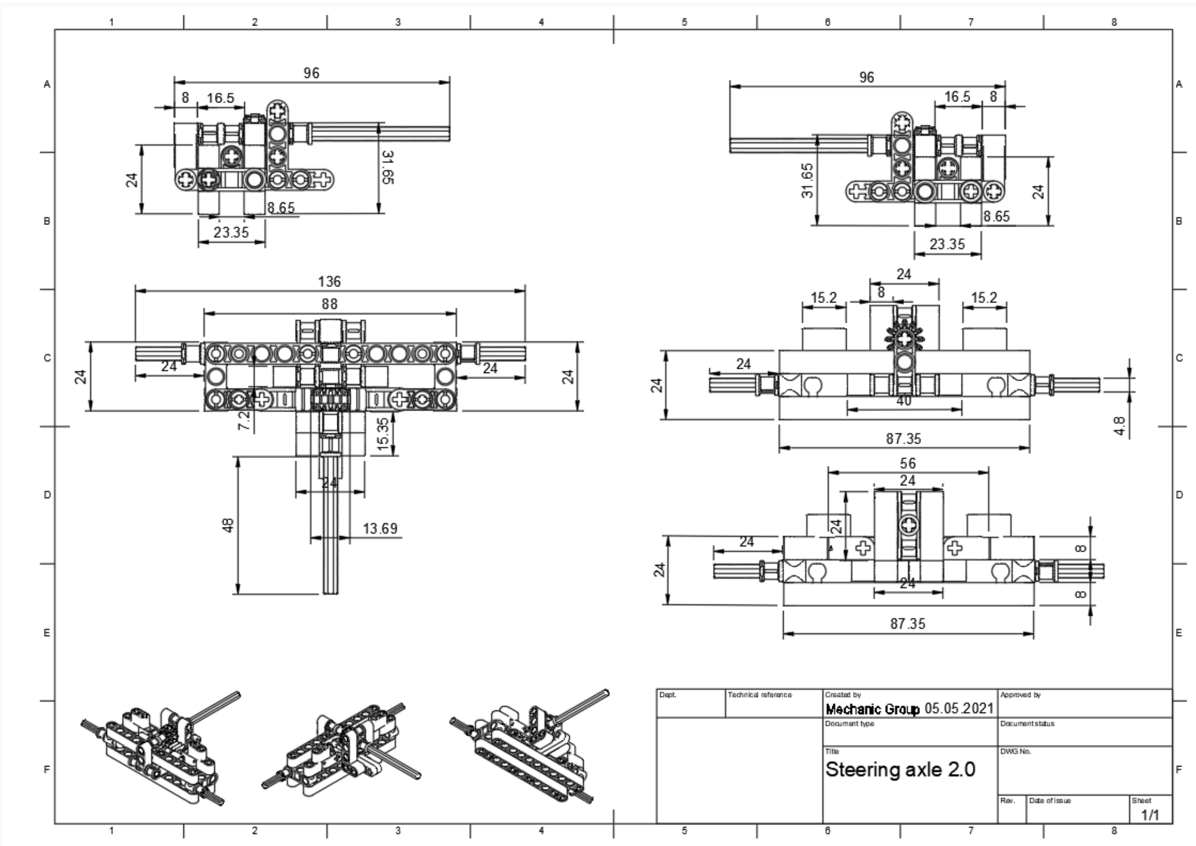


Figure 21. - All crucial measurements of the steering axle. (version 2.0)

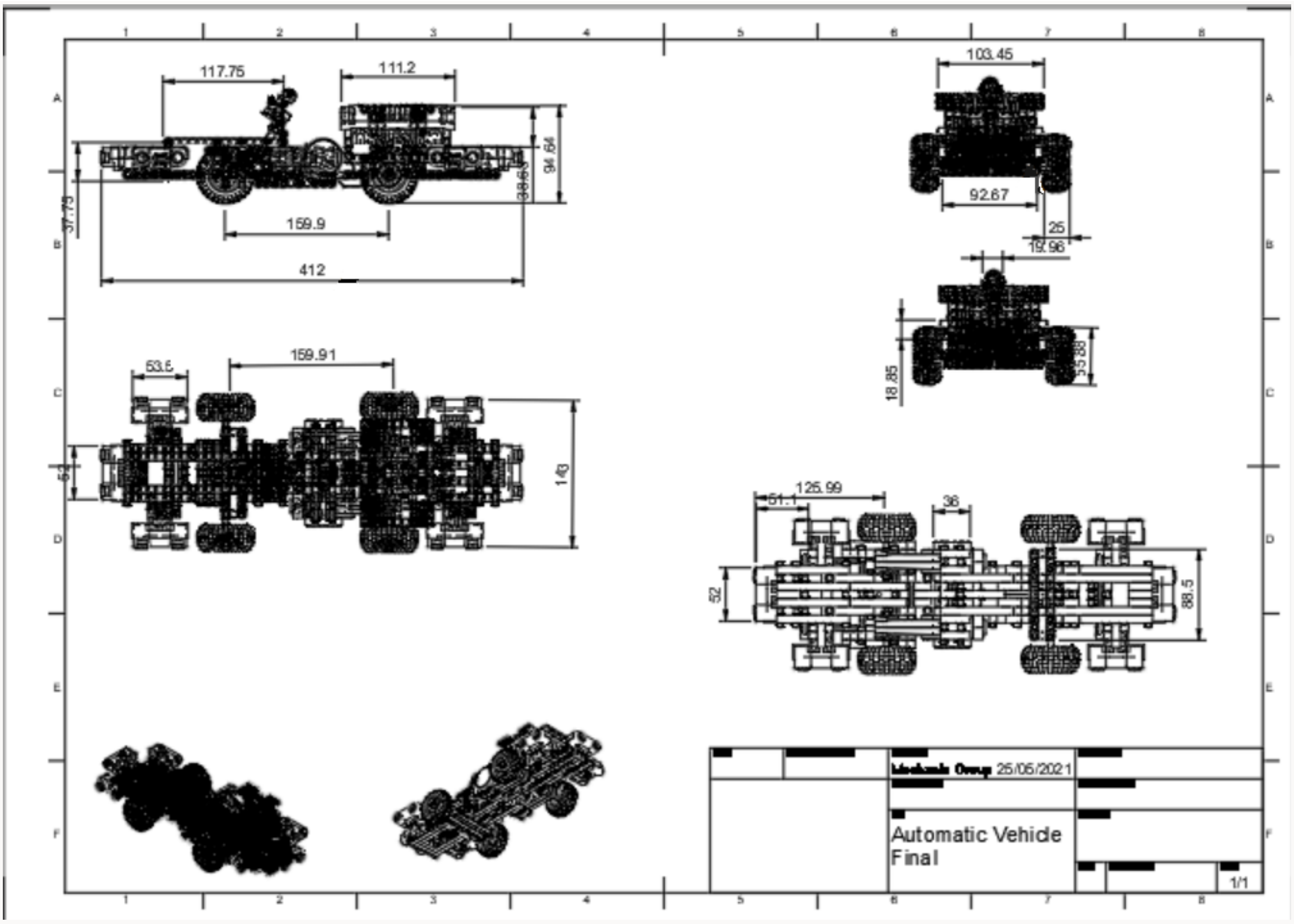


Figure 22. - all crucial measurements of the final project.

8. SUMMARY AND CONCLUSIONS

Our department has done a full body of the car including working under the steering axle. We have established a connection in between other groups by doing our part and letting them work on this body.

We have achieved a fully autonomous car steered by the bluetooth application and fully fulfilling its purpose as it parks on its own in any space it can fit. The most difficult part was to come up with the idea for sensors and which type of steering to choose but there was no major problem that we couldn't overcome. We have gone through several tests and made all needed adjustments. We have observed that all our initial ideas turned out to be alright. To build our Fusion 360 project we have used 454 LEGO components

9. BIBLIOGRAPHY

[1] https://cars.usnews.com/cars-trucks/best-self-parking-car

[2] https://www.daimler.com/innovation/case/autonomous/driverless-parking.html

10. APPENDIX (ANNEXES)

- Software used: Autodesk Fusion 360.

Tesla Autopark Trial Video

Self parking Tesla

- https://grabcad.com/