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Self-Driving Car

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ABSTRACT
An autonomous vehicle is a self-driving vehicle that uses various sensors, cameras, and advanced algorithms to sense the surrounding environment, make decisions and navigate without human intervention. These vehicles are rapidly evolving and have the potential to revolutionize the transportation industry by offering increased safety, efficiency, and accessibility. Autonomous vehicles are expected to bring significant benefits such as reduced traffic congestion, lower emissions, and increased mobility for people who cannot drive. However, there are still many challenges that need to be addressed, such as regulatory and ethical issues, cybersecurity concerns and infrastructure requirements. Despite these challenges, autonomous vehicles are poised to become an integral part of our future transportation system, changing the way we move and interact with our environment.
Keywords – Autonomous Vehicle, RADAR, Camera, Sensor Fusion.

1. Introduction

A self-driving car, also known as an autonomous vehicle, is a vehicle that is capable of sensing its surroundings and navigating without human interaction. This is made possible through the use of variable sensors [1], such as radar [2], lidar and cameras [3], as well as artificial intelligence algorithms [4] that process the sensor data and make decisions about how to drive and control the vehicle.
Self-driving cars have the potential to revolutionize transportation by reducing road accidents caused by human error [5], increasing mobility for people who cannot or do not want to drive on their own and improving traffic flow and efficiency. However, there are still significant technical, ethical [6] and legal challenges to overcome before self-driving cars can become a widespread reality.
Some of the challenges facing self-driving cars include developing reliable and safe technology that can handle unpredictable driving scenarios [7], addressing concerns about data privacy [8] and cybersecurity and establishing legal frameworks to govern the use and ownership of autonomous vehicles. Despite these challenges, many companies and researchers are working to develop and refine self-driving car technology, and it is likely that we will continue to see advances in this field in the coming years.
After analysing various vehicle model Go-kart model [9] is chosen for the project. The term "Go-Kart" was likely used to describe Ingels' (An American racing car mechanic) invention because it was a small, cost efficient, simple in design and easy-to-drive [10] vehicle that could be used for recreational purposes.

2. Methodology

The project starts with the selection of Go-Kart Model, followed by modelling and analysis of the model after then it is fabricated. Once the frame is fabricated then the required components (such as sensors, controllers and actuators) is selected. After this process code is written with the components and it is controlled using the controller.

2.1 Modeling

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Modeling of Go-Kart is done in SOLIDWORKS. The model is just the outline of the frame and other major parts the vehicle which is fabricated will be similar to this around 80%. The fig 1 shows the model of Go-Kart.

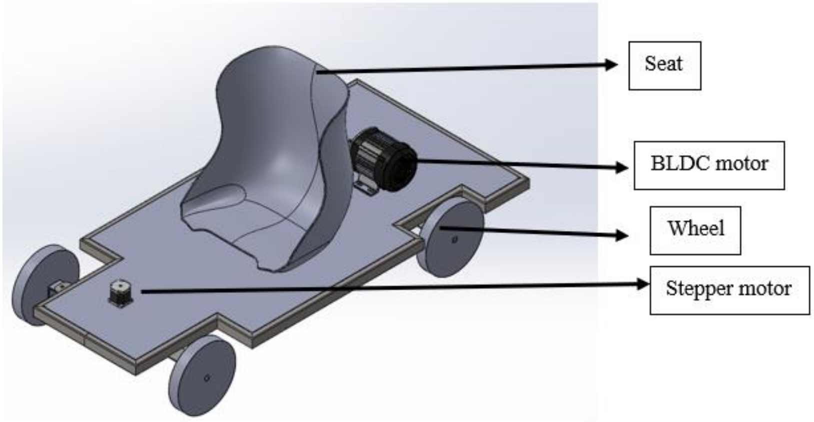

Fig. 1. Go-Kart model

2.2 Analysis

The structural analysis of the designed frame is analyzed using ANSYS software. Impact force analysis is the process of analyzing the forces that are generated when two objects collide. The goal of impact force analysis is to determine the magnitude and direction of the forces that are transmitted between the objects during the collision, and to evaluate the potential for damage or injury that may result from the collision. The fig 2 shows the von-mises stress analysis of the frame. The fig 3 shows the deformation values of the frame.

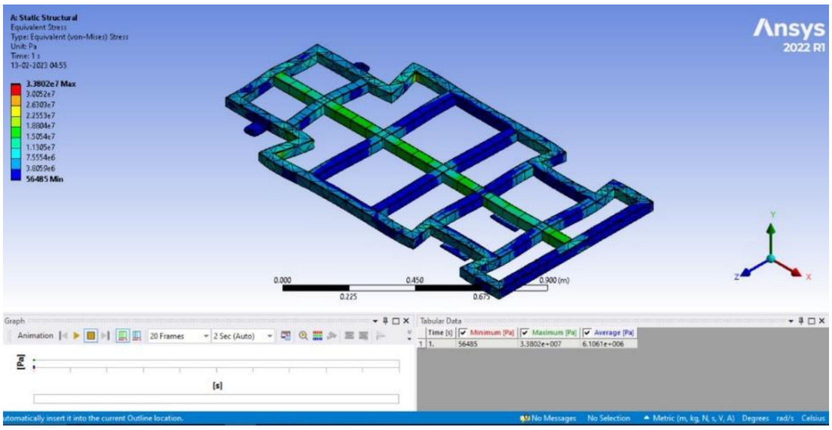

Fig. 2. Go-Kart Stress analysis

The maximum stress value measure in 3.38e7 Pa which is less than 200 GPa which is the Young's Modulus of the AISI 304 steel.

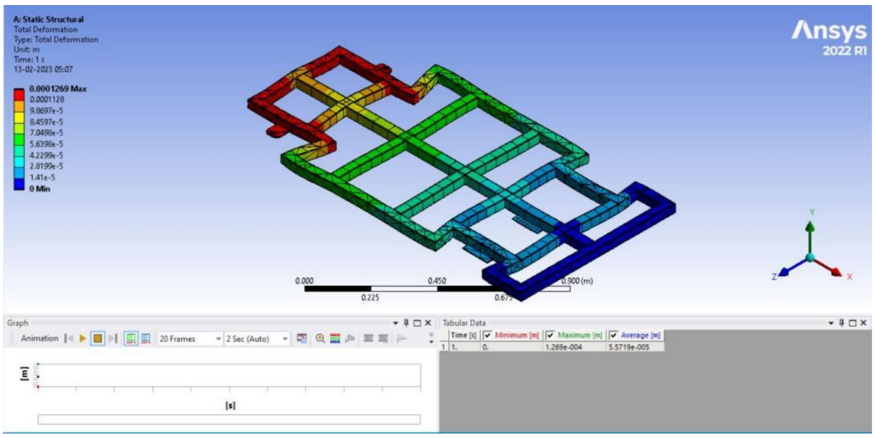

Fig. 3. Go-Kart Deformation analysis

The maximum deformation value is 0.0001269 m so there is very less chances of breaking.

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3. Fabrication

There are various kind of machines and tools used for fabrication some of which are MIG welding, Arc welding, Centre lathe, Radial drilling machine, Metal cut off saw, Angle grinder, Milling machine, Slotting machine, Vertical surface grinding machine and many other small machines are used.

3.1 Challenges Faced During Fabrication

Fabrication can be a challenging process, especially in the context of vehicle manufacturing. Some of the challenges that manufacturers may face when fabricating vehicle components are material selection, design complexity, quality control, cost control and time constrain.

Selection of Frame: Generally, for this kind of Go-Kart frame circular profile pipes are used because circular pipes have low weight to strength ratio but building a frame circular pipes require high skill and time. Since this vehicle does not goes at high speed, the feasibility and time is the major constrain in production square pipes are chosen for this reason.

Welding: Initially Arc welding was chosen for its low operation cost but since the material thickness is less than 2 mm the arc welding creates many holes in the frame due to overheat the current flow can only be marginally controlled by the machine which we used for welding. So, we changed our option to MIG welding which gives better finish than the Arc welding but the operational cost of this welding is higher than that of the Arc welding. There were many failures in the welding during the process of test since most of the welding was done unskilled person as a learning these failures increased our production time.

Steering Setup: Initially Rack and Pinion setup was designed as per requirement. The production cost of the rack and pinion goes very high since it is for a single piece. So, the used TATA Nano car steering was bought in the market and it is customized based on our requirement.

Alignment Issues: Once the frame is built as per the requirement there are other many possibilities that the design will not be in your expected state this is due to tolerance in each and every part makes overall tolerance even higher. So, this will cause alignment issues in the wheels and other parts in the assembly.

4. Control of Car

The major controller used in the vehicle is single chip computer Jetson Nano 2GB board. Other than this Arduino UNO boards are also used in this process. The major sensors used are camera, RADAR and ultrasonic sensor.

4.1 Steering Control

Steering control is done using Arduino UNO board where we use ultrasonic sensor as a primary sensing device for auto centre of steering. The actuator used for this process is the stepper motor because of its very high torque and precision over other motors.

4.2 Main Vehicle Control

It is done using Jetson Nano 2GB board. The primary sensors are camera (Kinect sensor XBOX 360) for object classification and depth measurement and the second sensor is the RADAR (HFS DC06) for distance location of the object. By fusing both these sensors into the main controller board we will controlling the 48 V BLDC motor which is the primary actuator of the vehicle.

5. Result and Discussions

The selection of the components is based on its features and also feasibility for this project.

5.1 Vehicle Specification

The specific details included in a vehicle report may vary depending on the type of vehicle, material used [15] and the purpose of the report. The general specifications of the vehicle are shown in Table 1.

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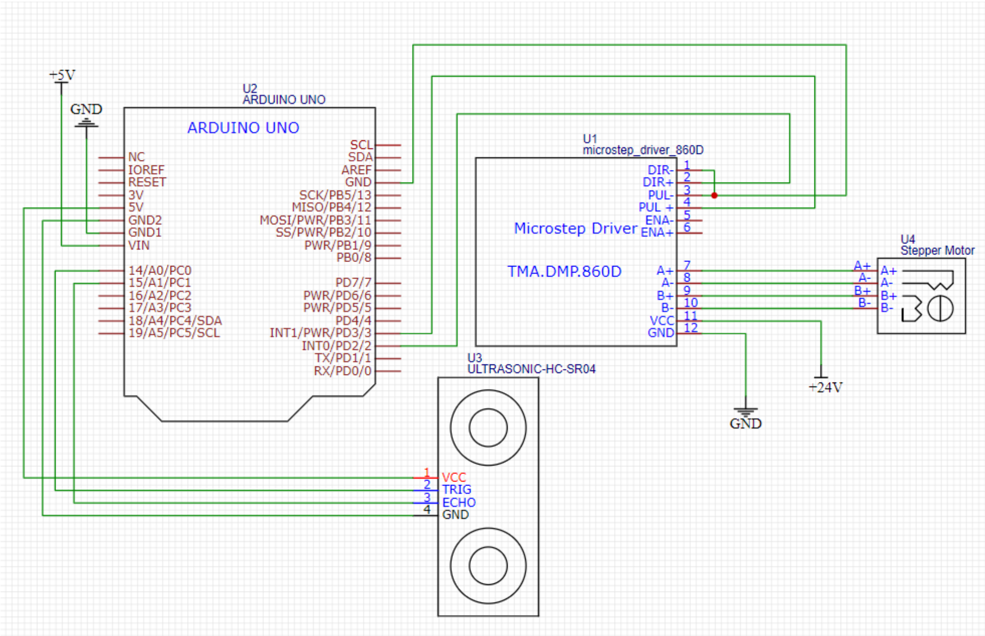

Fig. 4. Steering control schematic diagram

Table. 1. Vehicle Specification

Specifications	**Value**
Vehicle Length	1500 mm
Wheel Base	1050 mm
Track width Rear	760 mm
Track width Front	740 mm
Turning Radius	2120 mm (Approx.)
Steering type	Rack and Pinion (Ackerman Steering)
Max Speed (theoretical)	15 Kmph

5.2 BLDC Motor Specification

BLDC motor is selected for transmission of vehicle over other traditional DC and AC motors because of its high efficiency, high torque density, low maintenance, smooth operation, and regenerative breaking.

Due to the above-mentioned factors which will be ideal for the vehicle which has to be manufactured this motor with the following specifications [13] has been chosen. The BLDC motor technical specifications are given in Table 2.

Table. 2. BLDC Motor Specification

Description	**Value**
Power	Rated- 600 Watts, Peak- 1400 Watts
Rated RPM	500
Torque	Rated- 10 Nm, Peak- 400% of rated power for 10 seconds
Voltage	48 V
Current	Rated- 13 A, Peak- 32 A
Efficiency	80% on full load and full RPM
Protection	IP 33

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5.3 Depth Image

Kinect sensor XBOX 360 is the multi-use camera which is used for depth measurement, color sorting, sketching, etc. This sensor has 3D depth sensor, RGB camera, microphone array and tilt motor. The fig 5 shows the depth image at 1.2 m and 3.5 m from the camera respectively.

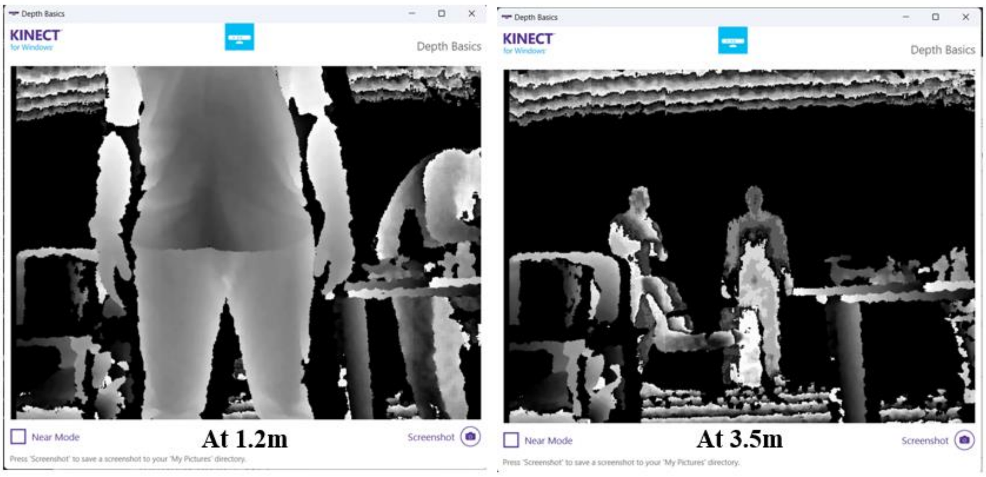

Fig. 5. Depth image

6. Conclusion

In conclusion, self-driving car have the potential to revolutionize the transportation industry by improving safety, reducing traffic congestion and increasing efficiency. However, their deployment also raises significant challenges related to technology, ethics, regulation and public acceptance. The following conclusion are drawn from this work

i. The Go-Kart model was simply designed with SOLIDWORKS software which can be used for analysis and can also be used for further simulation.
ii. The impact load analysis in done in ANSYS Workbench software which gives the deformation and stress concentration in the frame.
iii. The Go-Kart model is the primitive deign which is fabricated in house.
iv. The high torque BLDC motor was capable to run the vehicle.
v. The emergency stop to the vehicle is provided by the kill switch.
vi. The steering control is done using Arduino UNO and ultrasonic sensor and stepper motor is used as an actuator.
vii. Kinect sensor and RADAR are primary sensor for the vehicle.
viii. The major BLDC motor was controlled using Jetson Nano 2GB board.

References

1. Kocic, Jelena, Nenad Jovicic, and Vujo Drndarevic. "Sensors and sensor fusion in autonomous vehicles." In 2018 26th Telecommunications Forum (TELFOR), pp. 420-425. IEEE, 2018.
2. Bejgam, Rahul. "Brief study and review on the next revolutionary autonomous vehicle technology." In 2021 International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE), pp. 34-37. IEEE, 2021.
3. Badue, Claudine, Rânik Guidolini, Raphael Vivacqua Carneiro, Pedro Azevedo, Vinicius B. Cardoso, Avelino Forechi, Luan Jesus et al. "Self-driving cars: A survey." Expert Systems with Applications 165, p. 113816, 2021.
4. Bachute, Mrinal R., and Javed M. Subhedar. "Autonomous driving architectures: insights of machine learning and deep learning algorithms." Machine Learning with Applications 6, p. 100164, 2021.
5. Daily, Mike, Swarup Medasani, Reinhold Behringer, and Mohan Trivedi. "Self-driving cars." Computer 50, no. 12, pp. 18-23, 2017.
6. Karnouskos, Stamatis. "Self-driving car acceptance and the role of ethics." IEEE Transactions on Engineering Management 67, no. 2, pp. 252-265. IEEE, 2018.

7. Diels, Cyriel, and Jelte E. Bos. "Self-driving carsickness." Applied ergonomics 53, pp. 374-382, 2016.
8. Kuru, Kaya. "TrustFSDV: Framework for building and maintaining trust in self-driving vehicles." IEEE Access 10, pp. 82814-82833. IEEE, 2022.
9. Pattanshetti, S. Virendra. "Design and analysis of GO-KART chassis." International Journal of Mechanical and Industrial Technology 4, no. 1, pp. 150-164, 2016.
10. Aashish P., Nirmal C., Karunesh C. and Jhanvi C., “Design and Fabrication of Electric Go-Kart.” International Journal of Engineering Research & Technology, Vol 9, pp. 948-954, 2020
11. http://ai.stanford.edu/~jkrause/cars/car_dataset.html
12. https://arcus-www.amazon.in/XYGStudy-Raspberry-IMX219-83-Binocular-Megapixels/dp/B088Z23J8B
13. https://effi.saenis.org/wp-content/uploads/2022/08/Motor-Specs-EFFI-CYCLE-2022.pdf
14. https://sites.google.com/site/mrsdproject201415teama/system-implementation/drive-wheel-subsystem
15. https://www.azom.com/article.aspx?ArticleID=2867