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Steering redesign of Bogie Runt rover

INTRODUCTION

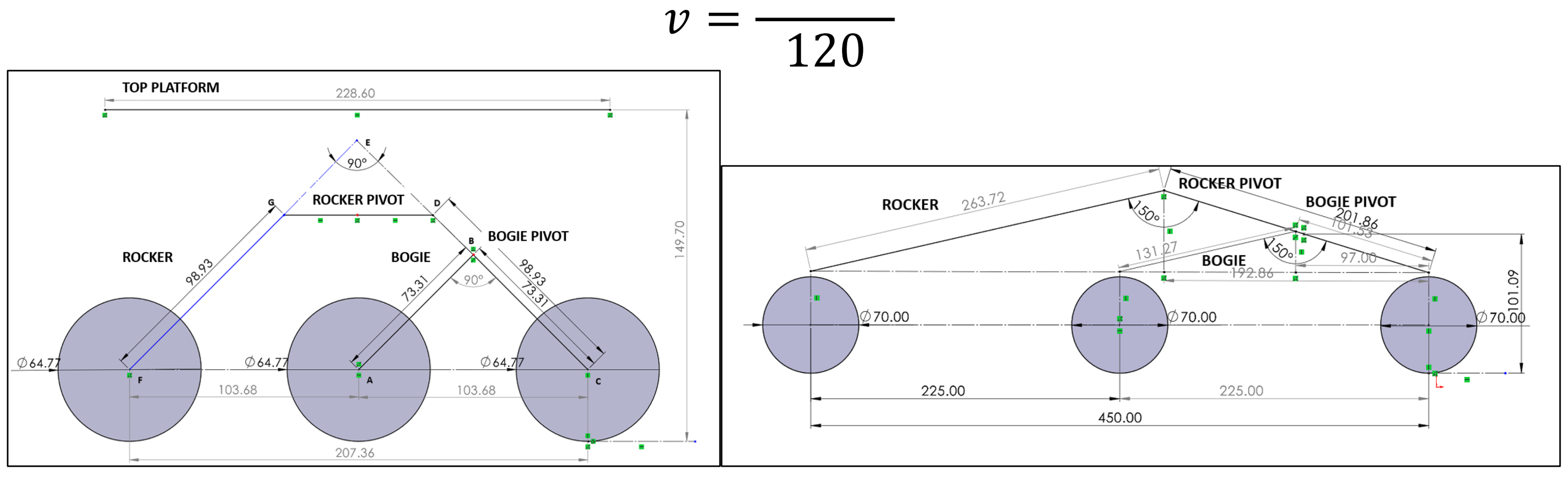
- The aims of this project include the redesign of the Rocker-Bogie suspension to have directional steering, enhancing the manoeuvrability and turning radius capabilities while maintaining the original Bogie Runt drive motors. To increase the Static Stability Factor and climbing efficiency, allowing for greater tilt angles without compromising stability and upgrading the electrical system to ensure seamless operation.
- The rocker-bogie suspension system, designed for low-speed traversal over challenging terrain, ensures all six wheels maintain contact with the ground, enhancing stability and obstacle climbing capability. Its simplicity, with each wheel powered independently and the absence of springs or axles, reduces potential points of failure.
- Explicit steering in vehicles allows for individual wheel control, enhancing manoeuvrability with lower power consumption than skid steering, albeit at the cost of increased complexity due to additional actuators. The use of individual motors for each wheel can mitigate the efficiency losses associated with torque transfer through universal joints and drive shafts.

DESIGN PROCEDURE

- Bogie-Runt Rover: To determine the lengths of the rocker and bogie for a rover, it's assumed that the obstacle height matches the wheel diameter for effective climbing, with a wheelbase set based on the rover's payload requirements. Using CAD software, the rover's design is sketched, depicting the bogie and rocker links as right-angled isosceles triangles, allowing the unknown lengths to be calculated using Pythagoras theorem.

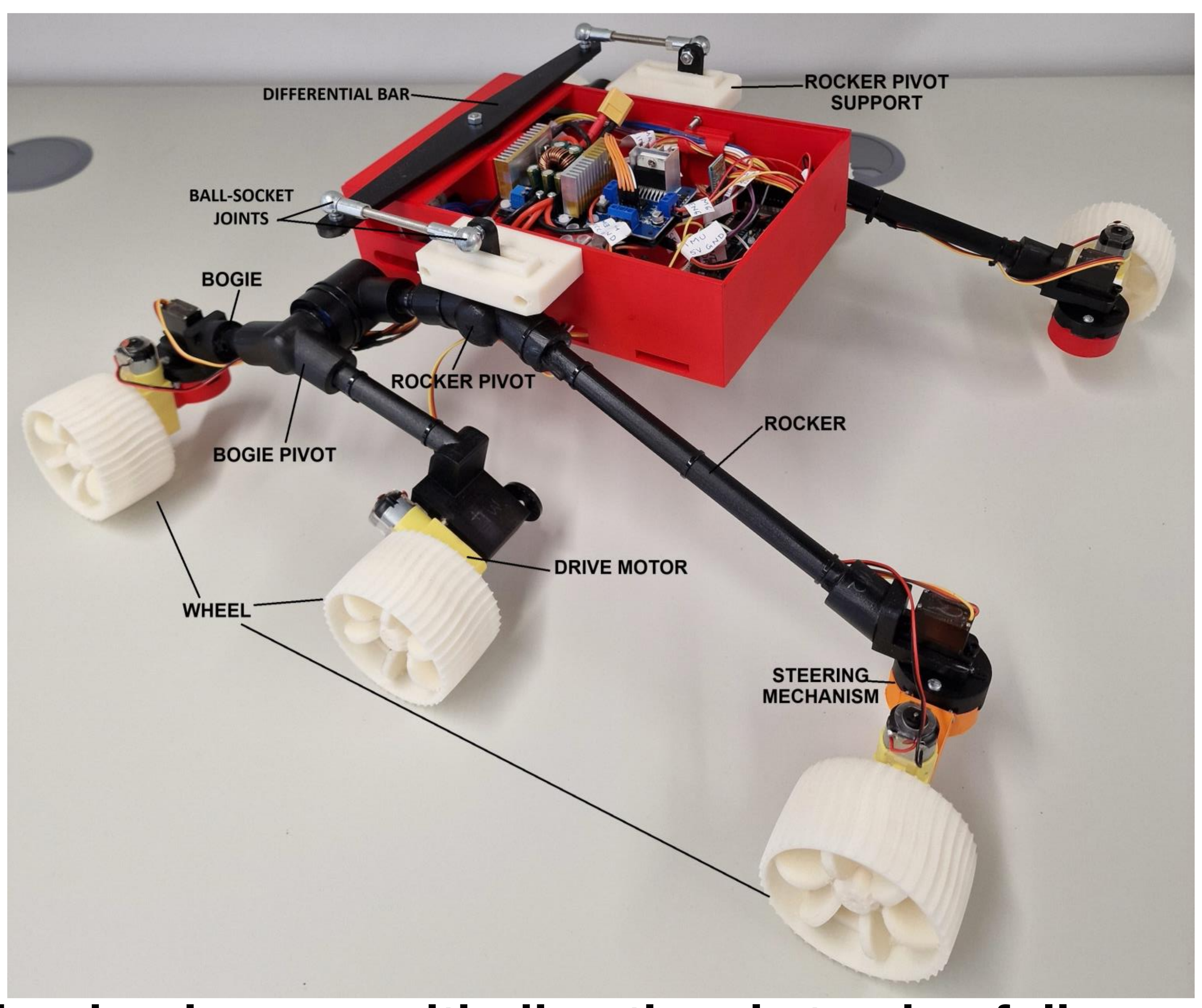
- Steerable Rover: To meet a maximum speed (v) of 0.5 m/s with a 200 RPM (W) motor, the wheel diameter (D) was calculated and rounded to 70mm using the equation below. The wheels are evenly spaced along a 450mm wheelbase. To enhance stability and safety factors, ground clearance was set to 101mm, and track width increased to 430mm, necessitating a steering mechanism and adjusted pivot angles for balanced weight distribution. CAD designs yielded rocker and bogie link lengths of 263.72mm, 201.86mm, and 131.27mm, 97mm, respectively.

$$v = \frac{2\pi DW}{120}$$



Rocker-Bogie link lengths of Bogie Runt rover and newly designed rover designed in SolidWorks (Units-mm).

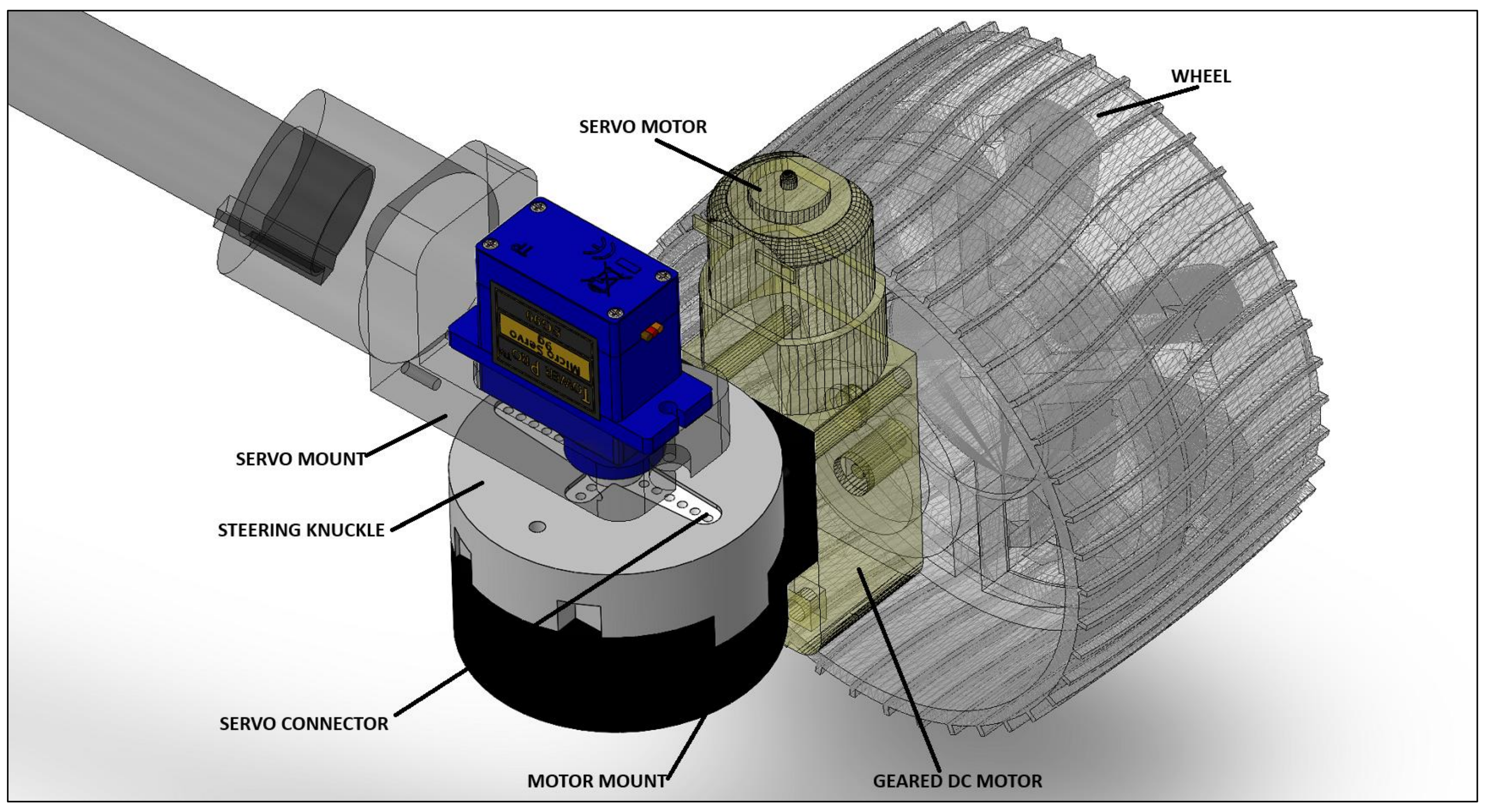
- All the parts were designed based on the above link lengths drawing in 3D using SolidWorks.



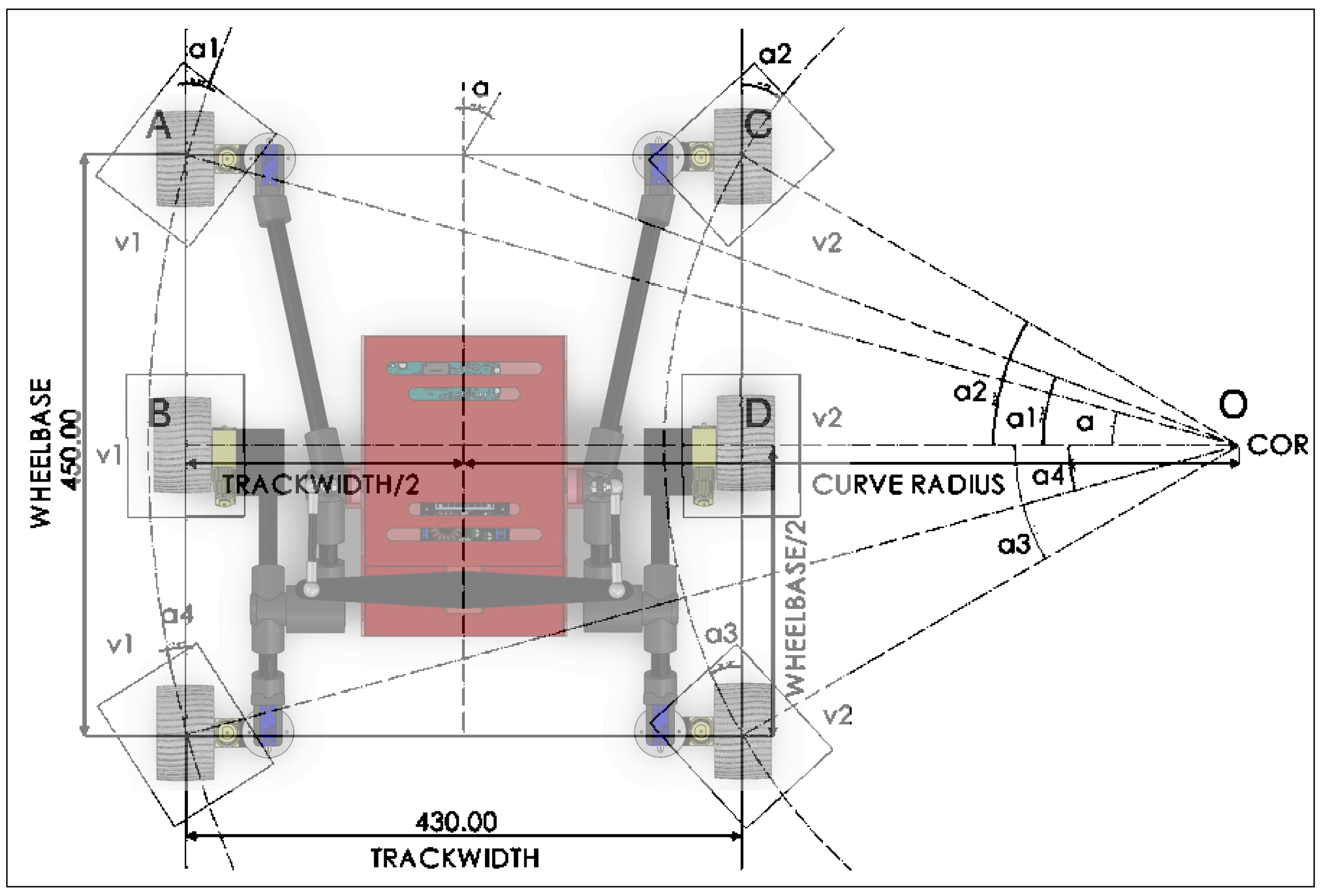
The rocker-bogie rover with directional steering fully assembled.

STEERING MECHANISM

- The explicit steering mechanism employs servo motors to rotate steering knuckles, which in turn actuate the wheel-driving motor mounts to which the drive motors are connected.



STEERING CONFIGURATION



- The steering angle and speed of the middle and four steerable corner wheels are as follows: The inner wheels have angles a2, a3, and speed v2. The outer wheels have angles a1, a4, and speed v1. COR represents the centre of rotation.

PROGRAMMING FLOW

- The control system initialises components like Bluetooth for communication, motor drivers, servos, IMU, and encoders for the rover's operation.
- User inputs from a laptop via the Putty terminal control the rover's steering and speed, with the software translating keyboard commands into precise movements.
- The system also logs IMU and motor encoder data, ensuring responsive and accurate navigation through feedback mechanisms for real-time control and potential future enhancements.

CONCLUSIONS

- All tests were performed continuously twenty times for consistency, showing very low standard deviations in completion times and RPMs.
- The rover achieved a minimum turning radius of 544mm with an improved Static Stability Factor of 2.19.
- Although the climbing and tilt angles were limited due to the lack of grip on the surface, the rover achieved a commendable maximum climbing angle of 28^0 and a tilt angle of 23^0.
- The rover could travel over an obstacle of 40mm in height.
- In conclusion, the rover achieved all the design objectives.