

# Problem



Robots and rovers cost a lot of money. NASA rovers cost between 2.5 billion and 3.2 billion dollars per mission! Now, this may not be a problem for NASA and other big tech companies but for the average person, spending thousands of dollars on a homecare rover does not seem reasonable. Many people can't afford to buy and repair a rover even though it could help them improve their lives. Small, start-up companies might want to utilize robots, but due to their high prices it becomes difficult. Our view is it that everyone should be able to get the same access to technology without worrying about breaking their bank accounts.

# Objective



We are building an analog-controlled rover to improve other's lives inspired by the rovers that traveled to outer space like Sojourner and Curiosity. Our project proves that you don't need high-tech equipment to build a fully functioning rover. We are doing this project so that others can use Alira, in any way they see fit. From seed planting to scientific expeditions our rover can perform very well. Our rover is made from low cost equipment. We designed a rover that can help others without being complicated or costly. This can improve people's lives because due to inflation the price of amenities and pleasure items are skyrocketing and having a rover can help in many ways. We want to help people by using technology that is low-cost, build from common parts, and can be easily repaired!

# Background Research



Our project is to make a low cost, analog rover that can be used in a variety of ways. Robots used for household tasks normally cost between \$20,000 to \$30,000. Many individuals cannot afford to have a robot that costs that much. Projects like Bill Gates "composting toilets" are meant to find an innovative solution to an already existing item. We are doing the same. A website called Raph Rovers is an example of high quality rovers. The rover is just a simple machine. It does not have fancy parts attached to it. But, compared to our rover, Alira which cost around \$600 to make Raph Rovers cost around \$20,000.



# Background Research



Another comparable website is the Jet Propulsion Laboratory at the California Institute of Technology. There you can build a "mars" rover that you can control and improve upon. Their rovers are better quality because they are built by a team of scientists but they cost \$2,500. Before we build our rover we need to first understand the key definitions that will educate us so that we already have existing knowledge before we start building. An analog-controlled rover means a rover that requires continuous signals to perform tasks instead of digital programming.

# Background Research



Our rover uses wires to connect the pieces instead of computer programming. A digital rover uses programming. The reason why we are not creating a digital rover is because it generally costs more to build and it is incredibly complicated to repair. The remote relay is the piece of the rover that receives the signal from the remote. According to Schneider Electric "Relays provide automated and remote control. This makes them ideal for power distribution and industrial applications." A five pin automotive relay is the type of relay we are using in our rover. It is a standard 12 volt relay that contains five terminals: 87, 87a, 86, 30, and 85.

# Background Research



These have wires attached to them. The wire colour can change depending on what relay you use but our relays have blue, white, red, yellow, and black wire.

A SPDT (Single-Pole, Double-Throw) is a type of switch that connects one terminal to one of two other terminals. This is important so we can change the motor rotation from backwards to forwards. A Relay Switch Normally

Opened (NO) is a switch that is a de-energized state until it is turned on. A

Relay Switch Normally Closed (NC) is a switch that is on until it is turned off.

# Background Research



A Relay Switch Normally Closed (NC) is a switch that is in its on state until it is turned off. We also need to be educated about the battery. A lead acid battery works best in 25 degree celsius weather. If the temperature reaches between 33 and 35 degree celsius than the battery life will get reduced. A fully charged battery freezes at -60 degree celsius but a battery that is low on battery is mostly water and can freeze at 0 degrees celsius. We will make sure to have all our batteries at full charge so they do not freeze during testing.



# Materials



- 12 volt electric motor/ 50 RPM (4)
- 12 channel remote control relay (1)
- 8 mm shafts (4)
- 8mm bearings (4)
- 8mm flange (4)
- 6 x 1.5 inch rubber tires (8)
- 5 pin automotive relay (8)
- DIN connectors (20)
- Compact splicing wire connectors (as many as we need)
- Terminal Block (4)
- Various colours of 12 and 14 gage wire
- 20 amp power batteries (2)
- 8 mm coupler (2)
- 4 position analog joystick

# Materials



- $\frac{3}{8}$  inch puck board (pieces were cut by lebeling Kaastra and Rob Loewen using a table saw. This was done using a cardboard model template.)
- Table Saw
- Measuring Tape
- Black Marker
- Ruler
- Original puck board (2x4')
- Cordless Drill
- Cordless Impact Driver
- Quarter Inch Metal Screws
- 90 Degree Angle Brackets
- Set screws

# Procedure



1. Gather Materials
2. Lay out the materials
3. Use the Cordless Impact Driver and the Cordless Drill to attach the puck board together using the  $\frac{3}{4}$  Inch Metal Screws
4. Drill holes for the shafts and the bearings
5. Determine the shaft height based on the shape of the electric motor
6. Drill holes for a 8mm shaft
7. Measurements are  $3\frac{3}{4}$  inches from the end and  $1\frac{3}{4}$  from the bottom
8. Screw bearing into the outside of the chassis using the shaft as a guide
9. Drill pilot holes for each of the bearing screws
10. Insert  $\frac{3}{4}$  Inch Metal Screws in to the holes in the bearing

# Procedure



11. Attach an OSB block onto the bottom of the rover
12. Screw it through the bottom and ensure that it covers the whole bottom
13. Screw in a 2 x 6 wooden block in the middle of the rover
14. This will be used to support the terminal blocks
15. Hot glue the 8 relays next to each motor
16. 2 relays should be associated with each motor
17. Use 1 inch screws to attach the 3 terminal blocks to the center wooden piece
18. Attach the couplers to each motor

# Procedure



19. Push the shaft through the bearing and attach it to the coupler using the set screws
20. Use the splicing wire connectors to connect the white wires from the 2 relays
21. Attach one of the white wires to the negative terminal block
22. Repeat steps 20-21 exactly for the blue wires
23. Repeat steps 20-21 for the red wires but attach it to the positive terminal block instead
24. Connect the black relay wires to the motor leads (test for the rotation direction later)
25. Connect the yellow wires (logic wires) to the center terminal block
26. Each one has its own separate connection

# Observations



During the testing, the couplers came loose and the wheels did not have any friction. We fixed that by drilling holes into the couplers and the shafts and inserting 6-32 bolts to keep it in place. We also drilled a hole through the flange and the shaft and inserted a 6-32 bolt in the hole.

When we went uphill to test the rover, the wheels kept getting stuck in the snow and would not move.

When we drove the rover in a lot of snow, it would get stuck while if we drove the rover in a little snow, the wheels would spin as there was no traction and that caused the rover to be slower.

The batteries performed very well and could run a long time.

# Analysis



Temperature (°C)	Terrain	Voltage (V)	Time (mins:secs)
-1	Flat and Paved	13.30	1:22
-1	Upslope and Paved	13.23	1:39
-21	Flat and Paved	13.16	1:24
-21	Paved Snow	13.16	1:31
-21	Upslope and Paved	13.18	Unfinished

# Analysis



The remote control worked very well, the logic worked very well, the relays could hold up for a long time, and the batteries were a very good choice because they were very powerful and could keep the rover running for a long time. Our motors were not powerful enough to turn the rover. The drivetrain and the tires were difficult to keep tight and stop from coming apart. The rover was likely too heavy for the torque of the motors.

# Speed of Rover

- Flat and paved terrain, Warm= 0.30 m/s
- Flat and paved terrain, Cold= 0.29 m/s
- Paved snow, Cold= 0.27 m/s
- Paved Slope, Warm= 0.25 m/s
- Paved Slope, Cold= Unfinished

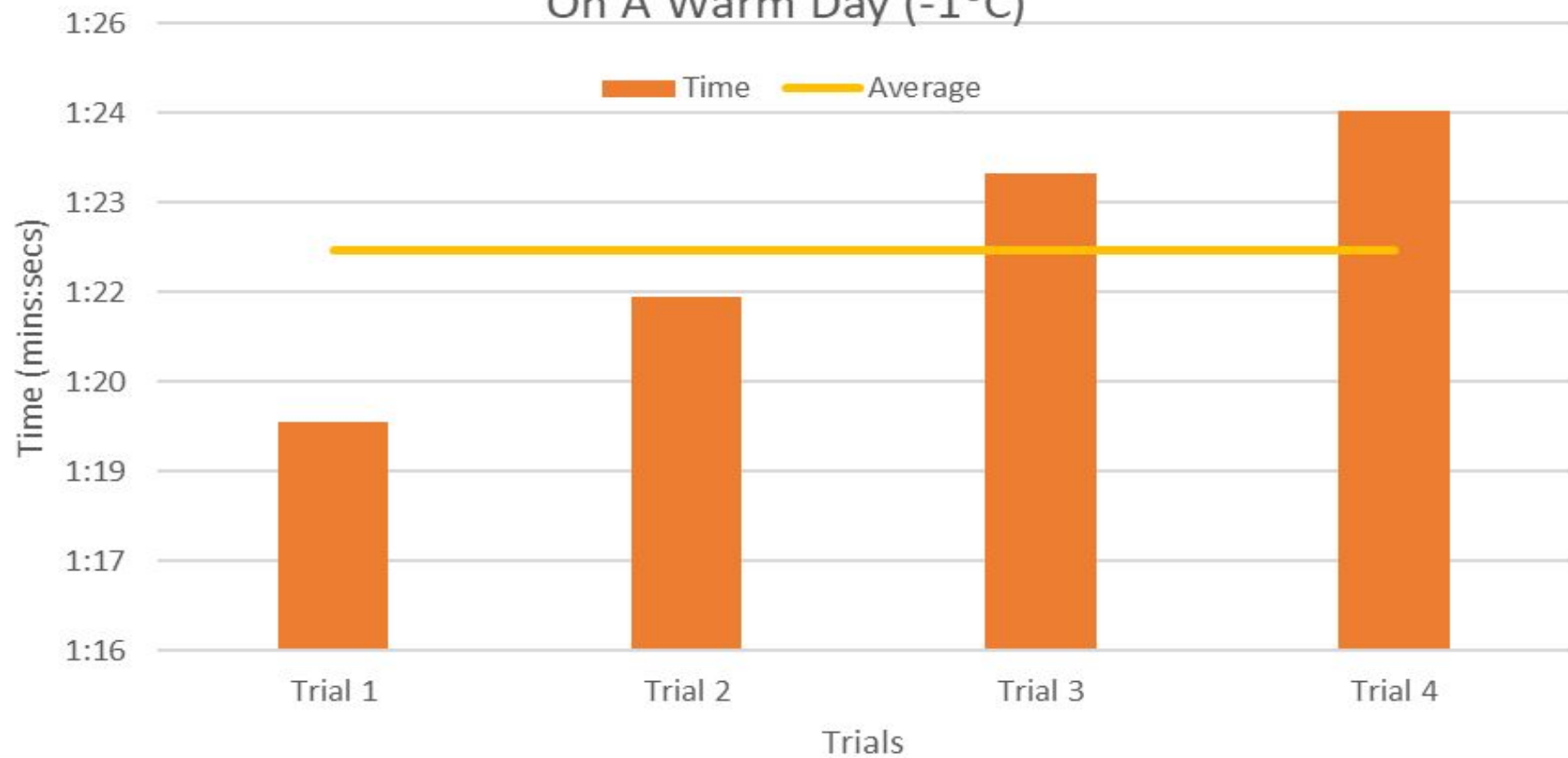
# Photos



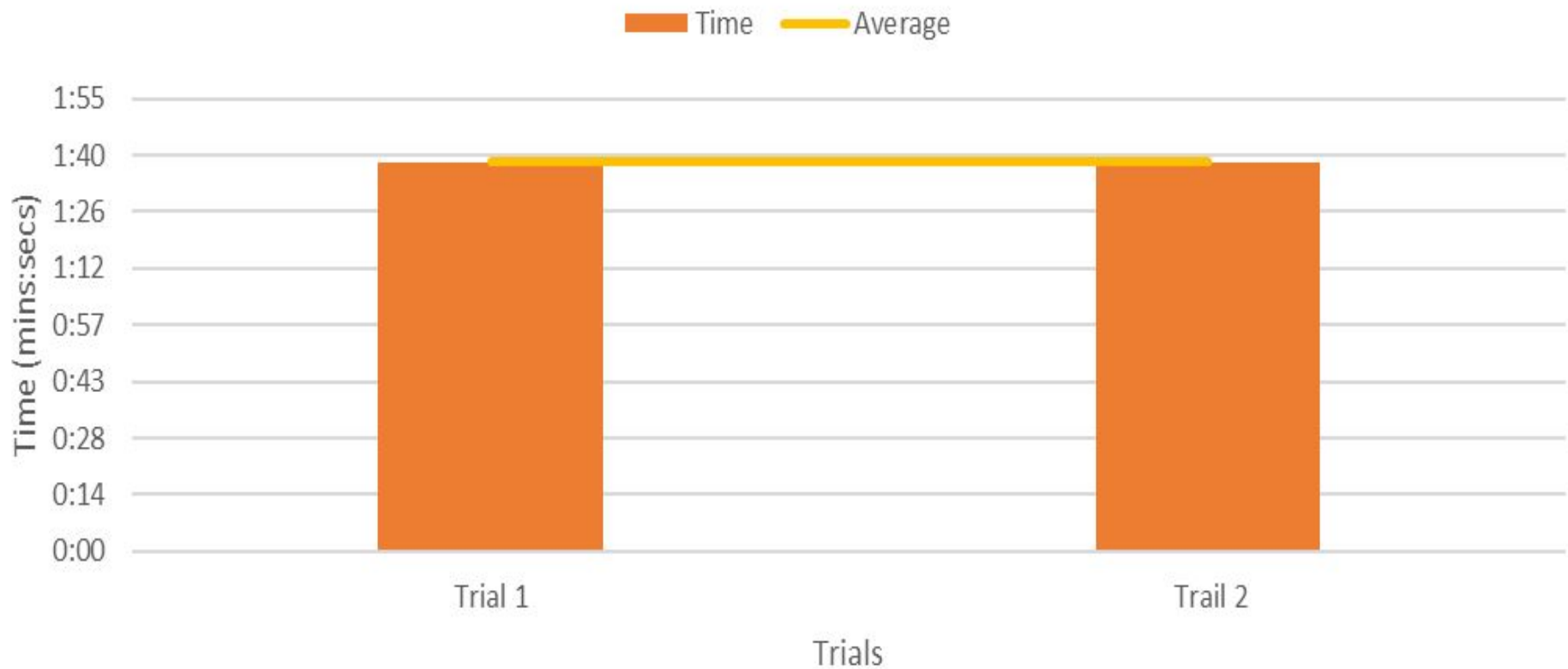
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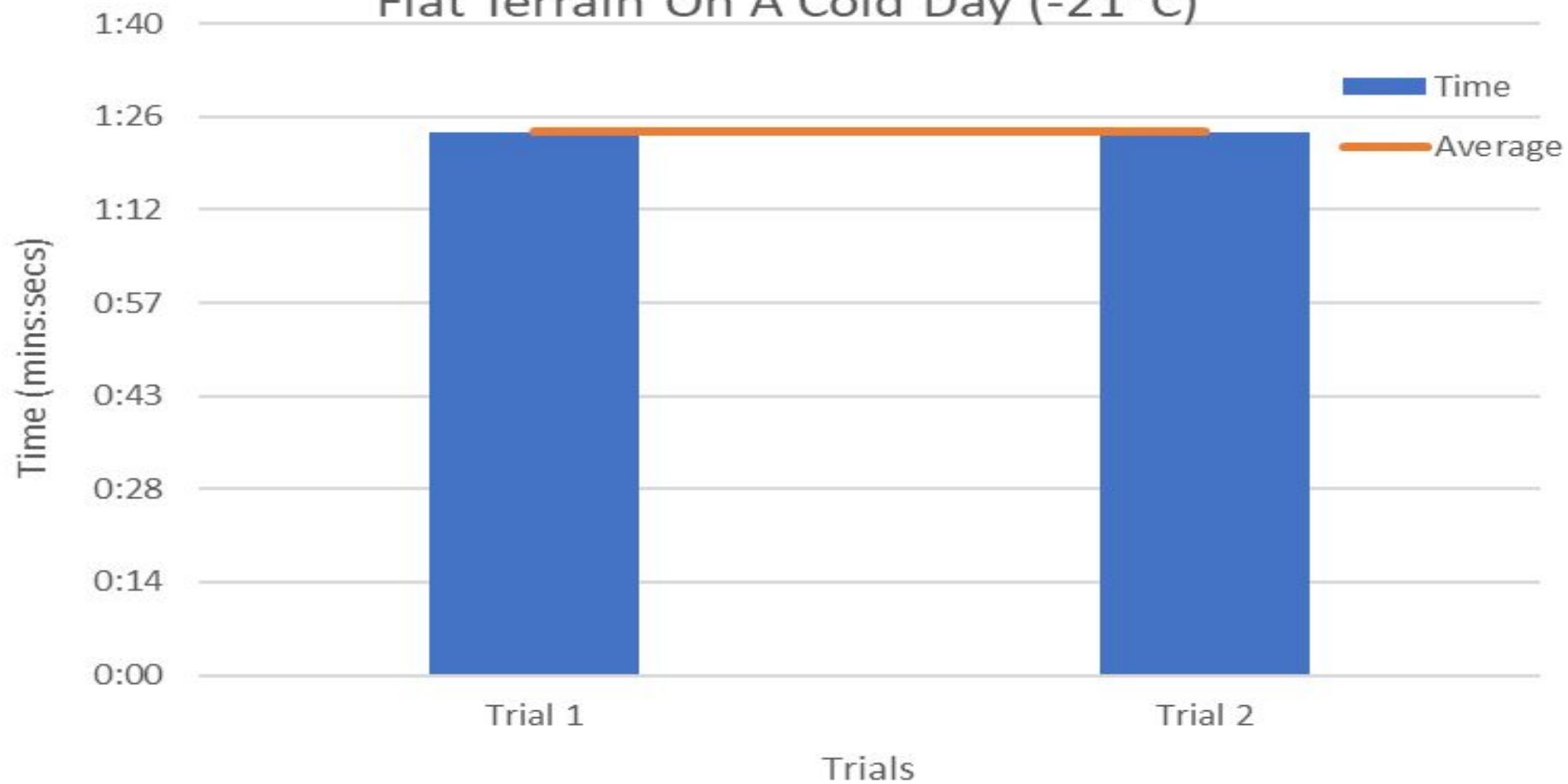
Bar Graph Showing The Time The Rover Took On Flat Terrain  
On A Warm Day (-1°C)



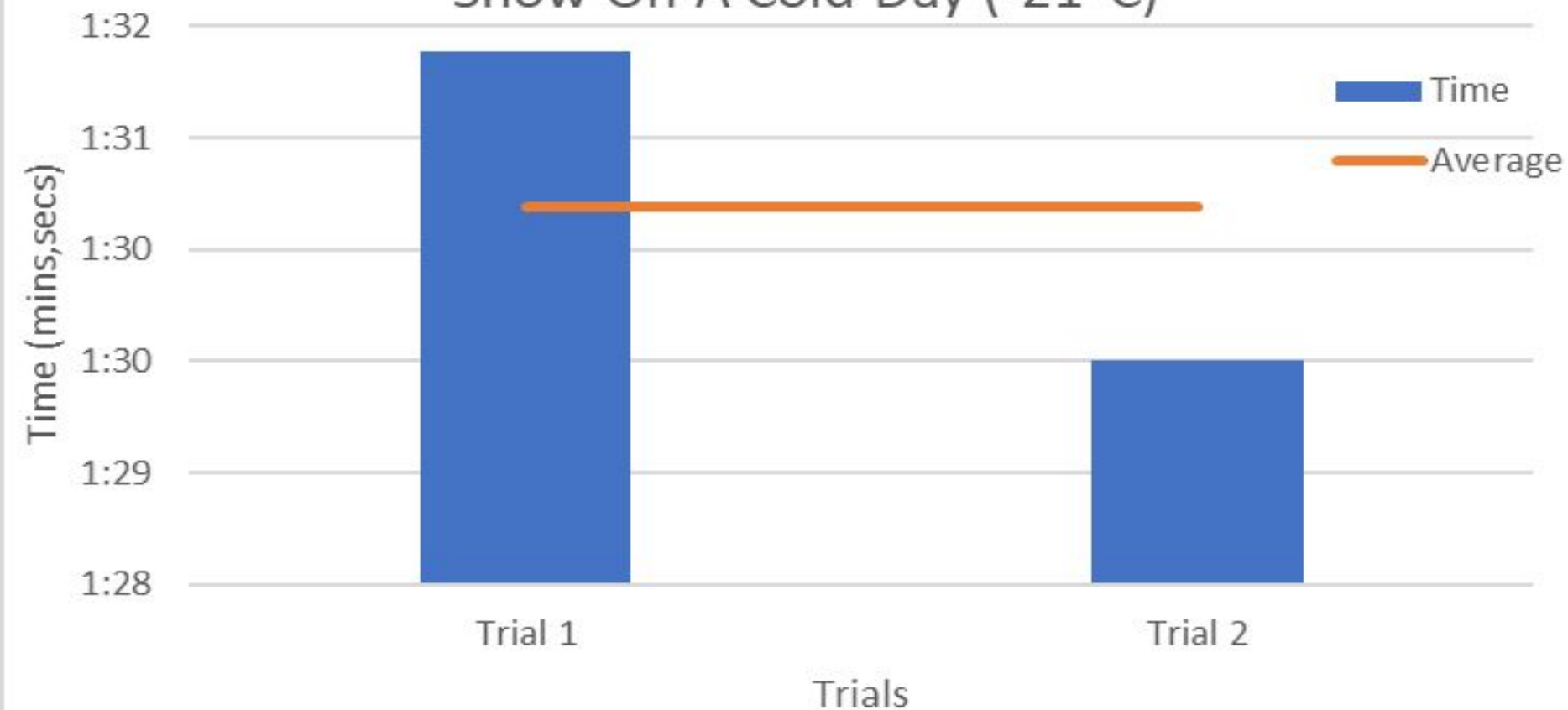
Bar Graph Showing The Time The Rover Took On Vertical Terrain On A Warm Day (-1°C)



Bar Graph Showing The Time The Rover Took On Flat Terrain On A Cold Day (-21°C)



Bar Graph Showing The Time The Rover Took On Snow On A Cold Day (-21°C)



# Conclusion

This is an innovation project because we are trying to make a rover to do household chores by making it more affordable and with everyday materials.

The procedure is not that challenging as we just had to connect all the wires and screw pieces together. Also, the materials are all low cost so it is more affordable.

The rover can also go on all terrains such as flat and paved, paved snow, and upslope and paved. For flat and paved on a warmer temperature, Alira went 0.30 m/s which is the fastest speed. The slowest speed Alira went was 0.25 m/s on upslope terrain on a warm day. One of the tests, however did not finish which was the upslope terrain on a cold day.

# Improvements

- We could switch from 10 inch to 6 inch wheels. This would increase the torque by 40 percent and help the rover turn.
- We could add suspension to improve wheel traction.
- We could insulate the battery to improve cold-weather performance.
- We could use lighter materials like composites which would increase run time.
- We could have used one relay for each motor. These are called double pole, double throw (DPDT). It contains two inputs and two outputs.

# Improvements

- We could connect the motor and the flange directly to the tires. We would then mount the motor on the outside of the chassis and insert the screws from the inside so we could drop the motor lower allowing it to have more clearance. This would make it simpler and reduce the cost. There would also be fewer parts.
- We could use only one battery to reduce the weight and the cost.

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