How does the type of robot design effect how straight the robot travels?

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Section 3

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Science Fair

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Introduction

I chose my Science Fair Project, "How does the type of robot design effect how straight the robot travels," for several reasons. One of these reasons was that many of the FLL robot teams in Sharon had trouble traveling in a straight line and I was wondering if there was a better way to make a robot travel straight without a joined-axle, or if a joined-axle robot would travel the straightest. I also did this project because the information I gathered would encourage more teams to participate in First Lego League (FFL) teams. Finally, I did this project so that this information could be shared with other teams to allow the new and experienced teams to have a better shot in the competitions. Hopefully all of this information I collected will allow other people in the Jr. FIRST competitions to do a better job with upcoming competitions.

Background Information

What is a robot?

A robot is machine designed to execute one or more tasks repeatedly, usually under computer control.

According to First Lego League, the FIRST Lego League has been a huge success in the United States of America. Children of age 9-14 can participate in Jr. FIRST Robotics. FIRST has grown from around 30 teams in 1992 and now there are around 800 teams in the U.S.A. for the 2003 season. FIRST has also been setting a goal to improve the learning of science, technology and engineering. Many companies and organizations sponsor and support FLL teams and competitions, such as Lego, NASA, Gillette, 3M, Worcester Polytechnic Institute, etc.

Robots: At Jr. FIRST the robots range from almost any design that a human can imagine. Some types of robots that did well in competition were modular robots, line followers, robots with a robotic arm and a robot that had a secondary robots smaller robot to do a task.

Hypothesis

I believe that using motors that are matched in rotation speed will help robots travel straight. I believe that joining two front wheels with an axle will help to keep the robot from turning. I believe that combining these two factors will result in the straightest path for the robot. Joining the front wheels with an axle sacrifices turning capability, so matching the motors alone is still important.

Materials

Computer:

1. **Window 98 -based laptop computer**
2. **Lego Mindstorms**
3. **MLCAD software**
4. **MS Word**
5. **MS Excel**
6. **MS Power Point**
7. **RIS 2.0 robot programming software for Lego Mindstorms**

Equipment:

8. **RCX computer**
9. **Lego Technic building pieces (wheels, beams, gears, plates, etc.)**
10. **Ten geared motors**
11. **One Rotation Sensor**
12. **One Light Sensor**
13. **One Touch Sensor**
14. **Three short cables and two long cables**
15. **72” by 18” piece of white paper**
16. **Five colors of highlighter (pink, green, blue, and yellow)**
17. **36” ruler**
18. **24 AA alkaline batteries**
19. **One black permanent marker**
20. **One ballpoint pen**
21. **One pair of scissors**
22. **One 3” by 1” piece of paper towel (any brand)**
23. **One notepad**
24. **Masking Tape**
25. **Canon G2 digital camera & flash**

Procedures

1. **Setup- Building Robot**
    1. **Build a scooter robot (see Appendix A)**
2. **Setup-Pen Holder**
    1. **Build a penholder attachment (see Appendix B)**
3. **Setup-Joined Axle Attachment**
    1. **Build a joined axle attachment (see Appendix C)**
4. **Setup-Motor Test Bed (Under Load)**
    1. **Build a test bed for under load (see Appendix D)**
    2. **Put Motor "0" in the holder for the motor, and then label motors 1-9 with pen.**
    3. **Attach a long wire to the motor and put a Black 2 by 2 plate on the top of the opposite end of the cable.**
    4. **Attach a long wire to the rotation sensor and put a Gray 2 by 2 plate on the top of the opposite end of the cable.**
    5. **Download the program called Test RPM in to slot 5.**
    6. **Push the button that says "View" until the screen displeases (you can tell this when you rotate the axle and the number on the screen goes up or down.**
    7. **Push the button that says "Program" until the screen displeases program 5.**
    8. **Push the button that says "Run".**
    9. **Record data and repeat step 8, 9 more times.**
    10. **Swap in motors 1-9 after every ten trials of a motor.**
5. **Setup-Motor Test Bed (Under No-Load)**
    1. **Build a test bed for under load (see Appendix E)**
    2. **Put Motor "0" in the holder for the motor, and then label motors 1-9 with pen.**
    3. **Attach a long wire to the motor and put a Black 2 by 2 plate on the top of the opposite end of the cable.**
    4. **Attach a long wire to the rotation sensor and put a Gray 2 by 2 plate on the top of the opposite end of the cable.**
    5. **Download the program called Test RPM in to slot 5.**

6. Push the button that says “View” until the screen displeases (you can tell this when you rotate the axle and the number on the screen goes up or down.
7. Push the button that says “Program” until the screen displeases program 5.
8. Push the button that says “Run”.
9. Record data and repeat step 8, 9 more times.
10. Swap in motors 1-9 after every ten trials of a motor.
11. Push the button that says “Program” until the screen displeases program 5.

6. Setup-Paper
   1. Take a roll of paper 36” across and cut the paper into a 6’ by 3’ piece of paper.
   2. Place Masking Tape to hold down paper during testing
   3. Take a yardstick and divide the 6’ by 3’ piece of paper into 6 equal sections of 1’ by 3’.
   4. At each interval of one foot mark a small line on the 3’ long line at 1’ 8”.
   5. Draw a line through all of the lines at the one-foot interval.
   6. At the end of the six-foot line write, “Stop”.
   7. At the opposite end write, “Start”.
   8. From were you wrote “Start” go up one line and write “0 feet”.
   9. From were you wrote “0 feet” go up one line and write “1 foot”.
   10. From were you wrote “1 foot” go up one line and write “2 feet”.
   11. From were you wrote “2 foot” go up one line and write “3 feet”.
   12. From were you wrote “3 foot” go up one line and write “4 feet”.
7. Setup-Robot testing
   1. Before testing write “blue-non-matched motors, green-matched motors, pink-joined-axle matched-motors, yellow-joined-axle non-matched motors.
   2. In the penholder at the back of the robot place a blue highlighter. Put in pair of motors farthest off from each other in counts.
   3. Place the robot before the “0 feet” line and leave a small amount of white to make it easier to line up the robot.

4. **Visually try to equalize the amount of white space on either side of the robot.**
5. **Go to “Program 2” on the RCX on the robot (this is a built in program in the RCX)**
6. **Hit “P2” on the Remote control.**
7. **Hit “Stop” on the remote when the highlighter travels past the “4 feet” mark on the page.**
8. **Grab a pen and mark the “1” next to the line.**
9. **Put the robot on the line and repeat steps 2-6 nine more times and for each one mark the line one more than the line before it.**
10. **In the penholder at the back of the robot place a yellow highlighter and attach joined axle attachment.**
11. **Put the robot on the line and repeat steps 2-6 nine more times and for each one mark the line one more than the line before it.**
12. **In the penholder at the back of the robot place a pink highlighter and remove RCX and take out motors with closest counts and then put RCX back on the robot.**
13. **Put the robot on the line and repeat steps 2-6 nine more times and for each one mark the line one more than the line before it.**
14. **In the penholder at the back of the robot place a green highlighter and remove the joined-axle attachment.**
15. **Put the robot on the line and repeat steps 2-6 nine more times and for each one mark the line one more than the line before it.**

Variables

My test variables (the variables I changed on purpose) were the robot design and motor. The robot design variables that changed were:

1. **Using closely matched or non matched motors (motors matched by rotation speed, RPM), and**
2. **Joined-axle attachment on the front of robot or not on front of robot.**

I changed these variables one at a time, and then I combined them. The variables that I controlled (kept the same) were the paper, the marker holder, and the placement of the robot, the robot device and the robot program being used.

I controlled these variables by using one sheet of paper, using a ruler to find the center and I kept the batteries from falling out , which would have destroyed the memory, I added a crossbeam to hold the RCX from moving around. I then was sure I kept the robot in the same location to prevent any problems with the robot. I also made sure that I didn't lose power in the RCX because then every program would be lost and there is a chance that the program wouldn't be the same exact program that was used before.

Graphs and Tables

See the attached spreadsheet (Robot Deviations.xls, Science Fair Motor RPM.xls) files.

Analysis

First, I analyzed the results of the motor RPM test to pick out motors that were closely matched in speed. I used motors 1 and 9 as my matched set, and motors 7 and 8 as my unmatched set.

My interpretation of my robot data is that the matched motors with a joined axle robot traveled the straightest of all of the types of robots I tested. The steadiest of all my line graphs was the graph on matched motors. Most of the graphs stayed pretty steady except for the graph on robots with non-matched motors. The joined-axle robot with the matched motors deviated the least of the four types of robots.

1. **The robot with the joined-axle robot with matched motors deviated the least.**
    - **The robot with the joined-axle robot with matched motors deviated only (at the most) slightly more than one-half of an inch.**
2. **The matched motors robot deviated somewhat more than the previous test.**
    - **The matched motors only deviated (at the most) slightly more than one and one-half inches off the line.**
3. **The joined-axle with non-matched robot somewhat more than the previous test.**
    - **The robot with the joined-axle with non-matched deviated only (at the most) slightly more than two inches.**
4. **The non-matched motors robot deviated the most.**
    - **The non-matched motor robot deviated in the range of six and one-quarter inches to eight and one-quarter inches.**

Out of all the robots I tested the data shows that the joined-axle robot with the matched-motors was the best robot to travel in a straight line.

Conclusion

The answer to my original question, “How does the type of robot design effect how straight the robot travels,” was that the joined-axle robot with matched motors went did indeed go straightest. My hypothesis was correct. I was somewhat accurate with my data because there was some of my testing I noticed that the robot jerked to one side very abruptly. Sometimes a wheel will slip, as seen during FLL competition as well. I was successful in making my data accurate because I did all of the testing in the same area and same day and I handled the equipment carefully. I was not surprised by the data that I got from the testing because my hypothesis was correct. My results could help new Jr. First Teams in Sharon, allowing them to have a better competition season.

Pictures and Appendixes

See the attached PowerPoint (ScooterPictures.ppt) file.