Integration of a NAO Robot with an Autonomous Mobile Platform

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Abstract— **This project strives to create an autonomous vehicle using Raspberry Pi and various other items. This vehicle is linked with a NAO robot in order to create a tour experience for visitors and students of Northern Illinois University. The tour is completely automated, negating the need of a human tour guide effectively saving the university time and money.**

I. Introduction

The NAO robot is an advanced piece of robotic hardware. It is capable of speaking, listening, walking, and much more. With the NAO robot being as sophisticated as it is, giving it a human job is not an issue. One possibility is a tour guide. This robot could serve as a great tour guide. It could self-navigate based on visual signs, speak to the guests following it, and potentially answer questions. However, the NAO robot falls short in the category of walking. It is very capable of walking itself around but does so at a very slow pace. At the speed it walks, a tour of a single building could take much longer than most people would prefer.

The inability of the NAO robot to maneuver quickly around the building is where we derive the purpose for our project. We seek to design a device to transport the NAO robot so that it can maintain the human walking pace of around three miles per hour. In addition, we seek to design a meaningful robot human interface to make receiving a guided tour for a small robot a natural experience for the average person.

II. Electrical Design

A. Motor System

The motor system is the driving force of the vehicle. The motors chosen for this project are the 12V DC 437RPM 305.5oz-in HD Planetary Gearmotor from ServoCity. Four motors are used in total, one for each wheel. It is capable of rotating at a speed of 437 rotations per minute. This is more than enough to get the platform moving at a normal human walking speed. The maximum torque is 305.5 oz-in. With four motors, this is able to move more than twice the weight of our platform fully loaded. The required voltage is 12V. The rated-load current is 2A with a stall current of 20A.

The motor driver used is the Cytron MDD10A motor driver. This driver takes in 12V directly from the power supply in order to power itself and the DC motors. It is capable of outputting 10A of current continuously with a peak of 30A for ten seconds making it a good fit for the motors. As there are four motors on the platform and the drivers are dual-channel, there is a need for two drivers. One controls the two front wheels and the other controls the two back wheels. The drivers take four logic level inputs (two from each motor) from a Raspberry Pi in order to control the speed and rotation of the motor.

B. Power System

In order to power the NAO Vehicle, a 12V, 142-Watt Hour lithium-ion battery will be used. This rechargeable battery was selected due to its long running life, and low cost. The four motors, the two motor controllers, and the Raspberry pi will all be powered by the battery pack. These loads will draw a maximum of 20.64 A of current.

III. Mechanical Design

The chassis of the vehicle is comprised of four 80/20 1010 series 6061 aluminum bars, connected using 80/20 end fasteners (Fig 1.). This will ensure a rigid, light weight, low cost chassis. In order to mount the wheels and motors a bracket was custom fabricated out of 2024 high strength aluminum 90-degree angle (Fig. 1). This bracket allows a high weight tolerance and a rigid suspension. The wheels selected for this vehicle are 100 mm Mecanum wheels (Fig. 1). These wheels allow the vehicle to not need a steering system while also allowing directional turning at full speed. The electrical controls are mounted on a 4.75 mm thick acrylic sheet insulated with Garolite spacers (Fig. 1). The vehicles platform is also 4.75 mm thick acrylic mounted with a Flat head screw and 80/20 drop in nut (Fig. 1). The Acrylic gives the vehicle an electrostatic resistant material that is very strong and low cost.

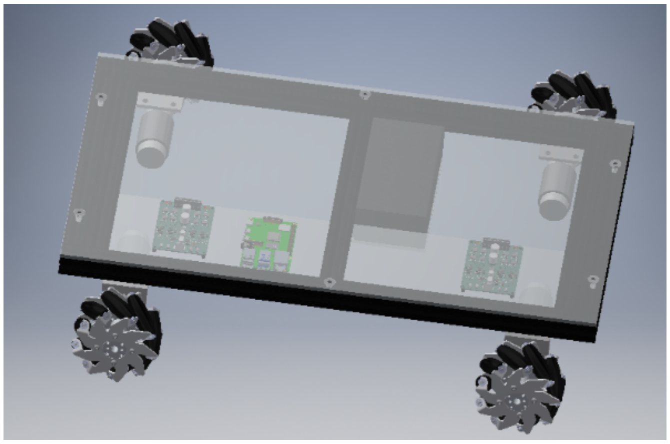

Figure 1. Autonomous Vehicle Platform

IV. SOFTWARE

A. *Image Processing Algorithm*

The image processing algorithm is the driving force behind the navigational decision making of the vehicle platform. It receives images from an onboard camera as an input. This input is processed to find a line on the ground in front of the vehicle. It then outputs a difference from center value that instructs the motor control algorithm which way to actuate the motors.

In addition to providing navigational instructions, the image processing algorithm also senses QR codes within each frame. These codes are used as cues for the NAO robot to talk about each room he passes on the tour.

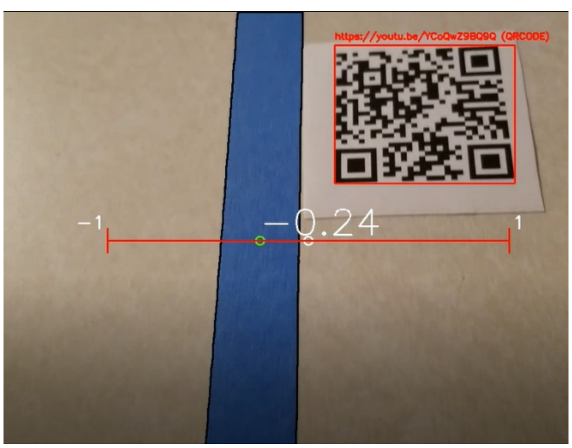

Figure 2. Image Processing Algorithm User Output

B. *Motor Control Algorithm*

The motor control algorithm is written in Python and utilizes the gpiozero library to control the I/O of the Raspberry Pi. The algorithm receives a number passed from the image processing algorithm. The value of the number is between -1 and 1. Based on the number received, the algorithm decides how to set the speed of the motors in order to keep the vehicle on the track.

C. *Depth Sensing Algorithm*

The depth sensing algorithm is written in Python and utilizes many libraries in order to function properly. The libraries are OpenCV, Numpy, and RealSense. The algorithm works with the Intel RealSense D435 Depth Camera. By using the preset functions from the libraries, it can return the distance in meters of the center pixel of the image. It is planned to be used with an object detection algorithm in order to tell the vehicle if it needs to be stopped due to an object or person in the way.

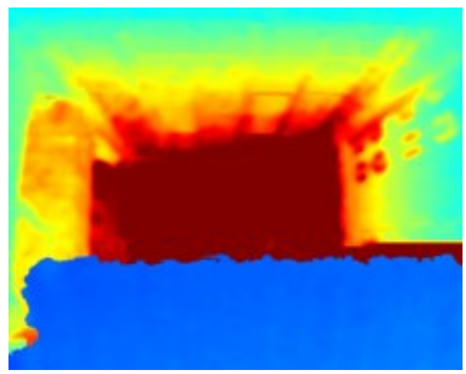

Figure 3. Depth Sense Image Output

V. CONCLUSION

This paper presents the progress made on this project by the end of the academic year. Through the resources provided, a theoretically working vehicle has been completed through software simulation. Due to unfortunate circumstances, the real testing and final product were not able to be seen as it was not possible to meet as a team for the second half of the spring semester.

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