Robot Hardware Documentation for Project 2
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1.0 Overview

The hardware design for the second project was intended to be as simple as possible while still able to meet the requirements of the assignment. The final robot design consisted of a sturdy chassis with a tall sensory tower. This design can be seen in Figures 1.0a and 1.0b. The robot included three classes of sensors – optical rangefinders to detect buckets, light sensors to detect light bulbs, and an encoder to detect the robot's locomotion. The robot's locomotion was provided by a front-wheel differential drive mechanism. The use of the larger wheels allowed the robot to turn accurately and to easily traverse small obstacles in the arena. Finally, the robot had a front bumper made from a copper scouring pad; this allowed the robot to complete the circuit presented by the lamps.

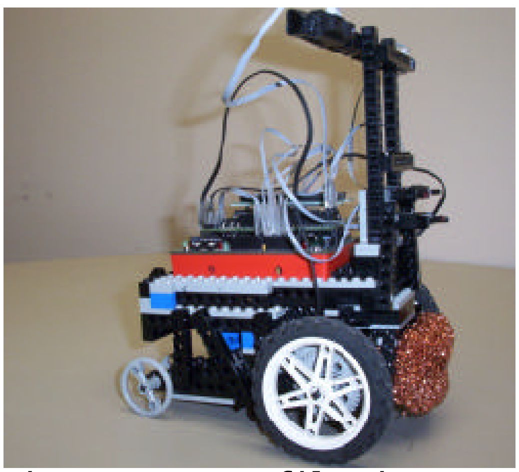

Figure 1.0a – Profile View

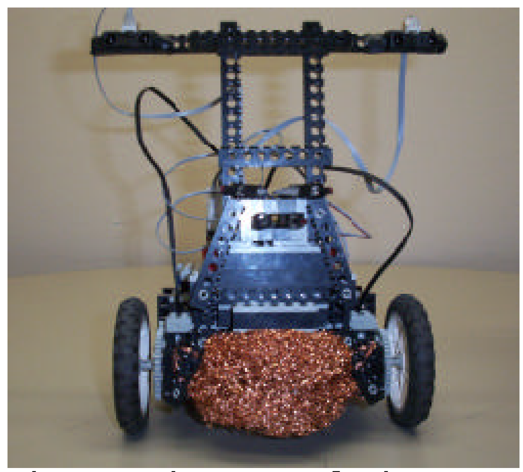

Figure 1.0b – Frontal View

2.0 Sensors

The major focus of the hardware design was the location and placement of the sensors. The selection of sensors was directly determined by the tasks that the robot must accomplish. First, the robot must detect and distinguish the tall buckets in the arena. This was accomplished by placing two optical rangefinders high atop a sensor tower at the front of the robot. Next, the robot must be able to detect the presence and location of light. This requirement was met by placing an array of light sensors mid-way down the tower. Finally, the robot must be able to sense when it has met an immovable obstacle. This condition was detected by the use of an encoder assembly placed on a rear passive wheel. Thus a unique set of sensors solves a single problem posed to the robot, and the entire assembly resolves all problems faced by the robot.

2.1 Optical Rangefinders

The optical rangefinders were placed specifically to detect the tall bucket obstacles in the arena. To this end, these sensors were placed high on the robot so that they would not detect the smaller rocks or lamps. Figure 2.1 indicates the location of the rangefinders on the robot. Each of the sensors was angled slightly to the outside in order to detect buckets that might be slightly to one side of the robot.

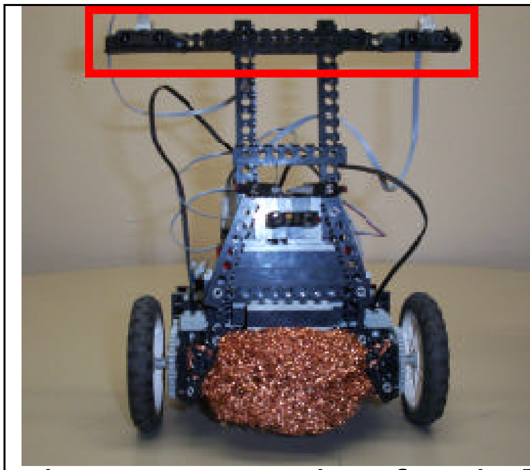

Figure 2.1 – Location of Optical Rangefinders

2.2 Light Sensors

Light sensors were added to the robot in order to detect the presence and direction of light in front of the robot. As shown in Figure 2.2, the four sensors were mounted about halfway up the tower, at the same level as the target light bulbs. The sensors were deployed in a spread pattern, thus allowing the robot to sense light to either side as well as mostly in front. Of the four sensors, one was directed to the far left and one to the far right. The two remaining sensors were directed just off-center from straight-ahead – one to the left and one to the right. Using the difference in the readings from these four sensors, the robot was able to determine the relative location of the goal with no additional information. To improve the readings from the sensors, each sensor was shielded with a piece of a coffee stirrer wrapped in black tape.

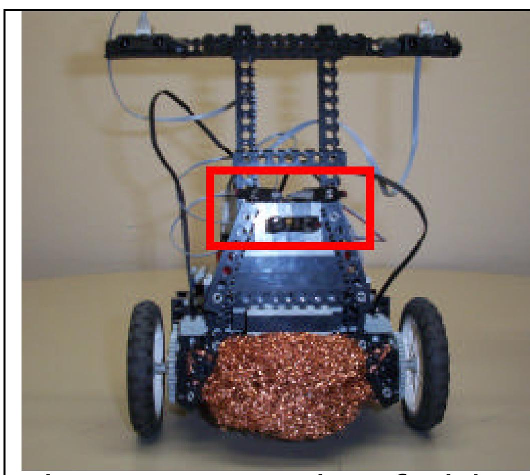

Figure 2.2 – Location of Light Sensors

2.3 Encoder

An encoder assembly was placed on the rear left wheel of the robot to gauge whether the robot was physically moving forward. Taken from the rear, Figure 2.3 shows the placement of the assembly, which consisted of an encoder, a six-hole pulley, and a passive wheel with axle. The encoder itself was mounted underneath the chassis using electrical tape. As the robot traversed the course, the left rear wheel would turn, and the encoder would register the motion. When the robot was stalled or otherwise stationary, the wheel would not turn, and the encoder would register no motion.

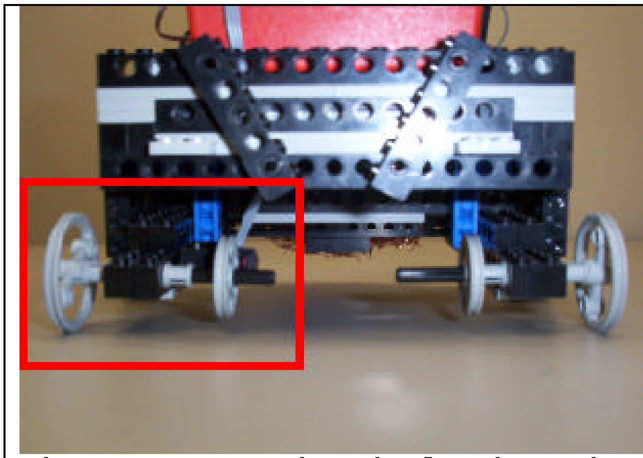

Figure 2.3 – Passive Wheel and Encoder

3.0 Locomotion

The locomotion for the robot was provided by a front-wheel differential drive arrangement. Independently controlled left- and right-motors provided the power to the robot. Each motor was related to its corresponding axle by a 1:2.5 reduction gearing. Finally, the robot employed the large wheels as shown above in Figure 1.0a. Not shown in this figure is the additional set of large wheels added to the front axles. The "double-wide" approach increased the traction between the robot and the smooth, dusty floor. In the rear, the robot had two passive wheels to support the robot's weight. These wheels were left without tires in order to reduce friction during turning. Under this arrangement, the robot was able to quickly cruise around the arena, yet it still had enough power to make the steering adjustments necessary for goal seeking. Additionally, the large wheels allowed the robot to pass over small obstacles, such as cables, with little trouble. Finally, the differential steering enable the robot to travel either straight or in an arc, or even to spin in place.