Group 5
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April 30, 2003

Hardware Description

Construction was an ongoing process throughout the entire development of the robot. As issues arose with the performance of the robot, corrections in the initial, conceptual design of the robot needed to be made. These corrections may be due to flaws in the design, or by shortcomings of the various sensors used. These changes included the addition and removal of some hardware components. This paper will describe the final design of the robot as it was demonstrated, and some of the design changes the robot evolved through.

The robot consists of three main parts, all of which will be explained in detail:

- Drive train
- Chassis
- Sensory Equipment

Drive Train (Figures B and D)

The drive train for our robot consists of two LEGO motors, each responsible for powering their respective side of the robot. Our robot implements AWD (All-Wheel-Drive), so both the front and back wheels rotate in unison with one another. Using this approach, all four wheels on the robot can be turned with two motors. All four axels (one for each wheel) have a large 40 tooth gear on it. The large gears for the front and rear wheels are connected with a 16 tooth gear to achieve the AWD. All-Wheel-Drive is a very important and critical feature of this robot's design. It allows for our robot to turn in place without losing its heading, a very important property when dead-reckoning is going to be implemented. In addition, AWD also increases tire traction with the floor and decreases wheel slippage. These are once again very important features to have when dead-reckoning is going to be implemented.
We used a 5:1 gear ratio on our drive train in order to achieve a large amount of torque to allow our robot to make slow, accurate turns. A small 8 tooth gear is paired with a large 40 tooth gear on each side of the robot to achieve this gear ratio. This gearing allowed our robot to not only move with large amounts of torque, but also with speeds appropriate to the project objective.

Chassis **(Figures A and C)**

The chassis of our robot is very small and quite simple. The footprint of our robot is basically a 7 inch by 7 inch square. This small footprint allows our robot to turn very easily and effectively and makes it easier to avoid object we do not wish to make contact with. Although the chassis has a very small footprint it is also very tall. The height of our robot, including the HandyBoard, is around 10 inches. The reason behind this is because of the small footprint, there is nowhere else to build but up. Our robot required very high encoder resolution and this was achieved by placing gears, axles and LEGO pieces on top of the motors, increasing the height of the robot. In addition, the HandyBoard is held in place by a cradle on the top-most part of the robot, adding more height.

A rig was made out of two curved yellow LEGO piece to hold the CMU camera in place. The camera is held in a way so that it points downward towards the front of the robot. The decision was made to hold the camera in a static position because we felt that it would not be that advantageous to have the camera able to move on a servo. Below the camera mount is a place where we mounted two IR sensors to detect black electrical tape. In order to “grab” the orange target objects, two static arms are attached to the front of the robot. These arms extend about 5 inches in front of the robot and curve outward so that objects the robot is not perfectly aligned with will still make it into its grasp. We chose the keep the “claws” static in order to simplify our robots design.

Sensory Equipment **(Figures A and C)**

Numerous sensors were used on our robot to aid in its navigation and sensing of the environment. Two IR sensors are hot-glued to LEGO pieces on the front of the robot underneath the CMU camera mount. The IR sensors are necessary to detect the black electrical tape goal-areas so our robot knows when to drop off target objects it has picked up. The most important sensors that our robot implemented are shaft encoders. Two shaft encoders are used on our robot, one per side. In addition, the shaft encoders are geared in a way that allows extremely high encoder resolution. Our robot uses the small, wide, racing-style tires and our encoders achieve a count of around 230 clicks per revolution. This high encoder resolution allows our robot to travel extremely straight (theoretically) and make very exact turns (again, theoretically). Another very important portion of this project was accurate navigation, and the high encoder resolution our robot has allowed it to move long distances with very good consistency. Perhaps the most important sensor used on our robot is the CMU camera. This camera allows our robot to detect and track colors for use in attaining target objects. We used the camera to recognize the orange blocks and the orient our robot towards those blocks in order to capture them with its claws.

Problems We Encountered

We encountered several different problems during the evolution of our robot. The problems of driving straight and turning exact were mitigated through our use of very high encoder resolution. However, our robot never did go very straight, and the turning depended too much on the status of the battery to get it very consistent. Another problem was focusing the CMU camera and getting it to recognize with accuracy and consistency the orange target cubes. This was solved through trial and error.

Figures

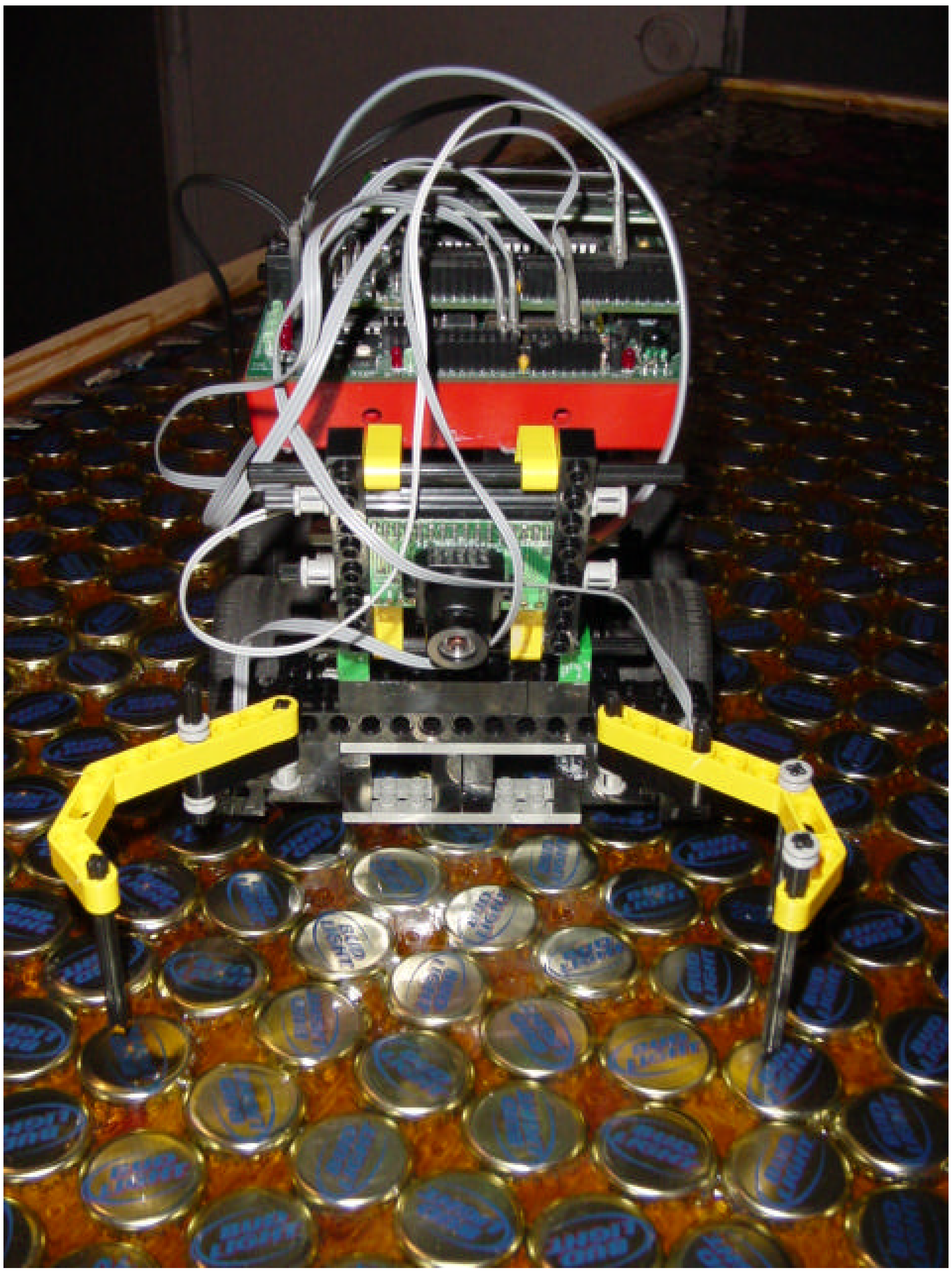

Figure A

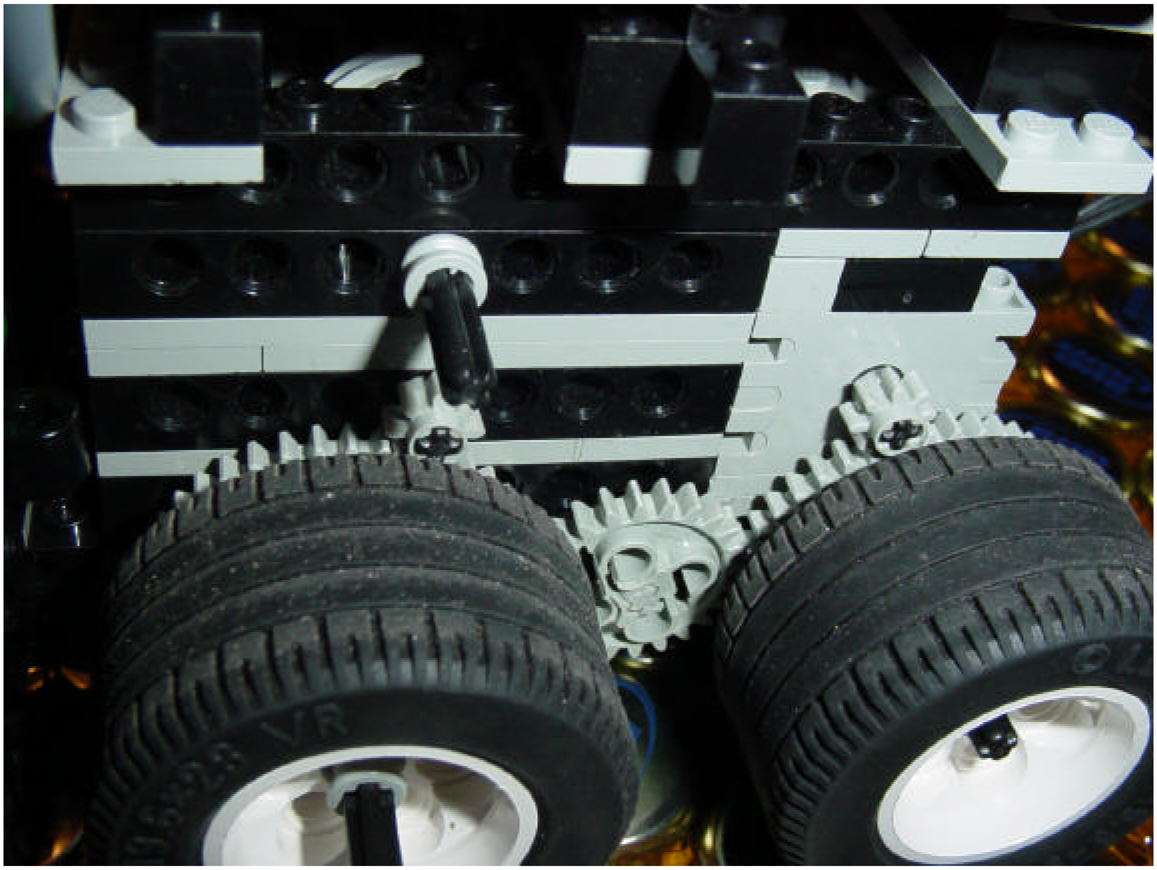

Figure B

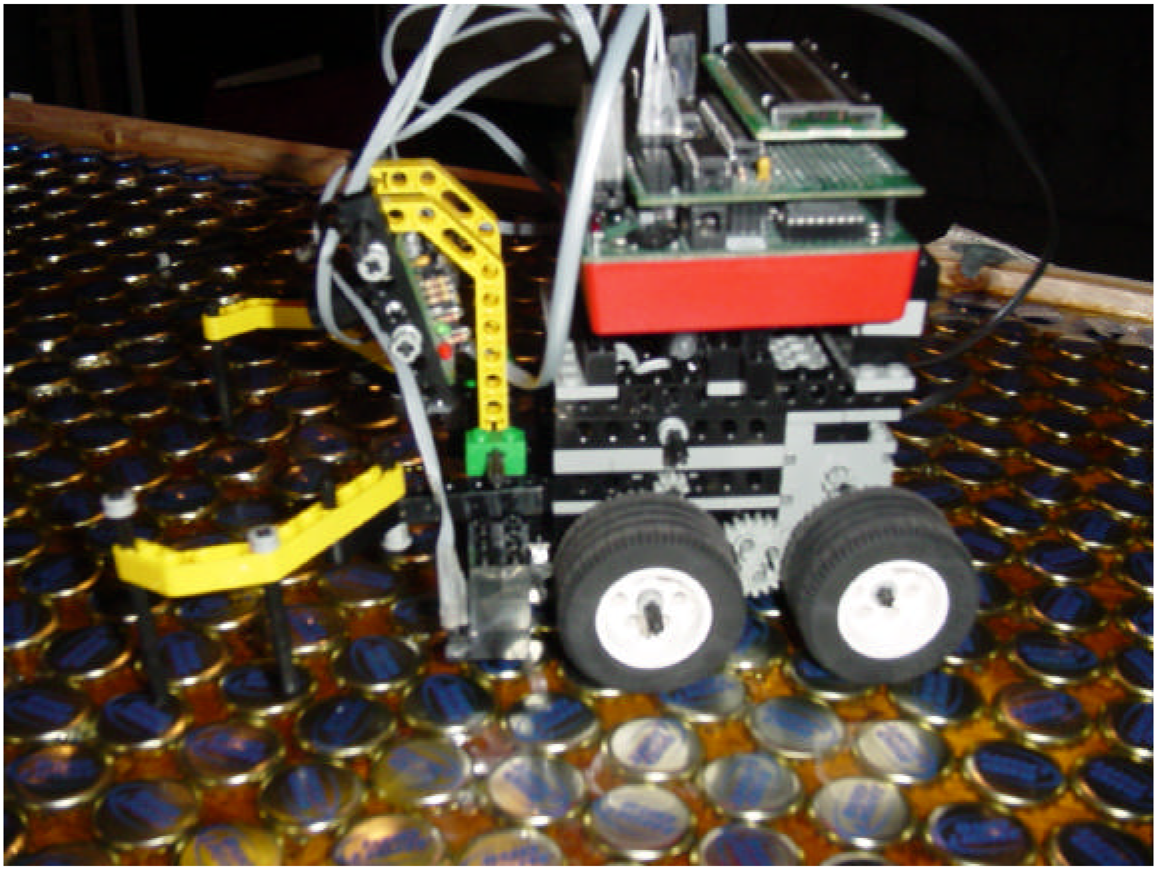

Figure C

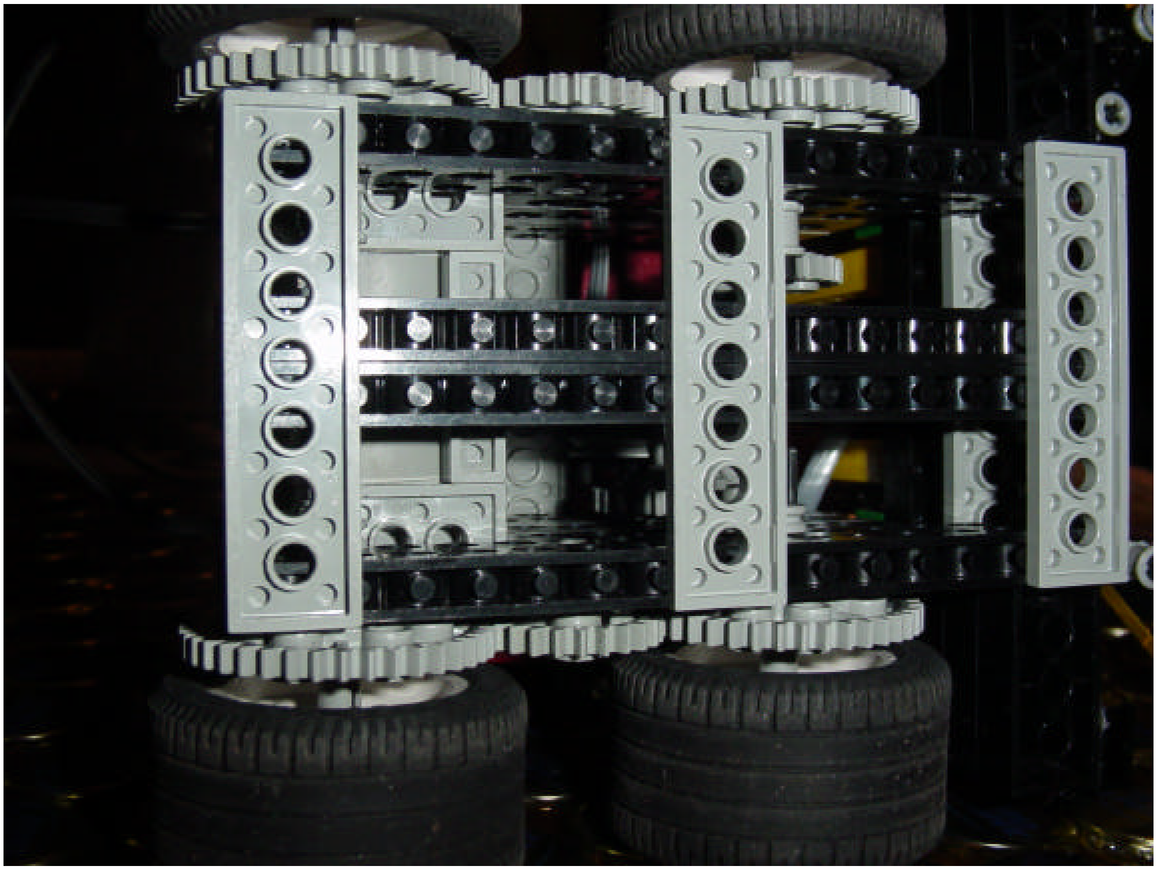

Figure D