CONVEYOR SYSTEM DESIGN

EXECUTIVE SUMMARY

Our team developed a dual conveyor system for efficient handling of Lunacy balls. This conveyor system used tubing to raise balls into a hopper, with a second conveyor belt system used as the “floor” of the hopper. The hopper conveyor belts could rotate right or left to shoot balls out either side of the robot. Ball control was a challenge, so we added extra components at each port to give positive control. In addition, we developed strategies that exploited the strength of our conveyor design, leading to our qualification for the finals in two regional events.

CONVEYOR SYSTEM DESCRIPTION

In 2009, our team focused on creating a robot using innovative conveyor designs to complete the Lunacy competition missions. Over the years, our team has worked with various strategies to find out what works the best, trying various new and different ideas. For this year’s challenge, we developed a conveyor belt system, multiple-drive-control system, and a matching strategy. With this system, our robot is able to efficiently pull balls into the cargo hopper, and shoot them out to the human players expediently.

We use a roller system that drags balls into the front of our bot at any speed (Figure 1). Initially, our ball intake port frequently knocked balls away instead of capturing them, so we added a header. The header of our robot uses hair brushes that are broken apart and fastened to a roller rod that is constantly spinning (Figure 2). Our roller instantly sweeps any balls on the ground that it touches to the lifting belts that raise the balls to the hopper. If needed, our robot can throw the brushes into reverse, just in case a ball gets jammed in the header port. While these jamming occurrences are rare, our design team believes it is best to be prepared for a worst case scenario.

The lifting conveyor belt is made of surgical tubing, and rolls the ball upwards against the front wall of our robot. The ball is carried from the roller header to the cargo hopper in roughly one second. The lift belts can also go in reverse. Whenever the hopper of our robot becomes full, we can hold extra balls in the lift belt chute. In competition, we rarely used this feature because despite the number of balls we picked up, we were unloading them almost as quickly as we were collecting them. Our hopper never became full during competitions because we quickly delivered them to the shooters.

Once balls are deposited in the hopper, a flap prevents them from falling back down the chute. The flap is a small, flexible, passive restraint that was easier to implement than active restraints we considered, increasing both the simplicity and the efficiency of our robot.

Our cargo hopper capacity is about 15 balls. The hopper is open-top, so balls can be thrown in by either human players or other robots, depending on the strategy in use for a particular bout. The “floor” of the cargo hopper is a transverse conveyor belt oriented perpendicular to the face of the robot (Figure 1). Left and right openings allow the conveyor belt to shoot the balls to either side. These openings are wide enough to easily let the balls out, which was initially a challenge during normal movement of the robot. The inertia of the balls caused them to fall out during turns. We solved this by installing active gates at the exits of the hopper. These gates are mechanical flaps with motors that open and close in response to the direction of the conveyor belt. In essence, if the conveyor belt moves left, the left gate opens, if the belt moves right, then the right gate opens.

One of the biggest problems we faced was the tendency of the balls to stay in place inside the hopper due to inertia. We solved this by modifying the rods that spin the hopper conveyor belt. We drilled holes through the rods and inserted rubber sticks that would catch the balls and whip them through the gate (Figure 3). By adding in these pieces of rubber, the conveyor and rod assembly threw the balls quicker and farther in the direction that we aimed the balls.

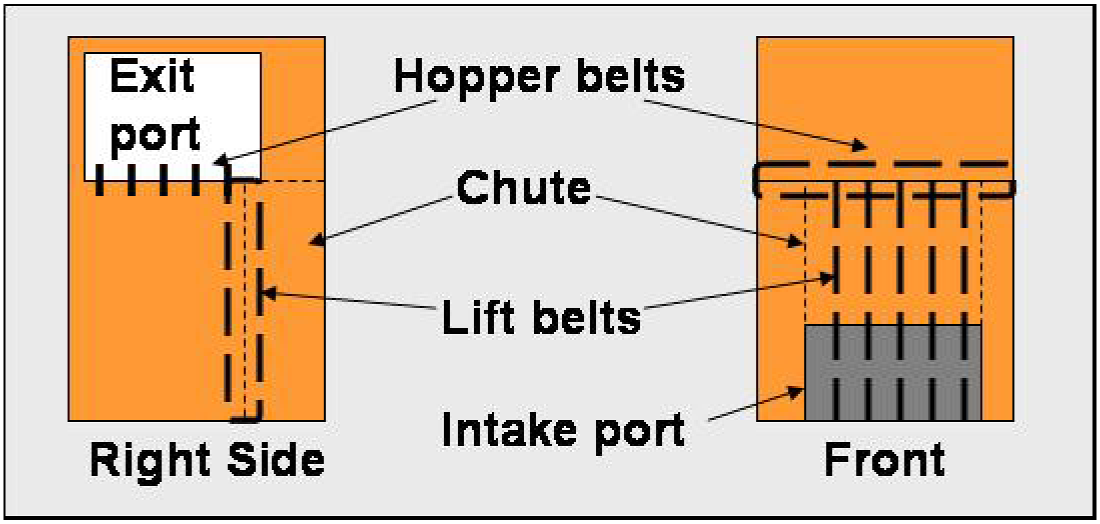
STRATEGY

During practice testing, we found that our robot wasn’t necessarily the best at dropping balls into enemy trailers. While we had the capability of filling a moving opponent’s trailer, our design was far more effective at shooting balls into stationary goals. We changed the focus of our strategy from scoring to supplying alliance human shooters. This strategy turned out to be both effective and quick. By having the hopper gates on the sides instead of the front of the robot, our trailer was less likely to get stuck or pinned from behind, and depositing the balls only took moments (Figure 4).

Another important feature of our robot is the control system. Our design accommodates multiple driving modes. Our robot has four options that can be selected with just the flick of a switch to match each user’s preference. The selections include standard joysticks operating in tank drive, arcade mode, and swivel mode, along with an additional handheld game controller using tank drive. The most popular selection was tank drive because we found it to be the most efficient for more accurate driving control and for making precision adjustments in the robot’s position, especially for accurately delivering the balls to the shooters.

FINAL SUMMARY

By focusing on our robot's abilities to capture and deliver balls, and by adjusting our strategies exploit our design, our robot proved to be a tough contender. Due to our technical quality and effective strategy, we successfully qualified for the finals in both the St. Louis and Kansas City Competitions. I believe our success demonstrates that we created a robot truly worthy of the label, "innovative."



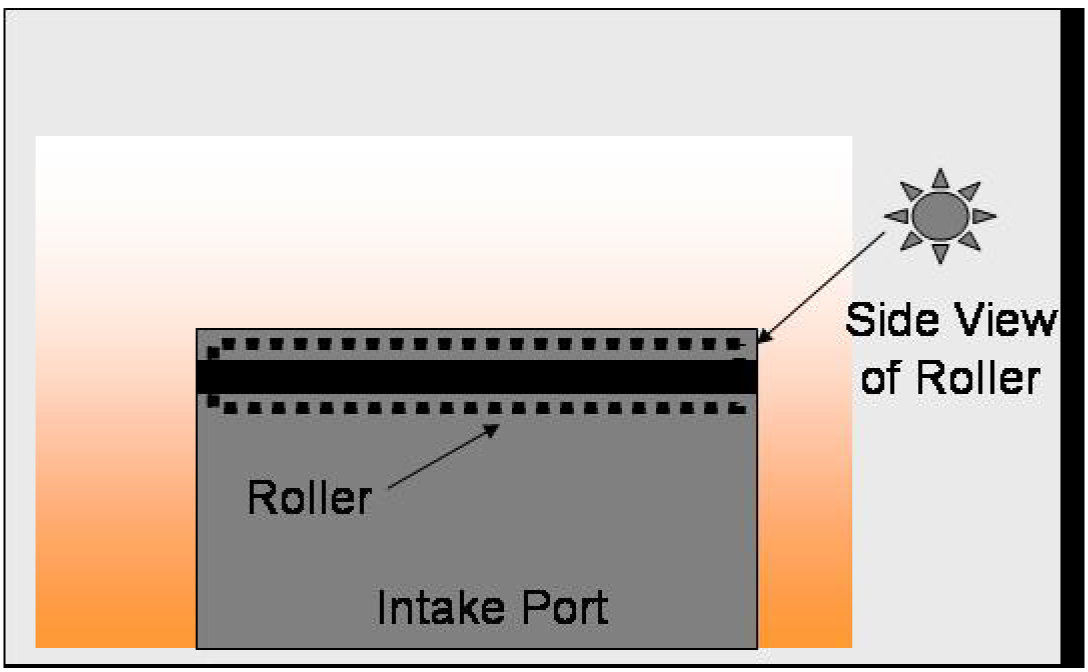


Figure 2. Roller system used in intake port

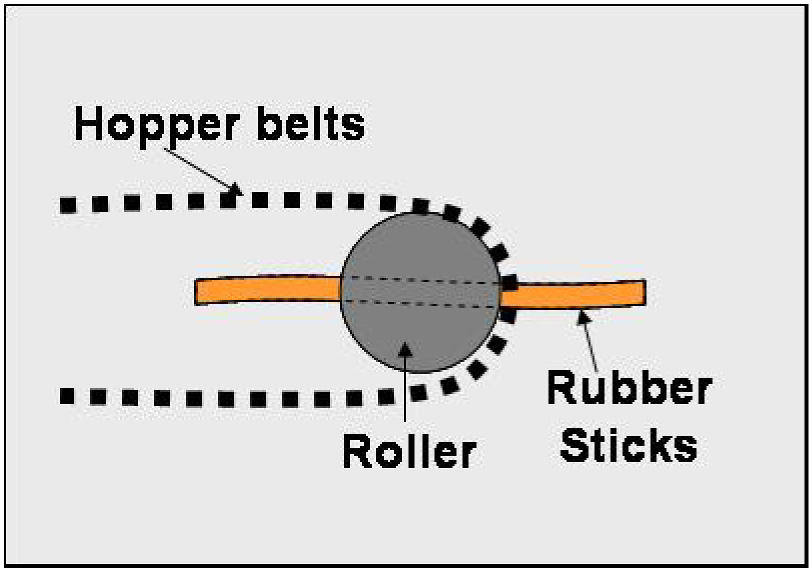


Figure 3. Rubber sticks used to eject balls from the hopper

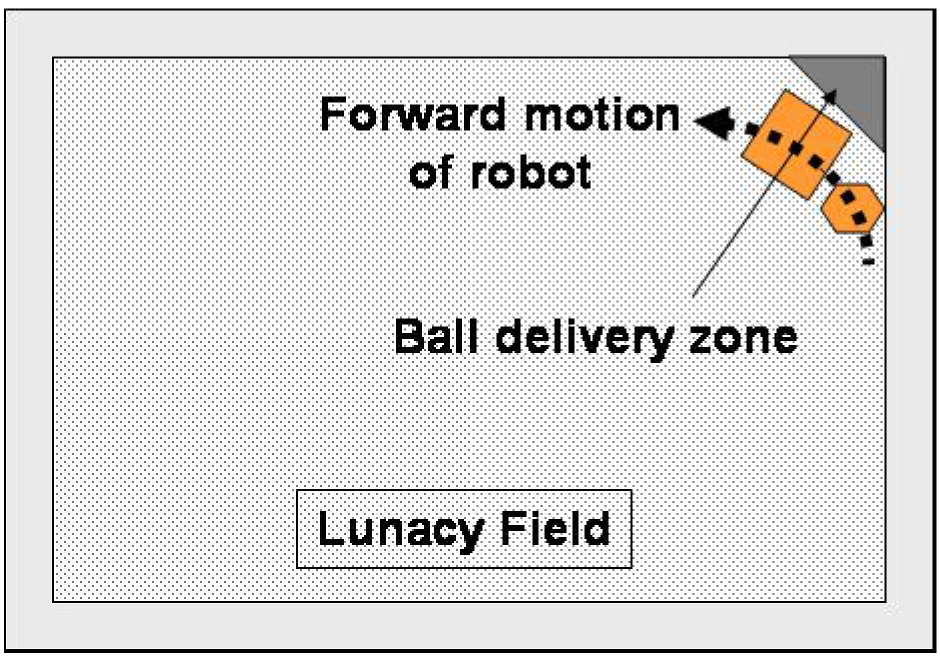


Figure 4. Approach to ball deliver zone that allows constant forward motion