Control Award, Sponsored by Arm, Inc., Submission Form

Team # 20181	Team Name: Shawnee Mission East Robotics

Autonomous Objectives:

- Read the custom signal sleeve - A camera reads the signal sleeve and stores where the robot needs to park at the end of the autonomous.
- Score cones - The cone loaded at initialization and cones from the stack on the field are placed on junctions. A maximum of 6 cones on high junctions generate 30 autonomous points and another 30 points during the driver-controlled period.
- Park entirely within the signal zone corresponding with the signal sleeve - The previously stored parking position is navigated to after every cone is placed for 20 points.

Sensors Used:

- Odometry Wheels (2) - Determines how far the robot has moved since it began the match. Used to accurately follow paths.
- Inertial Measurement Unit - Observes how the Control Hub has rotated over a match. Used to implement Field-Centric control algorithm during the driver-controlled period and path following.
- Voltage Sensor (2) - Each expansion hub has the ability to read the output voltage of the battery connected to it. The speed of a motor is proportional to the voltage it is powered by. Using the readings from the sensors, variances in battery current from use over a match can be compensated for to run the motors at a consistent speed.
- External Camera - Detects the orientation of the signal sleeve.
- Motor Encoder (5) - Measures the position and velocity of individual motors. On the drivetrain, this compensates for variances in individual wheels. Since the linear slide does not experience slip, it moves to different heights through only the encoder.

Key Algorithms:

- Path following - Data from the Inertial Measurement Unit and the odometry wheels is combined with a precomputed series of points to accurately follow a path. The robot supplies each motor with the ideal voltage to move in a direction towards the next point it is targeting. At the end of its route, it moves to correct any leftover inaccuracies.

- Linear slide gravity resistance - Since the mechanism responsible for moving the claw and its cone upwards is designed to move quickly at the cost of built-in resistance, it returns to the floor when it is left unpowered. Applying a small voltage compensated by the current sensor of no more than 10% of the normal speed of the motor prevents it from moving during the game.
- Signal sleeve reading - A webcam attached to the robot takes a picture after the field is initialized. It runs a search algorithm to find two-dimensional barcodes known as AprilTags in the image. Afterward, it picks the largest tag to avoid confusion arising from other distant sleeves. This technique is resistant to changes in lighting and camera orientation. At the end of the autonomous, it navigates to the parking spot indicated by the sleeve for 20 points.

Driver Controlled Enhancements:

- Field-centric control - The gamepad controlling the robot drives it relative to where the driver is standing instead of where the robot is oriented. For example, when the human driver holds forward on their control stick, the robot moves towards the opposing side of the field. To accomplish this, the driver's input is rotated by the angle derived from the Inertial Measurement Unit's monitoring.
- Linear slide levels - With the touch of a button, the claw quickly moves to a height perfect for depositing a cone on a junction. The positions of each junction corresponding to a rotation on the motor were determined in advance. Using the rotation sensor connected to the lift motor, the slide rises to the desired level and stays there.

Engineering Portfolio References:

1. Odometry pod designs featured on page 6
2. Linear slide explained on page 7

Autonomous Program Diagram:

1. Deposit the cone loaded on the robot at the start of the match on a high junction.
2. Obtain another cone from the stack of 5 present on the field.
3. Place that cone on another high junction.
4. Return to the stack to continue stacking cones on a single junction.
5. Drive to the parking spot indicated by the signal sleeve after cones have been placed.