Purpose:
This project has two design objectives. The first is to create a fun project that generate interest in multidisciplinary engineering. The second is to provide a practical and intuitive platform for studying and applying control systems.

Design:
The platform chosen was an RC car, specifically the same one used in the Freescale Cup. The concept of using a camera to drive the car in first person view (FPV) was selected to generate interest in engineering. For the control theory application, a closed loop velocity feedback torque vectoring model was used for improving cornering.

Budget:
- About $500 was allocated to this project from the RIT MSB.
- $535 was spent making the project.
- There is a total of over $1,600 in parts thanks to donors.

Programming:
- Coding was done using mbed serial support for the KL25Z.
- Open source libraries were imported for the Freescale Cup motor shield, quadrature encoders, then, and PID control.
- Excel VBA macros were made for using ActiveX controls for logging of serial data for comparison.

Car Hardware:
- Freescale KL25Z FRDM Board with ARM Cortex™ Processor and Motor Shield
- 600 mW 3.8 GHz Transmitter (Video)
- 2 Rear Drive Motors, Encoder, and Optical Switches (for Velocity Feedback)
- Extended Front Transaxles and Rear Axle
- Wheel Steering and Camera Servers
- 420 line CCD Camera
- 3000 mAh NiCd Battery
- 4 Laser Mounting Plates
- PE Foam Bumpers
- Xbee RF Module
- Standard RC Wheels

Electrical:
- The motor shield and console were reverse engineered (no adding and testing external electronic components).
- A perfboard interface was created for the console that added an Xbee and input signal conditioning to the KL25Z.
- A custom perfboard shield was created for the car that added an Xbee and encoder circuitry to the motor shield.

Console Hardware:
- Logitech MOMO Steering Wheel & Pedals
- Philips 19” LCD TV
- Freescale KL25Z FRDM Board with ARM Cortex™ Processor
- Xbee RF Module
- 3.8 GHz RF Receiver (Video)
- Computer (for Debugging and Data Logging)
- Adjustable Car Seat
- Adjustable Desk

Project Conclusions:
- The cars serves as a platform for future computer engineering classes to apply closed loop control systems.
- PID coefficients may be tuned easily in the code on the car.
- Data logging is achievable through two-way communication with the car.
- Torque vectoring may be switched on and off in the code on the car.
- Other sensors may be added for future applications.
- Camera is mobile and can be added and exhibited easily.

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Testing Results:
- Slalom simulations with first order time constant approximation agree very well with the measured encoder data.
- In the straight line data, the left and the right wheel speeds are equal, and in the left turn scenario, the left speed becomes slower than the right speed as expected.
- Car basic kinematics, controls, and user experience target metrics were met or exceeded in almost all capacities.
- Video quality issues due to multipath interference at the camera signal were mitigated through filtering and mounting.
- Noise issues on the car motor shield that led to errors in the encoder pulse widths used to calculate encoder speeds were mitigated through electrical shielding and physically limiting car performance through coding.