University of Wyoming
College of Engineering and
Applied Science

Control System for Tele-operated Rock-Retrieval Rover

Richard Yang

Dept. of Electrical and Computer Engineering, University of Wyoming

Introduction and Background

- Autonomous and tele-operated robots assist human exploration of outer space by obtaining samples from areas where humans cannot physically survive
- Our University of Wyoming team created a tele-operated rover design to retrieve rocks at NASA Johnson Space Center
- Our design was selected as one of the eight finalist designs to NASA's 2016 RASC-AL Exploration RoboOps Competition
- This poster specifically presents the control framework, sensor transmission, and autonomous motion aspects of the design

Rover Requirements

- Collect colored rock samples scattered across NASA JSC

- Time constraint: one hour
- Remotely operated by drivers at mission control at UW
- Transmit camera and other on-board sensor information to mission control

Project Specifications

- Create an interface between the human driver and rover
- Design a control system to translate driver input commands to signals to physically move electronic components
- Design a sensory transmission system that allows driver to be periodically updated on system status
- Autonomous operation through motion planning and using sensory information

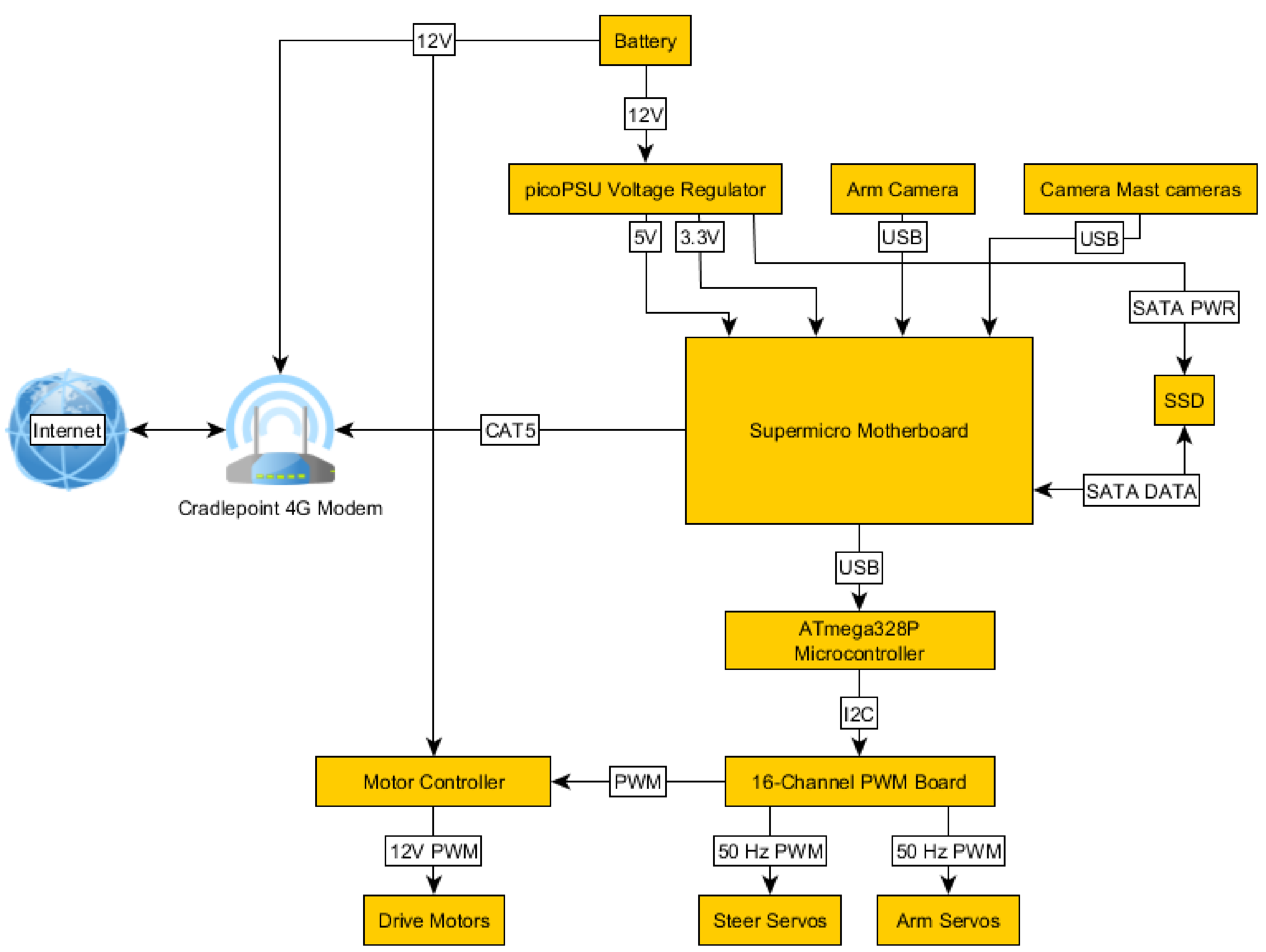
Software Framework

Controlling the rover is done through the Robot Operating System (ROS) framework. ROS provides a centralized framework to connect standalone programs called 'Nodes', which can be run on any hardware capable of running ROS and sending and receiving TCP connections. The control system consists of three ROS nodes:

Input parser

Software controller

Onboard processing/PWM generation



Hardware Components

Seven wheels in total, powered by brushed DC motors. Steering servos in the front two and rear wheels.

Four degrees of freedom arm with a two degrees of freedom claw gripper (controlled through servos).

The motors and servos are controlled via an ATMega328P microprocessor delegating control to Pololu Simple Motor Controllers and a RoboClaw servo controller. The front two and back wheel motors run synchronously, but are independently controlled, whereas the each two side motors are operated from the same controller.

Sensory Transmission and Autonomous Control

The rover is equipped with two 120-degree wide angle cameras, a single 720p HD webcam, a 10 degrees of freedom inertial measurement unit and three infrared proximity sensors.

Three types of autonomous functionality:

Arm Auto-relocation, Crash Detection, Obstacle Avoidance

Components and Budget

Our design received a $10,000 grant from NASA for full development of two rovers.

The control system budget for two rovers:

Budget Items	Costs
2x Supermicro Mini ITX Motherboard	$ 545.90
2x Samsung 120GB SSD	$ 133.96
4x Kingston 8GB DDR3 RAM	$ 231.96
6x Infrared Proximity Sensors	$ 35.70
2x ATmega328P	$ 7.40
2x 16-Channel PWM/Servo Shield	$ 35.00
2x 10-DOF Inertial Measurement Unit	$ 59.90
6x Infrared Proximity Sensors	$ 35.70
4x 120 degree Wide Angle Camera	$ 139.92
2x Microsoft LifeCam 720p Webcam	$ 60.00
4x RoboClaw 2x7A Motor Controller	$ 279.80
2x Pololu Simple Motor Controller	$ 63.90
Totals	**$ 1,629.14**

Future Work

- Non-traditional methods of control such as using a Virtual Reality representation of the arm
- Advanced autonomous movement: self-adjusting speed over obstacles
- More complex use of sensor information
- Create a shared virtual map between rovers, marking where each rover has explored already
- Use machine learning to recognize rocks and their colors

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