Reconfigurable Computing Telepresence Robot

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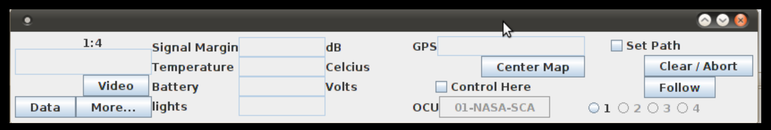
Abstract

The purpose of this project was to create a high performance sensor platform with hardware-level data processing capabilities. The proprietary electronics and control system of a military IED examination robot, the MARCbot, were replaced with a Xilinx Virtex-6 Field Programmable Gate Array (FPGA). The robotic sensor platform can be controlled from a remote computer which transmits drive commands to the robot and accepts return sensor data.

Introduction

Processing sensor data onboard the robot is significant because it decreases the amount of data that must be transmitted back to a remote computer. This is useful in situations where a Disruption Tolerant Network (DTN) is required due to a significant communication delay between the remote computer and the controlled device. This situation could arise when controlling a robotic rover on Mars, where there is a thirty-minute delay between initial instruction and data acquisition from the rover.

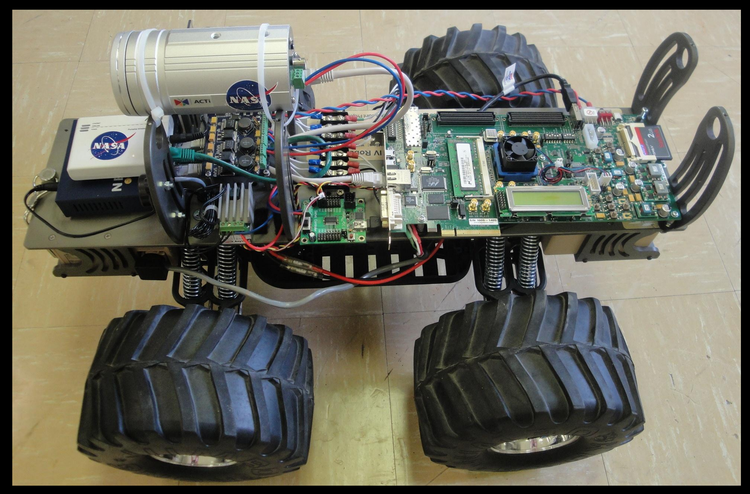
GUI



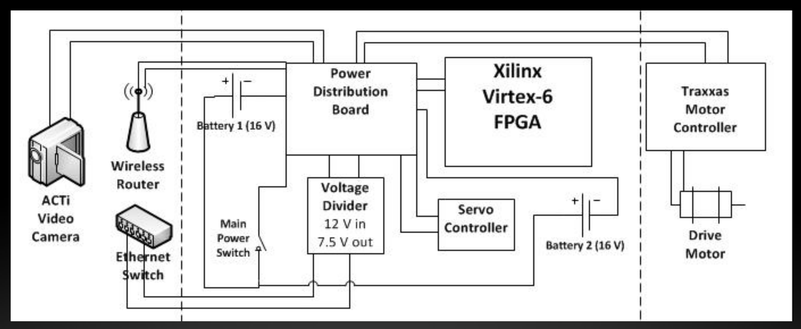
- Written in JAVA
- Uses a key listener to drive events
- Sends and receives UDP packets from the robot
- Provides feedback on the state of the robot
- Provides interfaces for communication
- Can be expanded to include sensor control and feedback

Robot / FPGA

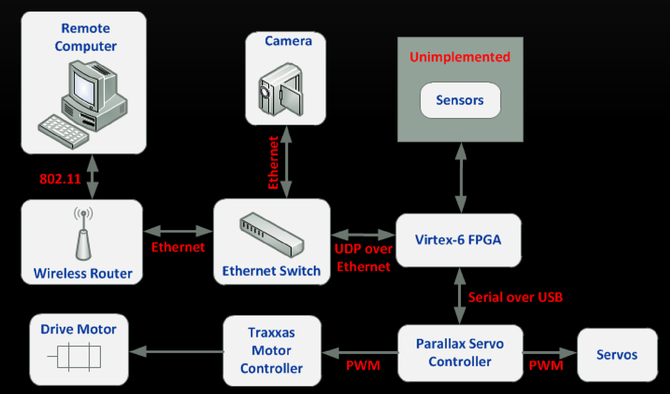
- System built on the MARCbot IV platform
- Wireless router and Ethernet switch installed
- ACTi Surveillance Camera onboard
- IFI Victor 884 motor speed controller
- Parallax USB Servo Controller
- Powered by two BB-2950 rechargeable military batteries



- Xilinx Virtex-6 Field Programmable Gate Array (FPGA)
- Implements a MicroBlaze soft processor
- Runs PetaLinux, a board specific Linux distribution
- Kernel is recompiled to include Parallax USB driver
- C program runs on board startup to control UDP and serial communication



Communication



- Two-way communication between JAVA program on remote computer and Virtex-6 to send commands and sensor data using UDP protocol
- C program on the Virtex-6 interprets UDP packets and sends drive commands to the Parallax servo controller over a serial protocol
- Extensible UDP packet structure to easily incorporate more sensors
- Onboard camera transmits live video to the remote computer over an 802.11 standard wireless network

Results and Conclusions

- Enabled control of MARCbot from remote computer
- Enabled live video feed view from remote computer
- Established UDP based communication between remote computer and Virtex-6
- Established serial communication between Virtex-6 and Parallax servo controller

- Work is being done to utilize the partial reconfiguration capabilities of the Virtex-6 to optimize multi-sensor processing

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