

Embedded Management System for Mobile Robots

Jon Cruz, *Harvard University* / William “Red” Whittaker, Joe Bartels, *Carnegie Mellon University*
RISS 2016

Motivation

- Many robots are designed for situations that are unsafe for humans – an operator must be able to **control the robot remotely**, including halting the robot in case of emergency.
- Monitoring internal diagnostic information** about a robot can help avoid unsafe operating conditions that could lead to damage.

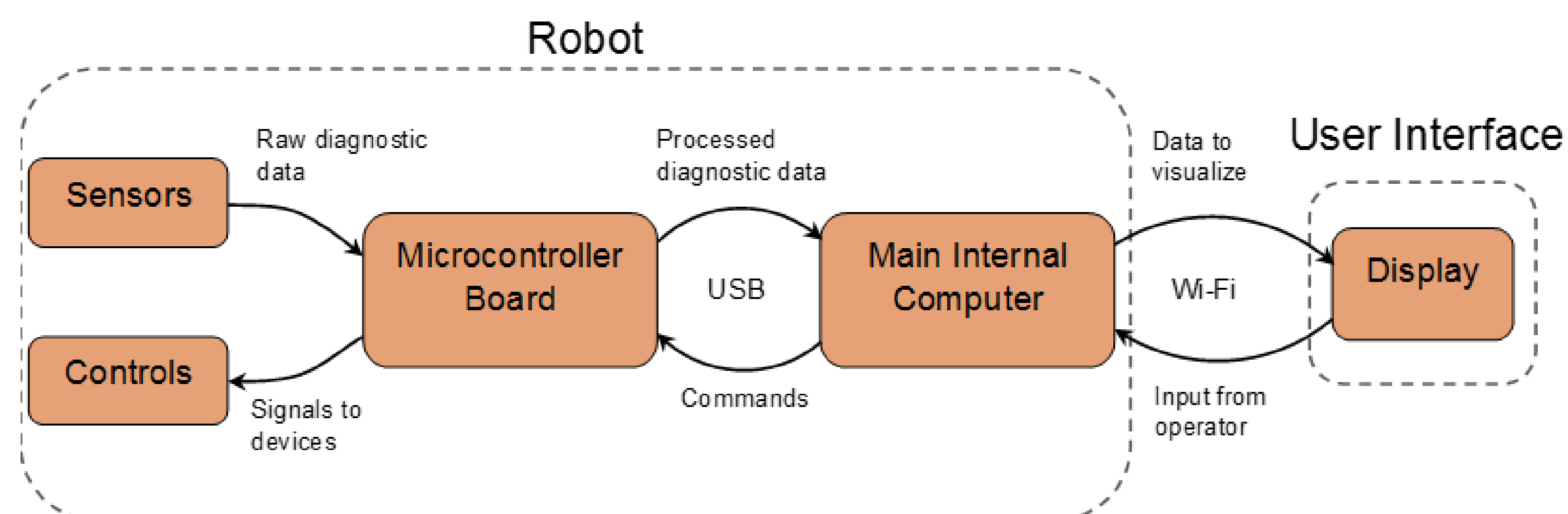
GOAL: Create an embedded system that can both monitor the robot's internal status and allow a remote operator to directly control functionality designed to mitigate or avoid unsafe conditions.



The robot that motivated this project, Lil' Red

Embedded System

Provides an interactive display for an operator to monitor the robot's diagnostic and control safety-oriented functions

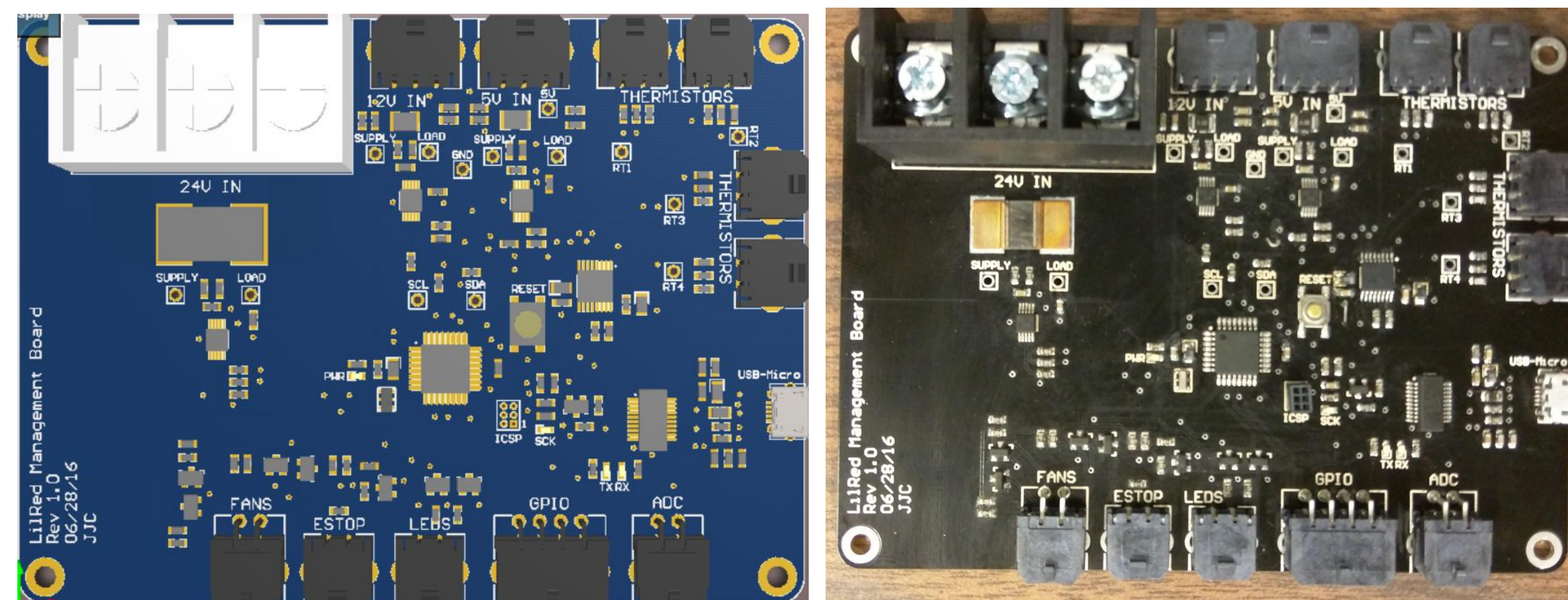


Sensors

- Thermistors are used to measure the temperature of each of the robot's four motors
- The current, voltage, and power on three internal power buses (24V, 12V, 5V) are measured with a dedicated chip

Controls

- The robot's emergency stop functionality can be triggered by the board's electronics
- The speed of the robot's internal cooling fans can be cycled among several settings
- LEDs connected to the board indicate the status of the emergency stop and the communication link with the robot's internal computer



The printed circuit board (right) and its CAD model (left) designed to house the microcontroller and interface directly with the sensors and control functions

Interactive Display

- Sensor data is color coded:
 - Green for safe operating conditions
 - Yellow for near unsafe conditions
 - Red for unsafe conditions
- Clicking on the respective lines of text cycles through fan settings, and enables/disables the emergency stop
- Two modes:
 - 'Minimal' mode displays the control buttons, 24V bus voltage, and data not in safe conditions
 - 'All' mode displays everything

```

Temp 1: 68.5381 F
Temp 2: 249.741 F
Temp 3: 351.068 F
Temp 4: 56.2063 F
24V Bus Current: 0 A
24V Bus Voltage: 22.8997 V
24V Bus Power: 0 W
12V Bus Current: 4.5677 A
12V Bus Voltage: 12.8322 V
12V Bus Power: 58.6136 W
5V Bus Current: 0.0376 A
5V Bus Voltage: 5.0425 V
5V Bus Power: 0.19 W
Fan Setting: 100%
ESTOP: ON
  
```

"All" mode

```

Temp 2: 249.741 F
Temp 3: 351.068 F
24V Bus Voltage: 22.8997 V
12V Bus Current: 4.5677 A
12V Bus Voltage: 12.8322 V
12V Bus Power: 58.6136 W
Fan Setting: 100%
ESTOP: ON
  
```

"Minimal" mode

Future Work

- Fully integrate system into robot
- Minimize size of the printed circuit board
- Generalize the system design for other robotic platforms

Acknowledgements

Special thanks to Dr. Red Whittaker and Joe Bartels for their guidance and support. Thanks to all those that made RISS possible.