Project Necromancer
Design Presentation Handout

Sponsored By: The Rainforest Connection (RFCx)

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1 Rainforest Connection

1.1 Organization - RFCx

- Non-profit organization based out of San Francisco
- Goal: stop illegal deforestation through repurposed Android phones
- Projects:
  - Borneo
  - Cameroon
  - Brazil *****
  - Ecuador

1.2 Device - RFCx Guardian

- Constantly records audio and sends to server about every 1.5 minutes and/or when it achieves the best GSM connection
- RFCx can detect the sound of **chainsaws, car/truck engines, and motorcycle engines** with DSP algorithms running on server
- Real-time alerts can be sent to ground patrols

  AND/OR
- Data can be collected and analyzed daily/weekly to prepare a large-scale intervention

1.3 Current Device

- 2 x 4400mAh batteries
- 1 x Android phone
- 4 x Custom solar panels
- 1 x Radioshack enclosure
- 1 x Adafruit solar Lithium-Ion battery charger
- 1 x External microphone
- 1 x External GSM antenna

1.4 Current Device Problems

- Modularity of electrical components
- Power consumption
- Heat
- No diagnostics

2 Requirements

2.1 Hardware

- Reduce power consumption
- Consolidate all electrical components to single PCB
- Simple assembly process
- Low-power MCU on PCB
- Monetary cost should not be more than $250

2.2 Software

- Microcontroller sends diagnostics to Android phone
  - Power
  - Temperature
  - Humidity
  - Solar/battery status
- MCU programmable via header on PCB
- Android companion app (RFCx Sentinel) to report diagnostics
- (Possibly) Investigate alternative audio compression schemes

3 Design

3.1 Power

3.1.1 MPPT - SPV1040

- Max Point Power Tracker
- Ensures solar panels are outputting maximum power
- Different MPPT configurations possible

3.1.2 5V and 3.3V Regulation - LMR6142B and SM72238

- 5V: Phone and battery charger
- 3.3V: I2C bus, MCU, various ICs

3.1.3 Battery Management - BQ2057CTS

- Prevent batteries from overcharging/overheating
- Single and dual-cell Li-Ion batteries
- IV regulation, charge status, charge rate auto compensation

3.1.4 Power Path Management - LTC4412

- Select between power sources (solar panels and Li-Ion batteries)
- Load sharing between sources
- LTC4412: Clean switch between sources

3.2 Microcontroller - ATmega328P

- Low power
- I2C interface
- Easy/inexpensive to program
- Community support
- Physical package
- **ATmega328P**

3.3 USB - FT230X FTDI

- Diagnostics: Microcontoller –> Android Phone
- UART to USB
- Android app must interface with FTDI/USB

4 Diagnostics

4.1 ADC - ADS1015

- ATmega328P ADC has poor resolution
- Only six total analog pins
- ADS1015: I2C communication, 12-bit, low-power

4.2 Input/Output Power - LTC6800

- Sense resistor for current sensing
- Must amplify current sense voltage: LTC6800 instrumentation opamp

4.3 Temperature - LM75BD and HIH6130

- LM75BD: Only temperature, $\pm 2°C$, \$0.60
- HIH6130: Temp + Humidity, $\pm 1°C$, $\pm 5\% RH$, \$14
- **Both** included on board as option

5 Android - RFCx Sentinel

- Open source Android *usb-serial-for-android* library supports FTDI
- Diagnostics displayed to screen
- Currently used for testing/debugging
- Could send diagnostics to RFCx server

6 Enclosure

- Secure PCB, phone, batteries
- External connection to solar panels, microphone, antenna

7 Heat Dissipation

- Drilling holes: **dust, water, bugs**
- Fans: **Fan noise similar pattern to chainsaws**
- **Heatsink**: Direct thermal connection to phone and protrudes through enclosure

8 GSM Interference

- 217Hz TDMA noise introduced in audio signal
- Special X2Y capacitors created to filter GSM TDMA noise

9 Budget

- $400 = 4 x $100 for PCB manufacturing
- $320 = 4 x $80 for PCB components
- $200 = 1 x $200 for general needs
- Estimated total: **$920**
- Funding: matched $500 funding between GVSU and RFCx