**WNR (Wireless Neural Recorder)**

Rice University

Weekly Progress Report 15

1/15/2016 - 1/22/2016

**Agenda for meetings**

Undergraduates Meeting:

1. Discuss Cycle III Documentation and logistics
2. Methods for verifying feasibility of Nordic nRF52 BLE link
3. Analog Front-End SPI updates
4. Compression updates

Mentor Meeting:

1. Reanalysis of BLE
   1. Data rate
   2. Compression
   3. Power consumption
2. SPI and Analog Front-End updates

**Activities this week**

1. Wireless Transmission:
   1. Confirmed that the throughput of one BLE link using Nordic nRF52 board should just satisfy the throughput requirements for one probe transmitting data
2. Analog Front-End:
   1. Finished implementing SPI on Nordic nRF52 board
   2. Need to begin reading in data through SPI to characterize constraints and data received through the Nordic nRF52.
3. Compression:
   1. Implemented and characterized compression using the MiniLZO library (MCU version of ALZ77).

**Problems encountered**

1. Wireless Transmission
   1. Throughput recalculations were done assuming only one peripheral to central link. We do not know if this will scale with multiple peripherals. In other words if we have two peripherals connected to one central, will we achieve double the throughput (128 \* 2 kbps) compared with only one peripheral connected to a central?
   2. The only way to verify throughput over multiple links is to implement and test using Nordic nRF52.
2. Analog Front-End and SPI:
   1. Power consumption tests show that we are still achieving around ~20 mA, rather than the theoretical estimated 6 mA from the Intan Chip documentation. We are still waiting to use Dr. Babakhani’s equipment for validation if required.
   2. There is a fatal error in the Nordic implementation of SPI to read the data; we must resolve this issue before we can continue with anymore tests.

**Time devoted to project this week**

|  |  |  |
| --- | --- | --- |
| **Name** | **Tasks Accomplished** | **Hours Spent** |
| Stephen Xia | * Characterize/Verify BLE throughput on Nordic nRF52 theoretically | 7 |
| Tingkai Liu | * Run SPI test to read data off Intan Chip to read data and measure power consumption | 7 |
| Xin Huang | * Characterize/Verify BLE throughput on Nordic nRF52 theoretically | 5 |
| Yuan Gao | * Implement and characterize compression algorithm (like MiniLZO) | 9 |
|  | **Team Total** | 28 |

**Meetings Minutes**

Undergraduate Meeting – 1/19/2016, 5:00PM - 6:00 PM

Attendees: Stephen Xia, Tingkai Liu, Xin Huang, Yuan Gao

Location: Lovett Commons

Completed objectives:

1. Discuss Cycle III Documentation and logistics
   1. Revised Cycle III functional specifications due January 25
   2. Cycle III design review is on the week of 2/22/2016
   3. Cycle III Documentation due February 26
   4. For now, confirm weekly mentor meetings for Fridays at 3:30PM
2. Wireless Transmission
   1. Nordic nRF52 currently only seems to support 5 packets per connection interval max, which yields a data rate of 107 kbps
      1. Even if we could get 6 packets per connection interval, we would still require a little bit of compression most likely
      2. Additionally, there seems to be no guarantee that Nordic nRF52 even supports 6 packets per connection interval
   2. Need to begin implementation on Nordic nRF52, hopefully achieving 128 kbps
3. Analog Front-End and SPI
   1. SPI is implemented, but there is a fatal error bug that has not been resolved.
   2. No data currently obtained because of the fatal error
4. MiniLZO compression
   1. Tested on data stored in files and single bytes
      1. single byte tests: no change since the number of bits is too small
      2. file tests: only a small amount of change; compression window was varied between 20 to 120 bytes since this is on the order of how many bytes we are sending in each packet or connection interval.
   2. Need to continue testing, namely using larger buffers to see if we can get a better compression ratio

Mentor Meeting – 1/22/2016, 3:30PM - 4:30 PM

Attendees: Stephen Xia, Tingkai Liu, Xin Huang, Yuan Gao, Gary Woods, Hamed Rahmani

Location: OEDK 104

Completed objectives:

1. Wireless Transmission
   1. Can theoretically achieve 100 - 128 kbps on one connection, but we do not know if this will scale up with more than one connection.
   2. We should test connection of multiple peripherals to one central and see how that affects the system throughput.
2. MiniLZO Compression
   1. We require at least a 50% compression rate in order for BLE to be feasible, but right now it seems as though the compression rate plateaus at just below 50% in the best case scenario
   2. Must keep looking into other algorithms to see if there are any that perform better
3. Analog Front-End and SPI:
   1. SPI is implemented on Nordic nRF52, but there is a fatal error that prevents us from reading from the Intan Chip; we must resolve this before continuing with the tests
4. PCB design for the final peripheral system
   1. The Nordic nRF52, battery, LVDS, patch antenna, and crystal oscillator will be on the pcb, or multiple pcbs wired that will be bound together by stacking individual pcbs.
   2. The Intan Chip will be extending off from the pcb because it is very expensive, so we do not readily have access to bare die chips that we can attach to the pcb.
5. Timeline
   1. We need to complete prototype by February 22 (Cycle III design review) and ideally to animal testing and create an IC.
   2. If we cannot complete a prototype by February 22, then we will probably not be able to do animal testing and create an IC by showcase.
6. Objectives for Cycle III
   1. Write up what needs to be included on the pcb for the peripheral device
   2. Design goals
      1. Read in and characterize data from Intan Chip through SPI using a MCU to confirm that the Intan Chip is functioning
      2. Compression:
         1. We require 50% for BLE to operate
         2. Currently we average around 30%
         3. Try to get 20% compression on actual data, and it needs to be working on the Nordic nRF52 or an MCU
      3. Wireless Transmission:
         1. BLE bandwidth testing with multiple peripherals
         2. Power consumption characterization
      4. Stretch Goal: Get end-to-end system working, meaning we combine wireless transmission, analog front-end, and compression

**Expenditures**

* N/A

**Action items list**

|  |  |  |  |
| --- | --- | --- | --- |
| **Action item** | **Owner** | **Due date** | **Status** |
| Characterize/Verify BLE throughput on Nordic nRF52 theoretically | Stephen Xia | 1/21/2016 | 100% |
| Run SPI test to read data and measure power consumption | Tingkai Liu | 2/25/2016 | 30% |
| Implement and characterize compression algorithm (like miniLZO) | Yuan Gao | 2/25/2016 | 20% |
| Sign up for competitions | Xin Huang | 2/26/2016 | 0% |
| Continuously transmit data over BLE from one peripheral to central device | Stephen Xia | 2/25/2016 | 0% |
| Characterize data rate while transmitting continuously over BLE from one peripheral to central device | Stephen Xia | 2/25/2016 | 0% |
| Continuously transmit data over BLE from at least two peripheral devices to a central device | Stephen Xia | 2/25/2016 | 0% |
| Characterize data rate while transmitting continuously over BLE from at least two peripheral devices to a central device | Stephen Xia | 2/25/2016 | 0% |
| Characterize power consumption of Nordic nRF52 board | Xin Huang | 2/25/2016 | 0% |
| Read “fake” data from Intan Chip through SPI and display to confirm the data is actually being received using Nordic nRF52 | Tingkai Liu | 2/25/2016 | 0% |
| Characterize/confirm power consumption of the Intan Chip + accessory devices (like LVDS) | Stephen Xia | 2/25/2016 | 0% |
| Implement a compression algorithm (like LZO) on Nordic nRF52 | Yuan Gao | 2/25/2016 | 0% |
| Achieve at least 20% compression on raw data | Yuan Gao | 2/25/2016 | 0% |

**Additional Comments/Questions for Mentors**

* Dr. Tandon did not show up this week, so we moved meeting to Friday afternoon rather than Thursday because it is more convenient for everyone.
* However, Dr. Tandon and everyone on the team can only meet on Thursdays, from 12PM to 1PM, so this is probably the standard meeting time for this semester.