**COLLEGE OF ENGINEERING**
DEPARTMENT OF ELECTRICAL ENGINEERING
UNIVERSITY OF NORTH TEXAS, DENTON TX 76203

8 Dec 16

MEMORANDUM FOR RECORD

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SUBJECT: VLC Dev Kit Progress - Week 10&11

1. The purpose of this memorandum is to report our progress in accordance with our predetermined schedule.

2. The specific purpose of this memorandum is to review the objectives of week 10&11 and what we have accomplished.

3. Over the course of the week, we went off on our own time to accomplish what we could for the projected goals, then came back together to consolidate our efforts. This utilized our free time since our schedules usually conflict. We worked based off of the Week 10&11 Schedule:

| *Week* | *Date* | *Projected Goals* | *Comments* |
|---|---|---|---|
| 10 | 11/27/16 | Build Prototype 2<br><br>Code T2:<br>T1 with UART<br><br>Code R2:<br>T2 with UART<br><br>Project Progress<br>Report due 8 Dec 16 | Implement UART to choose the bit being sent (hit the 0 or 1 key on Tx) and showing the received bit on the Rx side.<br><br>Report on progress done so far due to faculty mentor (Dr. Namuduri). |
| 11 | 12/4/16 | Build Prototype 2<br><br>Code T2:<br>T1 with UART | Implement UART to choose the bit being sent (hit the 0 or 1 key on Tx) and showing the received bit on the Rx side. |

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|---|---|---|---|
| | | Code R2:<br>T2 with UART | |

4. The schedule says to implement UART, but we have not gotten to it. We are finding advantages and disadvantages with components for hardware. We know we'll be using GUI to communicate with the user and have started coding for it already.

5. Nathan and Chris made a lot of progress when they met up on Sunday. With the feel for pressure to do a live demo in front of Dr. Namuduri, we wanted to show that we've made progress. Nathan was trying out multiple ways and different circuits for the photodiode. At first, he used a op amp with a resistor and capacitor in parallel on the negative feedback. The photodiode being powered by a Vref and going into the negative terminal of the op amp. He got a nice square wave on the o-scope with a gain of 1.2V and a DC offset of 5V. He sent the Vout through a electrolytic capacitor which did the job of rejecting the DC so we had a square wave going from 0-1.2V. The problem was afterwards when we tried to have a second stage amplifier so the output would go from 0-3.3V. 3.3 being the max where the signal is definitely a logic 1 to the Raspberry Pi. We know that there is a threshold voltage where it switches from a logic 0 and 1 (around 1.4V) but we wanted to see if we could make an ideal square wave with minimal distortion in the rise and fall times.

6. After trying quite a few combinations for a second stage amplifier, Nathan switched directions and used a MOSFET for the first stage amplifier. He used a NMOS FET, the photodiode powered by Vref feeding into the gate, a pull down resistor also hooked to the gate (to act as a voltage divider and make sure the small differences in photodiode current was seen across the transistor), a pull up resistor (to the same Vref) on the drain, and the source going to ground. Vref was set at 3.3V as a test since the Raspberry Pi could supply 3.3V and we wouldn't need another voltage source. Almost miraculously, it worked on the first try. Vout was hooked to the drain node and we saw a near perfect square wave going from 0 to Vref (we varied Vref and saw the same results). We saw that there was a roughly 17ms rise time on each rising edge. With how fast we want to transfer data, we needed to find a way to minimize this. We tried changing resistor values as well as varying Vref with varying resistor combinations. With all combinations, the smallest rising time we could produce was roughly 15 ms at 3.3V for Vref. We were also able to minimize the outgoing current just to make sure nothing is in the danger zone.

7. Nathan plans to stay with the NMOS circuit to receive data. We're looking at other components to maximize the signal sensitivity and minimize distortion. The NMOS circuit will feed into a MCU to use its timer and comparator. Almost the sole reason for the MCU is the timer since the Raspberry Pi is not a true real time processor. Since the Rx will need to measure the incoming frequencies to determine logic 1 versus logic 0, timing is critical. The MCU will time the incoming signal and assign a logic 1 or 0 values. That packet of 1s and 0s will go to the Raspberry Pi for decoding and output using GUI.

8. Chris got a GUI to operate by bringing up a window, taking in a string of characters, then outputting that string. This will act as the foundation to go into sending that message through the Tx circuit. He also found a number of useful Python techniques (including ASCII conversion

functions, and raspberry pi gpio modules) that will make our project easier to manage in the long run. He also began testing the newly arrived dichroic cubes in order to characterize their bandpass filtering and attenuation with respect to incidence angle and intensity. Initial testing proves promising however filtering is non-ideal with some cross band bleeding and output wavelength seems to be proportional to input light angle of incidence.

9. The Tx circuit was slightly modified to improve frequency response resulting in stable modulation at frequencies upwards of 10kHz. The circuit was also integrated with the raspberry pi such that data imported from the python GUI can be sent through the Tx module to modulate the output LED.

10. If you have any questions, comments, or concerns, please feel free to contact us at:

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