COLLEGE OF ENGINEERING
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9 Nov 16

MEMORANDUM FOR RECORD

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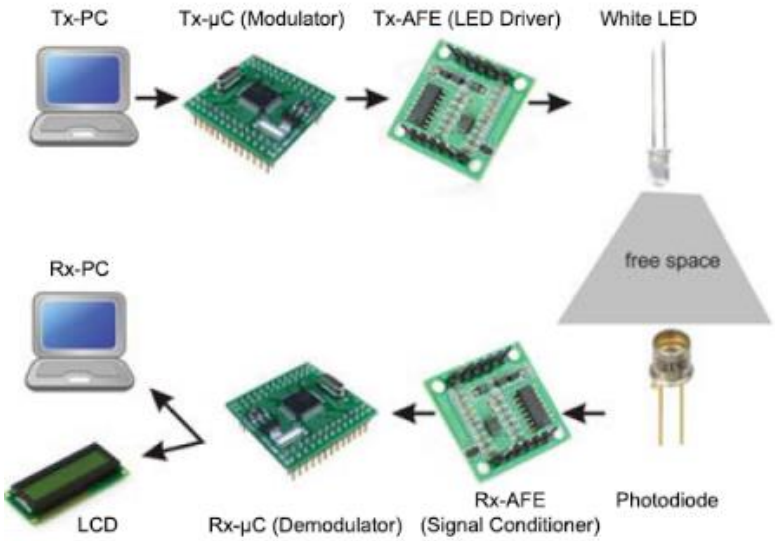
SUBJECT: Project Proposal for EENG 4910

1. The purpose of this memorandum is to submit our group idea for our Senior Design project – Development Kit for Visible Light Communications.

2. The specific purpose of this memorandum is to go over our project with regards to problem definition, concept generation/requirements specification, design, prototype, testing, system integration, project schedule, and deliverables.

3. Problem Definition. Visible light communication (VLC) is transmitting data by modulating the output of light, and receiving it with a light sensitive sensor that limits the noise from ambient light. There are almost no development kits on the market using VLC for students to use and learn from. We found 2 possible options: 1 from India for $85, another from China for $500. We want to practically start from scratch and learn VLC and build a develop kit for future research. We will need to understand how wireless communication works as well as extensive signal processing techniques (light modulation, signal analysis, etc.).

4. Concept Generation/Requirements Specification. What we want is one way communication via the light spectrum. On the transmitter side, it would include a microprocessor, feeding to a DAC, then to RGB+W LED. On the receiver side, it would include a photo-receiver, feeding to a TIA, to an ADC, then to a microprocessor for signal processing and output.



5. Design. There are a number of factors and any could change based on further research and testing. For Senior Design, we will use UART to send a message on a channel of the LED: a message specifically over red LED, or specifically over green, or specifically over blue. We found, and plan to follow, IEEE 802.15.7 standards for VLC. We found 2 different light modulation techniques that we want to pursue: PWM and CSK. We found source code for PWM VLC but CSK is significantly more difficult.

6. Prototype. Our prototype will be very basic and modular so we can use it for testing the different options for each piece. The transceiver will be a computer that provides the internet and power to a raspberry pi which will in turn be hooked up to a LED setup. The receiver will be a light sensor hooked to a TI microcontroller which will be connected to a computer for power and data output options.

7. Testing. There's a number of testing that can happen on both the Tx and Rx side to slowly piece together the project. On the Rx, we want to test the photodiodes by themselves with an o-scope to see what we can anticipate for signal. Knowing that, we'd send that signal through the onboard TIA so we have a voltage. We'd need to scale that for each color before we send it through an ADC. Only after that can we work on signal processing and outputting data through UART. We also wanted to look into a band pass filter so we have those 3 distinct channels. We would do it with three separate photodiodes, but an analog filter is up to us. We could go with actual BPF circuits or get a dichroic prism that separates the signal into its colors. For Tx, we need to work on current adjustment since each color can have different specs and we want a constant current driver. We also want to find out how changing the frequency can change our communication capabilities. There are a number of ways to achieve our goal, and it's a matter of more research and testing to find the best solution. Our testing will be done in the lab with the Tx and Rx modules hooked up to a computer for better interface and troubleshooting.

8. System Integration. This system would lay the foundation for students to learn VLC and implement different techniques for future technology. VLC already exists, but it is not developed enough for people to do it on their own time or to learn in a classroom

environment. Building a dev kit for VLC provides the opportunity for students everywhere to learn about a relatively young area of communications. The system will be very software intensive. We need to learn and deal with wireless communications along with signal processing. Implementing different communication techniques makes the code significantly more complex going from one level to the next. The parts themselves are easily recyclable to be used in other ways since they are basic shelf components. Software will be very specific in what its goal is and with those specific components.

9. Project Schedule. We will be providing weekly reports on our progress to Dr. Namuduri. We will be meeting at least once per week on Tuesday mornings and occasionally on Sunday evenings as the project timeline accelerates. Meetings will be subject change as we progress into the second semester of our project but will be established before arrival. We will save all articles and research to give credit and references later on. As our project is taking a change in direction, weeks 1 through 5 show what we did for light fidelity (LiFi). We changed to a VLC development kit starting week 6.

Week	*Date*	*Projected Goals*	*Comments*
1	9/25/16	Research: Street lamp standards Li-Fi standards Current traffic prediction techniques	Physical and electrical requirements of streetlamps. Do current Li-Fi standards exist? What regulations would we have to follow to broadcast Li-Fi? How are traffic patterns predicted and modified to improve flow? Basics of how Li-fi works.
2	10/2/16	Research: Photo receivers RGB LED's/LED drivers Optical filters (color prism)	Photo receiver types and specifications. LED technologies and specifications. Optical filter/splitter options Rx side sensor.
3	10/9/16	Research: Microcontrollers/Microcomputers Light modulation techniques	Is there a standard for Li-fi modem technology? What type of microcontroller/microcomputer would best for light modulation? What computer language? Details on how light modulation is commonly implemented.
4	10/16/16	Research: Photo receivers RGB LED's/LED drivers Optical filters (color prism) Choose/Buy Components for basic prototype	Advanced Li-fi research. Select hardware for initial prototype construction Choose specifics components to use for prototype
5	10/23/16	Test Components Code: Code familiarization Template code	Small scale component construction. Verify component specs in the real world. Become familiar with coding on the microcontroller and microcomputer.
6	10/30/16	Revamp Proposal Test Components Code: Code familiarization Template code	Rewrite proposal with TA feedback. Small scale component construction. Verify component specs in the real world. Become familiar with coding on the microcontroller and microcomputer. Dissect source code.

7	11/6/16	Revamp Proposal Prototype 1 Code T0: Tx portion of source code using PWM Code R0: Rx portion of source code using PWM	Rewrite proposal with TA Feedback Build a Tx and Rx circuit. Run source code with separate Tx and Rx (vary Rx LED brightness depending on Tx LED) Separate source code so 2 launch pads can be used. One as Rx, and the other as Tx.
8	11/13/16	Prototype 1 Code T0: Tx portion of source code using PWM Code R0: Rx portion of source code using PWM	Build a Tx and Rx circuit. Run source code with separate Tx and Rx (vary Rx LED brightness depending on Tx LED) Separate source code so 2 launch pads can be used. One as Rx, and the other as Tx.
9	11/20/16	*(Thanksgiving Break)* Reevaluate Prototype 1 Code T1: Modify T0 to send bits Code R1: Modify R1 to receive bits	Reevaluate parts being used for the circuit. Look at other options depending on findings. Make T1 send bit values with the RGB on a fixed time Make Rx launch pad blink LED to show bit value received.
10	11/27/16	Build Prototype 2 Code T2: T1 with UART Code R2: T2 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.
11	12/4/16	Project Presentation: First Semester	Present project. Submit report and any secondary required documentation.
12	12/11/16	Finals Week	
13	12/18/16	Winter Break	(buffer to reevaluate and catch up)

14	12/25/16	Winter Break	(buffer to reevaluate and catch up)
15	1/1/17	Winter Break	(buffer to reevaluate and catch up)
16	1/8/17	Winter Break	(buffer to reevaluate and catch up)
17	1//15/17	Re-familiarize with past research and code	Potentially retest system and verify points as to how to improve the system.
18	1/22/17	Build Prototype 2 Code T2: T1 with UART Code R2: T2 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.
19	1/29/17	Reevaluate Prototype 2 Code T3 & R3: Multi-channel communication	Reevaluate parts used for prototype 2 and circuit structure Modulate all colors (RGB) for multi-channel communication.
20	2/5/17	Code T4: Assign entire ASCII table to bit patterns to send to Rx Code R4: Assign entire ASCII table to bit patterns to receive from Tx	Need to hardcode all the values of keys to bit patterns. So when a certain key is hit, it's equated to a certain bit pattern that we can send.
21	2/12/17	Code T5: Send keystroke to Rx Code R5: Receive keystroke from Tx	Instantaneously send keystrokes from Tx to Rx
22	2/19/17	" "	
23	2/26/17	Prototype 3 Code T6: Wait to send message until enter key Code R6: Receive message and show it in its	Build prototype 3 Instead of single keystrokes, now an entire message being sent and needing to be processed. Still controlled on which channel (color) it is sent.

		entirety	
24	3/5/17	Other capabilities	Sending audio over a channel, CSK modulation, daylight operations, 2 way communication, etc.
25	3/12/17	*(Spring Break)*	
26	3/19/17	" "	
27	3/26/17	" "	
28	4/2/17	Completed/constructed system	Verify entire system is working at full capacity.
29	4/9/17	Test/Reevaluate/Big Picture Theory/Deliverables	Final testing and evaluating to confirm it works under all conditions
30	4/16/17	" "	
31	4/23/17	" "	
32	4/30/17	Project Presentation: Final Semester	After presentation, discuss project preservation. Write formal thank you notes to all staff involved. Pending graduation!
33	5/7/17	Finals Week	

We know there will be unforeseen problems and will need more time on some topics compared to others. We put multiple weeks for the same topic to allow for spillover as well as weeks set aside for catching up and evaluating what we have. To split up the project, Chris will be in charge of the Tx circuit and be the subject matter expert (SME) for UART communications. Nathan will be in charge of the Rx circuit and be the SME for coding using the MSP430. Forrest will be in charge of testing / evaluating and be the SME on parts used.

10. If you have any questions, comments, or concerns, please feel free to contact us at:
    - Chris Askings: (817) 367 – 8273 or via email at chrisaskings@gmail.com
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