ECE4011/ECE 4012 Project Summary

Project Title	Molecular communication over the air
Team Members (names and majors)	Jacob Callahan (EE) Nick Fahrenkrog (EE) Constance Perkins (CompE) Zhongyang Shi (EE) Jun Xiang (EE) Siyan Yu (CompE)
Advisor / Section	Matthieu Bloch / SD17F03
Semester	2017/Fall Circle: Either Intermediate (ECE4011) or Final (ECE4012)
Project Abstract (250-300 words)	The goal of the project is to prototype a molecular communication system capable of sending text messages through chemical signalling. The system consists of motorized spray gun that sprays an alcohol solution to a sensor. The spray rate and concentration of molecules will be controlled by a microcontroller. The sensor that receives the message is also connected to a microcontroller that measures the concentration of alcohol to demodulate the data. Further analysis of the gathered data will be done in MATLAB. Molecular communication is a form of communication that uses molecules instead of electromagnetic waves to transmit information. This form of communication mimics how bacteria communicates with each other within organisms. It has a variety of potential applications in biomedical, military, and environmental fields. This prototype will be a large-scale model of this form of communication to focus on researching how bacteria may communicate. The total cost to build a prototype of this device is expected to be \$91.09, which covers two Arduino Uno microcontrollers, one spray bottle, three gas sensors (with different sensitivities and operating points), and PCB board costs. Since the primary purpose of this project is in research, the device will remain in a cycle of working product and implementing improvements; it will never be manufactured. One prototype will be produced to show that text messages can be encoded into binary then transmitted by sending molecules with either low or high concentration, and all improvements will focus on increasing the rate of communication.

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List codes and standards that significantly affect your project. Briefly describe how they influenced your design.	 IEEE P1906.1 Recommended Practice for Nanoscale and Molecular Communication Framework: Defines standard terminology and provides a framework for molecular communication systems. IEC 61188 Printed boards and printed board assemblies - Design and use - Part 7: Electronic component zero orientation for CAD library construction: Describes how to lay out a printed circuit board. A PCB will be constructed for the sensors and microcontrollers
	- International Telegraph Alphabet No. 2: Code for converting letters into binary strings.
List at least two significant realistic design constraints that applied to your project. Briefly describe how they affected your design.	 Since the main scheme of propagation channel is diffusion, by allowing the alcohol to travel purely on diffusion can make the process slow and inaccurate. A fan would be needed in the setup to assist the propagation, so that the alcohol can travel faster and land more accurately in range of the sensor. While the slow nature of diffusion-based molecular communication poses
	a limitation on size of the training data generated by the transmitter, the receiver requires as many data as possible to better estimate received signals.
	 Our demodulation method reflex on time-synchronous protocol. In synchronous failure case, the system fails to demodulate correct number of '0's, thus gets longer or shorter length of bit sequence. The difficulty comes with the fact that we currently can't determine number and location of missing bits in our one-way communication system.
Briefly explain two significant trade-offs considered in your design, including options considered and the solution chosen.	 Increasing heater voltage on gas sensor after concentration reading will decrease waiting period between messages. However, the current reading will spike during hot periods and the heater's product life will decrease. Overall, the projected speed gains outweigh the negatives because this product will never be manufactured and sold.
	- Building the liquid transmitter requires either a commercially built electronic spray bottle or a set of basic embedded hardwares. The former is easier to integrate but more expensive and harder to find, the latter is more cost efficient, easier to acquire but harder to build and configure. Overall a commercial electronic spray bottle is chosen to smooth and speed the prototyping process.
Briefly describe the computing aspects of your projects, specifically identifying hardware-software tradeoffs, interfaces, and/or interactions.	- On the transmitter side, a user interface (UI) will be implemented so that data, such as a text message, can be entered, translated into 0s and 1s, then transmitted through varying concentration of molecules. The UI can a physical UI operated by pushbuttons or a GUI on a laptop. While realistically it seems improbable that messages from a laptop would need to be encoded in this manner, the team decided to go with programming a GUI rather than building a physical UI so more time can be focused on improving the transmission speed.
Complete if applicable; required if team	- Two "hobbyist chip" brands considered for this project were Arduino and Raspberry Pi. The Arduino brand is a microcontroller designed for easy prototyping while the Raspberry Pi brand are essentially small computers.

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Leadership Roles (ECE4011 & Forecasted for ECE4012) (NOTE: ECE4012 requires definition of additional leadership roles including: 1.Webmaster 2. Expo coordinator 3. Documentation	Jacob: Lead hardware engineer, PCB designer Nick: Expo coordinator, receiver engineer Jun: Lead signal processing engineer Siyan Yu: Lead embedded software engineer, transmitter engineer Constance: Lead firmware engineer, Webmaster Zhongyang: Documentation coordinator, receiver engineer

International Program:	N/A
Global Issues	
(Less than one page)	
(Only teams with one or	
more International Program	
participants need to complete	
this section)	