ECE 4011/ECE 4012 Project Summary

Project Title	Mobile Non-Contact Vital Sign Monitoring
Team Members (names and majors)	Nydrel Jack (CmpE) Arianne Perez (EE) Chelsi Taylor (EE) Ethan Vargas (CmpE, CS) Nathanael Williams (EE, ISyE)
Advisor / Section	Dr. Ying Zhang / L2A
Semester	Spring 2019 Circle: Either Intermediate (ECE4011) or **Final (ECE4012)**
Project Abstract (250-300 words)	This project develops a data acquisition system and mobile device application for a non-contact vital sign monitoring system whose purpose is to monitor an individual's vital sign information, such as heart and respiration rates, in real-time without requiring physical contact with the individual. Previously, the vital sign data visualization and processing was done on a computer. The goal for this project is to present the vital sign information on a mobile device, where it can be monitored remotely by clinicians and/or individuals, making it more accessible and reducing the time necessary to observe and analyze the data. Building upon the efforts of the Non-Contact Analysis of Health-Informatics via Observable Metrics (NAHOM) Team, this project monitors the health of individuals by collecting their vital sign signals through transceiver antennas, interpreting those signals using signal processing by applying noise reduction to extract the signals, and transmitting the vital sign data via Bluetooth to a mobile device for display in a mobile application. The mobile application shows vital sign information in both graphical and numerical formats. The vital sign information can also be made available to healthcare providers, who will have access to the data that will be stored locally after processing and transmission. Since this vital sign technology is non-invasive, it allows healthcare providers to measure and record the vital signs of individuals who cannot have their vital signs measured using traditional instruments, such as burn victims, or patients, such as the elderly and infants, who often suffer skin damage as a result of continued use of electrodes, adhesive tapes, and other probes. Additionally, non-contact vital sign monitoring technologies allow individuals and healthcare providers to continuously monitor vital signs, which may change the scope of healthcare worldwide.

Project Title	Non-Contact Vital Sign Monitoring Mobile Application

List **codes** and **standards** that significantly affect your project. Briefly describe how they influenced your design.	1. IEEE 802.15.1-2002 specifies wireless personal area network standards based on Bluetooth technology. Bluetooth is a standard form of wireless communication and is used to transmit data between the microcontroller unit and mobile device.
	2. Android Open Source Project (AOSP) Java Code Style is a coding standard used for Java code contributions to official Android open source projects. To ensure code readability and design reusability, the MNCVSM Team is enforcing a consistent coding style by following the guidelines outlined under this coding convention. This affects the way the mobile application's pages and data structures are designed.
	3. Codes and standards identified by the previous Senior Design team:
	    a. HIPAA (Health Insurance Portability and Accountability Act) - Each individual's medical information is confidential.
	    b. ANSI/AAMI ES60601-1:2005 - This regulates the signal-to-noise of vital sign signals.
	    c. IRB (Institutional Review Board) for Protection in Human Subjects in Research - Radiation is used to obtain the health data of human subjects, and therefore, there is concern for safety for the human subjects. Dr. Zhang and her graduate level students from a previous semester have chosen a 6 dBm power level, which has been approved by the IRB.

List at least two significant **realistic design constraints** that applied to your project. Briefly describe how they affected your design.	1. Signal-to-noise ratio (SNR): If the amplitude of the noise present in the signal is greater than or equal to the amplitude of the vital sign data to be extracted, the vital sign measurements cannot be accurately obtained from the signal. 2. Data resolution: If the ADC does not have sufficient resolution, it cannot accurately collect the vital signal information to be communicated to the mobile application in real-time. To sustain the amount of data that must be processed on the MCU, the on-board ADC must have a minimum of 16-bit resolution. 3. The MCU used in the final system (an STM32F373VCT6 microcontroller) has a flash memory size of 32 kB. This limits the amount of memory that the on-board signal processing algorithm can use, which affects the number of samples of the signal that can be stored and processed at a given time.
Briefly explain two **significant trade-offs** considered in your design, including options considered and the solution chosen.	1. On-Board Processing vs. Processing via the Mobile Application: Processing the data on-board the MCU means that only the vital sign data is transferred to the mobile device. Processing the data via the mobile application means that raw data will be processed on the mobile device. The on-board processing depends heavily on the capability of the MCU but eliminates challenges regarding the ability to process the data on a variety of different mobile devices. 2. Precision of the Calculated Rates vs. Sample Period: The time it takes to collect the samples that are used to determines a user's respiration rate and heart rate is inversely proportional to the resolution of the calculated rates. Decreasing the sampling rate comes at the cost of requiring users to sit still for longer periods of time to obtain enough samples to run the signal processing algorithm but increases the resolution of the calculated rates. Choosing a sample period of ~33 seconds maintains reasonable precision (~1.83 bpm between possible calculated rates) and does not require a user to remain still for a long time.

Briefly describe the **computing aspects** of your projects, specifically identifying **hardware-software** tradeoffs, interfaces, and/or interactions. *Complete if applicable; required if team includes CmpE majors.*	1. Communication Protocol vs. Data Transmission: Once a signal is processed, it must be sent to the mobile device through a wireless connection. Several protocols can accomplish this, such as Bluetooth, BLE, and Zigbee. Each protocol requires a different module to be connected to the MCU and a different communication API to be used by the mobile application. These protocols have different guarantees concerning data integrity, security, and bandwidth. 2. Android Version: A mobile application must be created for a certain version of Android. Developing for an earlier version of Android may increase the number of devices that are compatible with the application, while developing for a later version of Android may offer additional functionality and APIs. The Android version also dictates which software packages are available to use during development, which can help with efficient real-time data visualization.