ECE4011/ECE 4012 Project Summary

Project Title	Non-Contact Analysis of Health-Informatics via Observable Metrics
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Project Abstract (250-300 words)	The Non-Contact Analysis of Health-Informatics via Observable Metrics (NAHOM) Team built a device that improves health and minimizes response time in medical emergencies. The NAHOM device serves this purpose by alerting users of certain health emergencies and general health trends without physical contact with the measurement device. It addresses the need for a device that monitors heart and respiration rates in real time without physical contact with the user. Every year, approximately 735,000 people in the United States have a heart attack, and 1 in 4 deaths are related to heart disease [1]. In addition, while overlooked by many hospitals, respiration rate is an excellent predictor of a wide array of many medical issues [2], [3]. By making heart and respiration rates measurements easily and quickly accessible, the NAHOM device allows for more continuous monitoring of health. This team continued past development efforts for the NAHOM device. A signal generator and a transceiver, with transmit and receive antennas, were set up by previous teams to extract a signal. The transmit antenna sends a 5.8GHz signal, which is reflected off of the subject's body to the receiving antenna. The team was responsible for a STM32 microcontroller (MCU) that uses SPI to control an AD7770 analog to digital converter (ADC) to digitize the signal and send it to the microcontroller. The microcontroller transmits the waveform to a PC through UART and an RS232 to USB connection. The PC processes the waveform and calculates the subject's biometric data using the frequency components of the reflected signal. The biometric data is displayed to the user in a user-friendly interface on a computer application. The team used \$607.83 for the prototype that was developed, and the device would be sold for \$500 on the market
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List codes and standards that significantly affect your project. Briefly describe how they influenced your design.	 HIPPA: Health Insurance Portability and Accountability Act (HIPPA) governs how the system can store data. Only medical professionals using the data to assist the patient or the individual whose data is being measured are allowed to view health data related to that individual. ANSI/AAMI ES60601-1:2005: ANSI/AAMI ES60601-1:2005 has rules and mandates relating to medical instruments. This standard governs the Signal to Noise Ratio which must be low enough so as not to mislead users. Abiding by that standard was important because sensitive medical data is shown on these devices. IRB: Institutional Review Board for Protection in Human Subjects in Research (IRB) approval was needed because testing is done on human subjects. Since radiation is being sent towards the body, the main concern for human subject safety is the radiation power level. Dr. Zhang and her graduate students have already received IRB approval and training. A power level of 6 dBm was chosen. The Industrial, Scientific, and Medical radio-frequency (ISM) Band: This device uses a frequency of 5.8GHz which is within the ISM band. Radio frequencies in the ISM band can be used for any purpose without a licence from the Federal Communications Commission(FCC). C# ANSI ISO: Describes a standard method to program in C#.
	and the GUI were programmed.
List at least two significant realistic design constraints that applied to your project. Briefly describe how they affected your design.	 Analog to Digital Converter (ADC) speed - the device needed to convert the analog signal to digital samples in real time with high resolution. However, ADCs are limited to conversion of a specific number of samples per second which limits the ADC speed. ADC resolution - a higher ADC resolution was desired in order to be able to detect small variations in the amplitude of the waveform. Those small variations provided information about the heart and respiration rates. Microcontroller speed - The microcontroller should have real time processing and data transfer capability. Power consumption - Ideally, the device should consume lower power for energy efficiency, portability, and battery compatibility. Signal to Noise Ratio(SNR) for:

	 a. Doppler Radar sending and receiving signals b. Analog to Digital Conversion c. Data Transmission A high SNR can lead to inaccurate readings due to noise 6. Cost - limited budget 7. Device Size.
Briefly explain two significant trade-offs considered in your design, including options considered and the solution chosen.	 ADC Speed vs. ADC Resolution: The NAHOM Team used a Delta-Sigma ADC to convert the incoming analog signal from the doppler radar to a digital signal. In a Delta- Sigma ADC, an increase in speed leads to a decrease in resolution. This could have been offset by increasing our budget to buy a more expensive ADC. However, this wasn't necessarily feasible. The team settled on a mid-range ADC so that speed and resolution are acceptable. Processor processing speed vs. Processor cost: This device required, and now has, real time analysis. As such, it required sufficiently fast DSP abilities to handle the incoming data. We considered low and mid-range signal processors and decided to use a lower end signal processor. The chosen processor reduced cost and was sufficient to attain real time performance. MCU DSP vs. PC DSP: The major design alternative was to perform the signal processing on the MCU or a portion of the processing on the MCU. Signal processing on the chosen MCU was a viable option because the MCU included a floating point unit (FPU) that could implement a full set of DSP instructions. This might have been beneficial in real time processing because performing an FFT on the data set on the MCU could have resulted in a smaller amount of data that needs to be transferred to the PC. However, the MCU has a clock speed of 180 MHz which is about 10 times slower than a normal PC. Given that a relatively small amount of information was required to be sent to the PC, the slower processing speed on the MCU was a more significant factor than data transfer speed. For this reason, the signal processing was done on the PC side.

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.	The NAHOM project involved several computing aspects such as microcontroller programming, application development, digital data transfer and Graphical User Interface design. Data had to be transferred between the microcontroller and a PC and displayed on a GUI. The data transferred to the PC from the MCU could have been unprocessed waveforms or processed biometric data. Using the microcontroller's specialized hardware to perform digital signal processing would have meant less data was sent to the PC. This would have led to faster communication. However, the PC had faster and more superior digital signal processing capabilities. The team chose to process the waveform on the PC side because the capabilities of the PC outweighed the advantages of faster
	In the design process of the GUI, the team had to find a balance between a flexible and transparent but complex interface and a simple interface. A complicated interface may have narrowed the user base but a simple interface would have limited the device's flexibility. The NAHOM Team decided to use SPI communication instead of UART due to SPI's faster speed and parallel communication features.