EE/CprE/SE 491
wDAQ System (sddec24-19)
Design Document: Requirements

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2.1. REQUIREMENTS & CONSTRAINTS

The key requirements for our design include the following: compact size and mobility (constraint), wireless laptop communication, accuracy and reliability of results, and longevity. On the physical side, the device will need to be compact and convenient for mobile applications. The device will initially be used to explore small animals' anatomy and physical makeup & health, as part of a photoacoustic tomography (PAT) system in the ISU Biomedical Imaging Laboratory (BILab), and up to 20 copies of the device will be connected to transducers (devices that convert physical signals to electrical signals) in a circular configuration. Because of the number of devices that will need to fit within the PAT system, the size of the devices is constrained to an approximately 1" by 1" by 5" volume. Furthermore, since the devices will be rotating and moving continuously, they will also need to be wireless to prevent cord entanglement.

In the way of the user interface and experience, we will need the device to be Wi-Fi connected to enable wireless communication with the user interface and control software on a computer or mobile device, as well as be easy to use. The wireless connection requirement also

ties into the physical constraints of the device, because there will not be space on the PAT system for the traditional features of an oscilloscope. Most scopes contain a graphical display with buttons to view and analyze signals, but with our device's application, having a display on each individual scope would be redundant, and there is no way that the buttons and display would be able to fit in a 1" by 5" space. It makes much more sense to have a single software program where the user can view and adjust signals from all scopes (up to 20) at once, which can be best achieved by wirelessly connecting the scopes to the software program, so this is one of the key requirements. For ease of use, we want to make sure the device is easily accessible to all, which means creating a product that can be used by lab technicians and amateur users alike. We will want the user interface to be straightforward and easy to use, as well as ensure the device can easily be connected physically to the PAT system and wirelessly to the user software. This way, newer lab employees and non-technical users will all be able to utilize our product.

The main functional requirement of our device is to obtain accurate and reliable results. This requirement is somewhat vague and difficult to quantify, because there is always a possibility of error in results, even if the results are consistent between devices and trials. One way we can more easily gauge the accuracy and reliability of our device is by ensuring we are meeting the specifications in the project proposal. We have slightly modified the requirements, but we are looking to create an RF (MHz frequency range) signal with an amplitude of 1 V (peak-to-peak) and a rise time in the range of around 5 µs. Additionally, we are looking for an ADC with a 12-bit resolution and a sampling rate of at least 100 MS/s (million samples per second). For transmission to the user interface, we want to have a data rate of over 100 Mbps (megabits per second) to ensure fast transmission of results. By creating a device that meets all or most of these specifications, we will be much more likely to have a product that gathers and transmits data accurately and consistently.

The last major requirement for our device, longevity, ties into economical and environmental applications, as well as resource requirements. We will want the device to be durable and long-lasting, because it will be duplicated up to 20 times and used in a larger application for data acquisition. If the device we create breaks easily or becomes less reliable over time, we may need to recreate a higher quality product, which will cost us time, money, and resources, and delay the use of the PAT system until the DAQ systems can be fixed. Additionally, we would waste significant resources and have to discard old products, which would have an environmental cost associated with it. By creating a quality product from the start that is likely to last for several years, we can avoid complications in the long term.

2.2. ENGINEERING STANDARDS

- IEEE Microcontroller Programming Standard (IEEE 1118.1 1990): This will likely be used because a major portion of the project is programming the microcontroller to receive the digitized data and perform an action. So, it can be assumed that programmers will need to use this to standardize code and be as efficient with distributed data acquisition.
- IEEE 802.11: Our project will use an ESP32 chip that will send data via wifi to a computer. This device makes use of 802.11 for setting up local area networks and MACs.