High-Output Stoma Detection System

<u>Background</u>

An ileostomy is a surgical rerouting of the small intestine to the exterior of the body due to complications in the large intestine or colon. This results in the creation of a stoma, a protrusion of the small intestine on the abdomen where effluent is expelled. These people are called ostomates, and wear ostomy bags around the stoma to collect effluent. During the first 30-60 days following the operation, patients are at risk of high-output stoma, a condition defined by the output of around 1200-1500 mL or more of effluent per day. Without proper attention and care, patients can be rehospitalized due to dehydration and subsequent kidney failure, so it is crucial that patients track their fluid intake and output. Patients are instructed to do so as a part of post-op care when they are released from the hospital. Currently, ostomates are directed to manually measure the volume of effluent by removing the ostomy bag and pouring it into a graduated cylinder. Due to the burdensome nature of this task, patient compliance is low, leaving many patients unaware of whether they have high-output stoma and at a potential risk of dehydration. Hence our design: a device that can take automatic effluent volume measurements, log the data, and send it to a phone app inclusive of all of the instructed post-hospital journaling processes.

<u>Design</u>

Our design consists of a series of metallic conducting strips, placed horizontally on the inside of an ostomy bag at regular intervals (colored red in Fig. 1) and connected to a microcontroller. The conducting strip, also known as a conducting trace, at the bottom of the bag is a current source and each of the other traces are current sinks. An attached microcontroller constantly measures the resistance between the source trace and each of the sink traces using a voltage divider as shown in the right panel in Fig. 1.

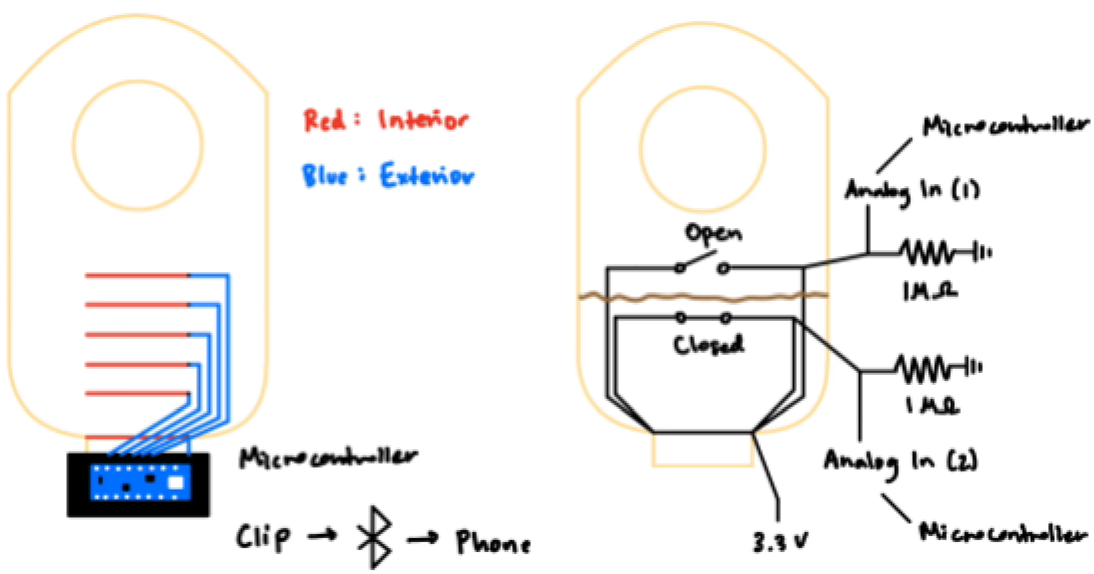

Figure 1: A diagram showing the functional basis of our design. On the left is a panel showing parallel conducting traces at even intervals up the side of the ostomy bag. On the right is a panel showing a basic circuit diagram of the voltage divider used to calculate resistance.

In an empty bag, the resistance between the source trace and each sink trace is nearly infinite, but when effluent, a conducting fluid, connects the source trace and a sink trace, the measured resistance decreases significantly. Therefore, by constantly polling the resistance between the source trace and each of the sinks, a microcontroller is able to determine the highest sink trace that effluent is contacting. In testing, we found that a 25 mL interval between source traces results in accurate data that is consistent between replications, meaning that at any point in time the microcontroller is able to report the effluent volume to the nearest 25 mL.

An important aspect of the design is how to measure a user's daily stoma output – it is typical for an ostomate to empty their bag multiple times a day, so functionality to detect this situation is fundamental. To empty the kind of ostomy bag employed in our design, the user must open a clip holding the bottom of the bag closed. Our design places an electrical contact on each side of the clip, resulting in a detectable signal when the effluent is released.

The firmware of the microcontroller polls the current volume of the bag at 2 Hz, and stores a minute's worth of volume data. When the clip is opened, it calculates the mode of the last minute of volume data and stores that in non-volatile memory as the volume of the bag before it was emptied, as shown in Fig. 2. It can store up to two months of this data in typical usage. The microcontroller also uses Bluetooth; a phone app can query the microcontroller for both current volume and all stored volumes, also shown in Fig. 2. This allows the user to view their current and historical effluent volumes, eliminating the need for the current measurement system.

On top of communicating with the microcontroller, our phone app also contains functionality for journaling symptoms, water intake, diet, and all other qualities that a new ostomate journals.

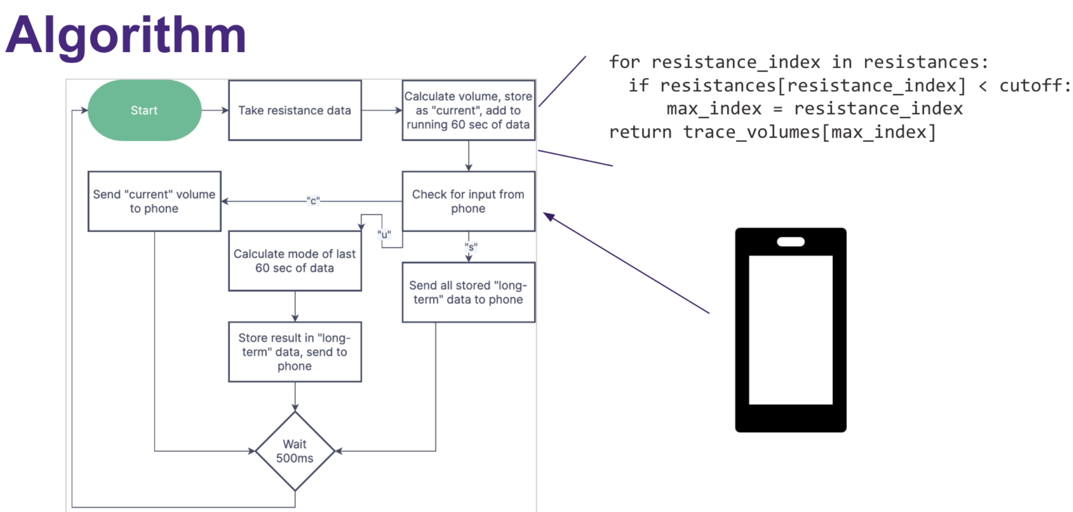

Figure 2: A diagram showing the algorithm run by the microcontroller, especially its capabilities to measure volume when the clip is released and transmit data wirelessly on demand.

<u>Significance</u>

There are currently no devices on the market that can automatically measure and track stoma output, forcing patients to measure output manually. Having an automatic measure of volume that is processed and sent to a mobile app where it is recorded for you, removes the burden of responsibility from the patient. With this device, low compliance with measuring output would no longer be an issue, drastically raising compliance. Higher compliance will decrease the amount of patients re-hospitalized due to dehydration, allowing patients to better adjust to and understand their body's changing needs. Ultimately, this device reduces the burden on patients during post-op care, and decreases the amount of serious health risks that result in rehospitalizations.