Breastmilk Pump Volume Detector

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LactoLevel

THE FOUNDRY

Motivation & Objective

Many women use **portable electric breast pumps** to provide breast milk for their children while at the workplace or on-the-go. Plastic **wearable collection cups,** held in by a maternity bra, have become popular as a means to make the pumping process more discreet and convenient.

However, women using these collection cups cannot easily see breast milk flowing into the apparatus, preventing them from:

- Identifying when a pump may be **misaligned** (and thus not extracting milk)
- Identifying when the containers are **overflowing**

Our project is to develop a **portable device** that attaches to collection cups and updates users with **live volume data** throughout a pumping session (Fig. 1).

Design Blocks

- **Capacitive sensing mechanism** (Fig. 3, Fig. 4)
  - 2 copper strips
  - Elegoo Arduino Nano V3.0
  - ESP32-WROOM Feather
- 3D-printed **attachment** system - hook, velcro, snap buttons (Fig. 1)
- **Website** + **notification** - JavaScript, Firebase RTDB (Fig. 2)
- **Battery** - TBD

Design Solution

Figure 1: Final prototype design

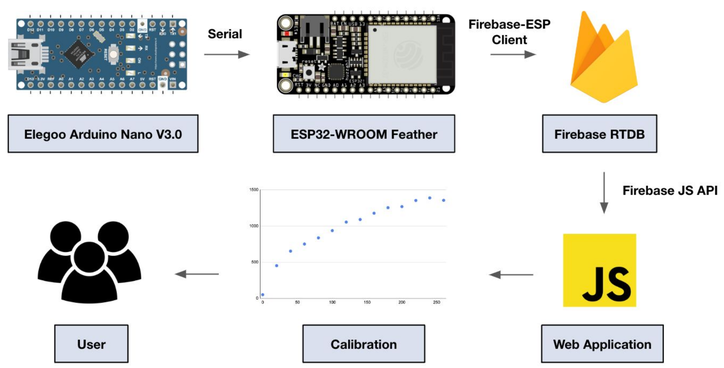

Figure 4: High-level project breakdown

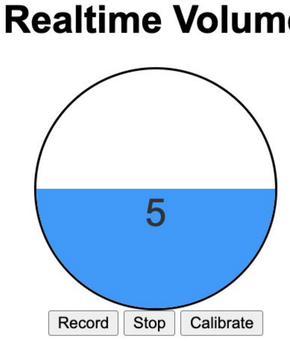

Figure 2: Live notification website implementation

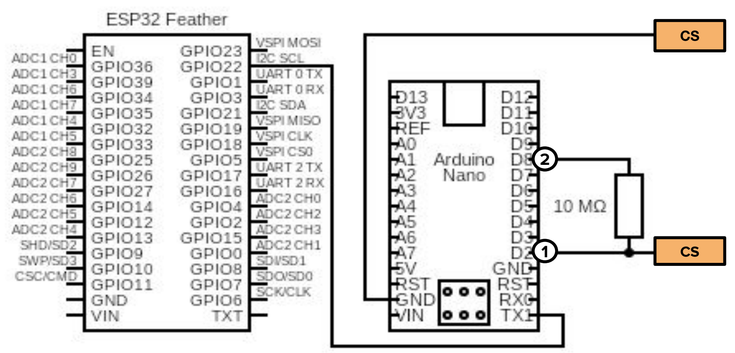

Figure 3: Circuit diagram for capacitive sensor

- Measures delay from sensor pin (1) to receiver pin (2), measured by R (Resistance) x C (Capacitance)
- Copper strip (labeled CS) connected to ground gives capacitance between strips
- Implemented with Arduino CapacitiveSensor library

User Defined Scales

User Defined Scale for Ease of Use Test

Ranking	Ease of Use Scale
5	**Extremely easy** to attach, detach, and set up
4	**Easy** to attach, detach, and set up
3	**Attachable**, detachable, and able to set up
2	**Difficult** to attach, detach, and set up
1	**Extremely difficult** to attach, detach, and set up

(refer to **Figure 1** for final version of method of attachment)

User Defined Scale for Form Factor Test

Ranking	Form Factor Scale
5	**Very comfortable** and **well designed**. Perfectly sized, shaped, and weighted.
4	**Comfortable** and reasonably **well designed**. Minor improvements required.
3	**Neutral** comfort and **adequate design**. One of size, shape, or weight is poorly optimized.
2	**Uncomfortable** and **flawed design**. Two of size, shape, or weight are poorly optimized.
1	**Extremely uncomfortable** and **very poorly designed**. All of size, shape, and weight are poorly optimized.

Testing

Objective	Testing Method	Target Values	Testing Results
Battery Life	Measure battery usage in 30 minutes and extrapolate	> 210 minutes	TBD
Form Factor	UDS described above	≥ 4 average rating	TBD
Ease of Use	UDS described above	≥ 4 average rating	4.14 > 4
Precision	Distance between measured volume and actual volume	± 0.25 oz of actual volume	TBD

Future Plans

- Test on human subjects to evaluate device's ability to detect on different people
- Consolidate design to improve form factor
- Improve battery to prioritize safety
- Refine algorithm that relates data value to ounces (project architecture outlined in Fig. 3)
- Consider different materials for attachment and volume detection

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