Development of a Device to Measure Pressure Waves Along the Infant Tongue During Bottle Feeding, G6

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Problem Statement

8% of newborns have a tongue-tie, and about half struggle to breastfeed—yet no clear diagnostic exists to determine if treatment will help.

We hypothesize that quantifying intraoral pressure, pressure wave dynamics, and tongue movement coordination during infant sucking may serve as predictors of frenectomy outcome.

Methods

- Saline-filled pacifier modeled
- Voltage changes across saline at 3 locations recorded via 3 Arduino analog input pins
- Device connected to voltage divider circuit
- Data collected over 5-minute feeding simulations and graphed in MATLAB to visualize sinusoidal pressure patterns across sensor points

Programming Details

Arduino

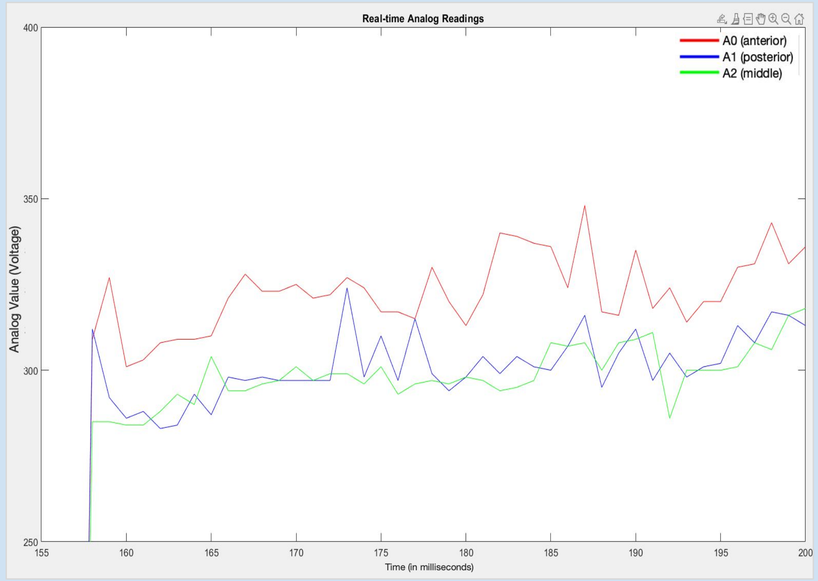
```
%% Main loop to read and plot serial data
while true
    try
        line = readline(s);
        % Find the positions of A0 and A1 in the line
        idxA0 = strfind(line, 'A0: ');
        idxA1 = strfind(line, ' | A1: ');
        idxA2 = strfind(line, ' | A2: ');
        line = char(line);
        if ~isempty(idxA0) && ~isempty(idxA1)
            % Extract numbers from the string
            valA0 = str2double(line(idxA0 + 4 : idxA1 - 1));
            valA1 = str2double(line(idxA1 + 7 : idxA2 - 1));
            valA2 = str2double(line(idxA2 + 7 : end));
            % Shift data and append new values
            A0_data = [A0_data(2:end), valA0];
            A1_data = [A1_data(2:end), valA1];
            A2_data = [A2_data(2:end), valA2];
            % Update plot
            set(h1, 'YData', A0_data);
            set(h2, 'YData', A1_data);
            set(h3, 'YData', A2_data);
            drawnow;
        end
    catch ME
        % Print error message and stop the loop
        disp("Error occurred:");
        disp(ME.message);
        break;
    end
end
```

MATLAB

```
%% Initialize data buffers
bufferSize = 200;
A0_data = zeros(1, bufferSize);
A1_data = zeros(1, bufferSize);
A2_data = zeros(1, bufferSize);
% Set up the plot
figure;
h1 = plot(A0_smoothed, 'r'); hold on;
h2 = plot(A1_smoothed, 'b'); hold on;
h3 = plot(A2_smoothed, 'green');
ylim([200 400]); %0 1023
legend('A0', 'A1', 'A2');
xlabel('Time (in milliseconds)');
ylabel('Analog Value');
title('Real-time Analog Readings');
```

Prototype & Test Results

- Initial bench testing confirmed that voltage readings increased consistently when the electrodes were compressed
- Sensor points captured waveforms corresponding to movement along tongue
- Third sensor added to determine wave direction
- Data recorded demonstrates the device's potential to differentiate organized vs. disorganized tongue pressure patterns



Voltage Divider Calculation

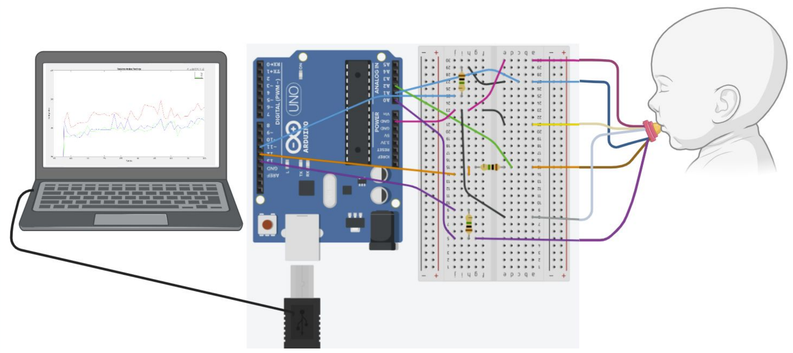
$$V_{out} = V_{in}\,(R_2 \div (R_1 + R_2 + R_3))$$

- Using 330 kΩ resistors
- $V_{in} = 5V$

$$V_{out} = 5V((330k\Omega) \div (330k\Omega + 330k\Omega + 330k\Omega))$$

$V_{out} = 1.67$ V $\therefore$ There will be 1.67V across each resistor.

Final Design



Bioethical Implications

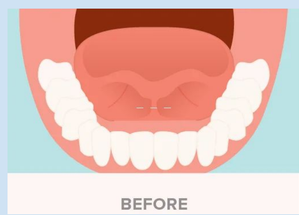
- Potential for reducing unnecessary frenectomies
- Anonymization of data to protect patient privacy
- Improve health benefits for mother and child

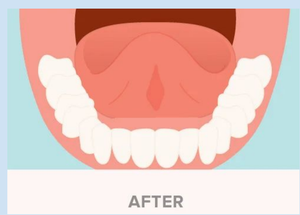
Future Work

- Raise sensor resolution for better pressure mapping
- Automate data analysis for real-time clinical use
- Refine prototype model for testing

Conclusion

- Device captures intraoral pressures using a saline-filled pacifier and Arduino sensing system
- Preliminary results show potential to identify organized vs. disorganized feeding behaviors
- Improve ability to predict success of frenectomy





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