



# **Electropalatography with Programmable Integrated Circuits for Speech Rehabilitation**

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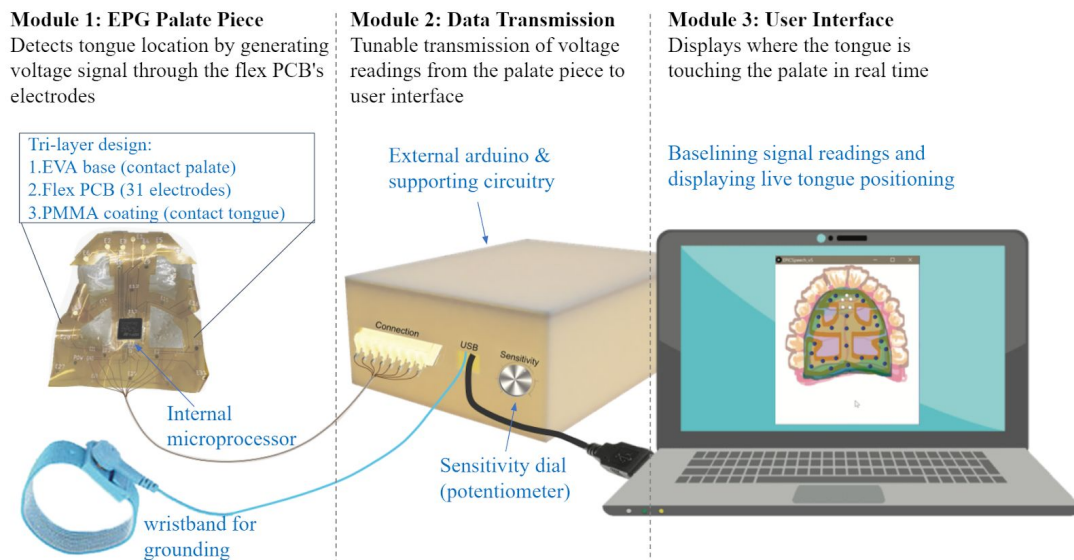
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For the 17,000 Canadians diagnosed with tongue cancer in the past year, a tongue resection surgery is the likely course of treatment [1]. During this procedure, cancerous regions of the tongue are surgically removed, resulting in impairment of speech and swallowing functions [2]. To facilitate rehabilitation, a speech pathologist uses an electropalatography (EPG) device. EPG devices enable precise localization of tongue contact with the roof of the mouth, in real-time. As a patient speaks, the speech pathologist can use an EPG device to detect abnormalities in tongue motion and prescribe specific exercises to help restore tongue functionality. The current benchmark in EPG technology is designed by the company Rose Medical [3]. This device consists of a custom-made palate piece, with 62 electrodes that must be individually wired and attached. It takes over 20 hours to manufacture a single Rose Medical EPG device, significantly increasing production costs and leading to a shortage of devices. Additionally, the current device has 62 wires coming out of the user's mouth, causing discomfort to patients who already have sensitive oral tissue. To address these limitations, we created EPICSpeech - an improved EPG device that is easy to manufacture and can help expedite tongue cancer patients' recovery.

As shown in the figure below, EPICSpeech incorporates three core modules: a palate piece, data transmission and a user interface. EPICSpeech includes a flexible printed circuit board (PCB) that can be mass produced. Based on prototypes, EPICSpeech is projected to reduce the device's unit production time by 60% at a fraction of the cost. Interfacing between an internal and external microcontroller enables reduction of the number of wires exiting a patient's mouth from 62 to 8. A user-friendly graphical interface has been developed using the open-source platform Processing to help increase the accessibility of EPICSpeech for patients.



Assessment of the extent to which EPICSpeech fulfills functional requirements was completed through rigorous testing. Testing completed includes (1) tongue detection accuracy and response time, (2) biocompatibility and electrical safety, (3) Impact testing to ensure durability, (4) Saliva immersion to guarantee device functionality. A detailed risk analysis was completed to ensure that all possible adverse events are mitigated, fast tracking EPICSpeech for clinical approval.

The EPICSpeech device improves restoration of tongue function by reducing patient discomfort and streamlining production. By decreasing the number of wires exiting the mouth, we can remove physical obstructions to natural tongue movement, provide a comfortable experience, and reinforce rehabilitation compliance. The use of flexible PCBs reduces production time and cost, enabling larger clinical studies and potentially expediting Health Canada regulatory approval for therapeutic use in the future. Clinical implementation of EPICSpeech would allow thousands of tongue cancer patients to have wider access to rehabilitation that can truly restore their normal lifestyle.

## References

1. "Cancer of the Tongue - Cancer Stat Facts", *SEER*, 2019. [Online]. Available: <https://seer.cancer.gov/statfacts/html/tongue.html>.
2. Bodin IKH, Lind MG, Arnander C. FREE RADIAL FOREARM FLAP RECONSTRUCTION IN SURGERY OF THE ORAL CAVITY AND PHARYNX: SURGICAL COMPLICATIONS, IMPAIRMENT OF SPEECH AND SWALLOWING [Internet]. Vol. 19, *Clinical Otolaryngology*. 1994. p. 28–34. Available from: <http://dx.doi.org/10.1111/j.1365-2273.1994.tb01143.x>
3. Electropalatography | Rose Medical Solutions Ltd [Internet]. [cited 2019 Oct 10]. Available from: <http://www.rose-medical.com/electropalatography.html>

## Supplementary Videos

**Video S1:** Demonstration of the first iteration of EPICSpeech prototype

[https://drive.google.com/file/d/1Gts3dZ\\_azgBqHvAsWyAohgwVpMDJdMOo/view](https://drive.google.com/file/d/1Gts3dZ_azgBqHvAsWyAohgwVpMDJdMOo/view)

**Video S2:** Demonstration of the final iteration of EPICSpeech prototype

[https://drive.google.com/file/d/1Y\\_sZyA9tZW44vnIybQbvTXUW35wY-Bpi/view](https://drive.google.com/file/d/1Y_sZyA9tZW44vnIybQbvTXUW35wY-Bpi/view)