



T.C.SAĞLIK BAKANLIĞI
SBÜ GAZİLER FİZİK TEDAVİ
VE REHABİLİTASYON EAH

Neuro Voice Speller

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Abstract

The NeuroVoice Speller is a non-invasive Brain-Computer Interface (BCI) system that enables individuals with severe motor disabilities (such as ALS or locked-in syndrome) to communicate through gaze alone. Using code-modulated Visual Evoked Potentials (c-VEP) recorded via a 32-channel EEG cap, the system decodes the user's intended target in real time and converts it to synthesized speech, requiring no physical movement.

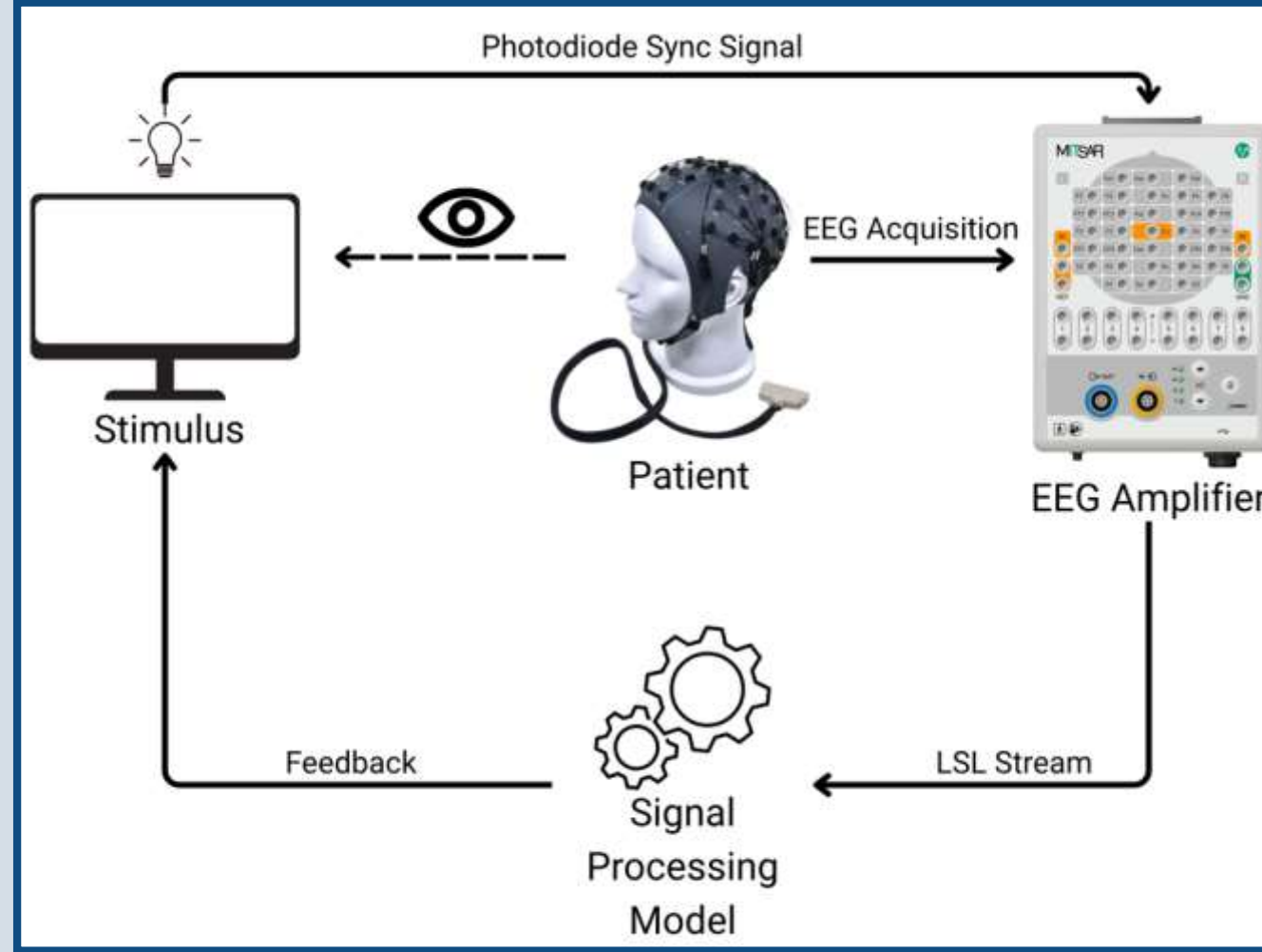


Figure 1 - System
Diagram

Project Info

The system is developed by a senior engineering team at Çankaya University, Department of Software Engineering. The project combines expertise in EEG signal processing, BCI algorithm design, embedded hardware, and real-time software architecture. It is conducted under academic supervision as part of the SENG 491–492 Graduation Project program. The NeuroVoice Speller is entirely non-invasive, locally processed, and designed as a practical communication aid for clinical deployment in Turkey, contributing to the growing field of assistive neurotechnology.



Figure 3 - Screenshot

Introduction

Patients with ALS or locked-in syndrome lose the ability to speak or move, yet retain intact visual function. Existing BCI communication aids are either invasive, slow, or require continuous caretaker involvement. This project presents a fully non-invasive, real-time speller that operates in two modes: a standalone 6-word asynchronous mode for independent patient use, and a 32-character synchronous keyboard for caretaker-assisted free-text spelling. The system is built on the EEG2Code methodology and validated with a custom hardware-based synchronization circuit.

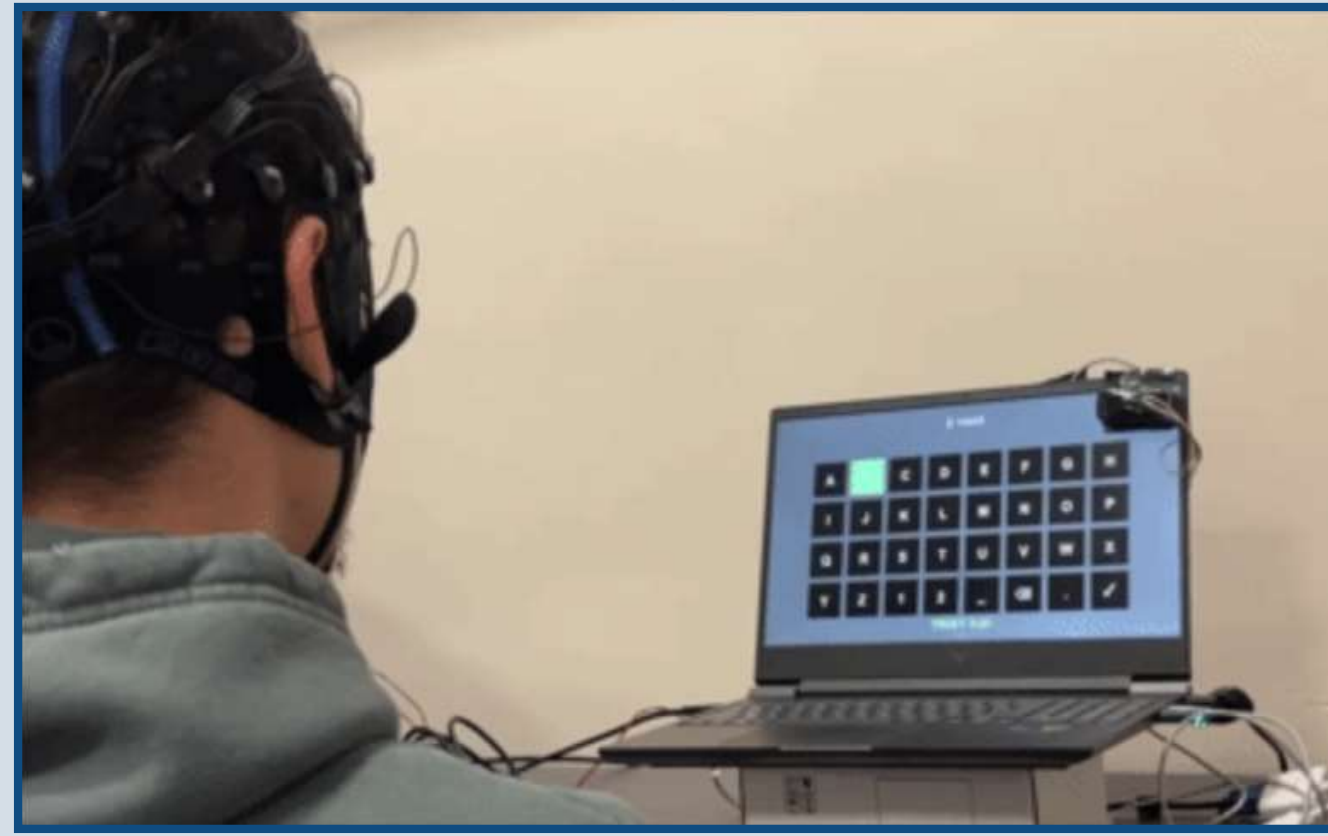


Figure 2 - Finished
Product

Operating System	EEG Software	Signal Streaming	Stimulus Presentation	Development	Hardware
Windows 11	WinEEG	LSL (Lab Streaming Layer)	PsychoPy	Python 3.10	Arduino

Figure 4 - Technologies Used

Results & Conclusion

Key Achievements:

- **Mode A (sync, 32 targets):**
- 97.8% training accuracy (overfit check)
- 95.8% LOO-CV accuracy (on 96 calibration trials)
- 30–31 / 32 correct in live trials ($\approx$ 94–97% online accuracy)
- ITR $\approx$ 49–52 bit/min

Mode B (async, 6 words):

- <0.1 false-positives/min in NC state
- Threshold refined via 120 s NC recording
- Two-process asynchronous architecture working reliably over LSL

Lessons Learned:

- LSL clock drift requires hardware-level synchronization for reliable c-VEP
- Per-participant calibration and NC threshold refinement are critical

Future Work:

- Wireless EEG support (Emotiv, OpenBCI)
- Expanded async vocabulary with user-configurable phrases
- Clinical trials with ALS patients

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