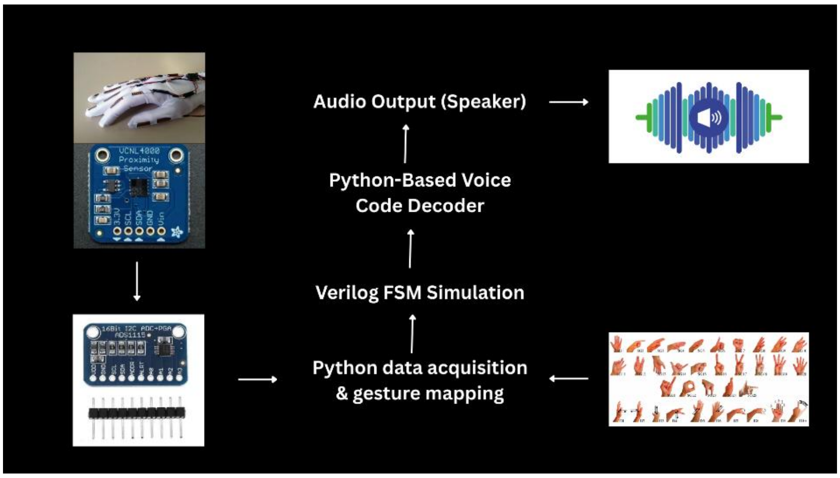
HACKELITE 25’

ABSTRACT

TEAM NAME: PROTOTYPERS	PS ID: STUDENT INNOVATION

PROJECT TITLE: GestureSpeak - Real-Time Gesture to Voice Conversion Using VLSI

Speech is the most natural and effective medium of human communication. However, for millions of individuals with speech impairments, expressing themselves becomes a major challenge, leading to social isolation, barriers in education, limited healthcare access, and reduced employment opportunities. While several assistive technologies exist today, such as mobile-based text-to-speech applications, camera-driven gesture recognition systems, or Arduino/Raspberry Pi-based glove devices, they often suffer from key limitations. These solutions are typically bulky, software-dependent, high in latency, and lack adaptability or scalability, making them impractical for continuous real-time use. To overcome these challenges, we propose “GestureSpeak” – a low-power VLSI architecture for real-time gesture-to-voice conversion. The solution integrates flex and proximity sensors into a lightweight wearable glove that captures hand gestures. The signals are digitized using a USB-based ADC (ADS1115) and then processed through a Finite State Machine (FSM) designed in Verilog HDL. Each gesture is mapped to a unique code, which is subsequently translated into synthesized speech via a lightweight Python interface. Unlike conventional systems that rely on multiple layers of microcontrollers or cloud computation, this design directly integrates sensor data with VLSI-based logic, ensuring low latency, compactness, and energy efficiency.



The novelty of GestureSpeak lies in shifting the computational burden from software-heavy platforms to a hardware-first VLSI approach. By leveraging parallelism and optimized FSM architecture, the system achieves real-time responsiveness, reduced power consumption, and scalability for future FPGA or ASIC implementations. Furthermore, unlike rigid existing solutions with fixed outputs, GestureSpeak supports a customizable gesture-to-speech library, making it adaptable to multiple languages, personal vocabularies, and region-specific needs. This makes the system not only technically efficient but also socially inclusive. The primary use case is to empower speech- and hearing-impaired individuals by providing them with a portable, affordable, and real-time voice communication tool. It can be used in classrooms to enable inclusive education, in healthcare settings to facilitate smoother patient-doctor interaction, and in workplaces to help differently-abled employees integrate better into professional environments. Beyond this, the system has potential applications in human-computer interaction and hands-free communication in smart environments. The methodology includes sensor signal acquisition, Verilog-based FSM design, digital filtering, and simulation using Xilinx Vivado, followed by Python-driven speech synthesis for testing output. The final outcome of this project will be a validated design and simulation model. Upon successful validation, the system can be extended for FPGA prototyping and ASIC fabrication, paving the way toward a commercially deployable chip that can transform the lives of millions by enabling seamless, real-time, and dignified communication.