Team 20 Modular Assistive Device for the Visually Impaired (MADVI)

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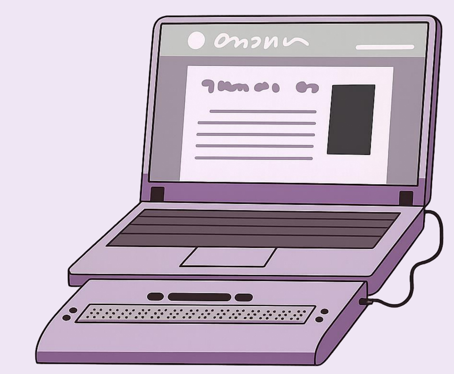
BOTSTIBER WINNER

Background:

Visual impairment affects more than 2.2 billion people worldwide, with many experiencing limitations that reduce independence, productivity, and quality of life.

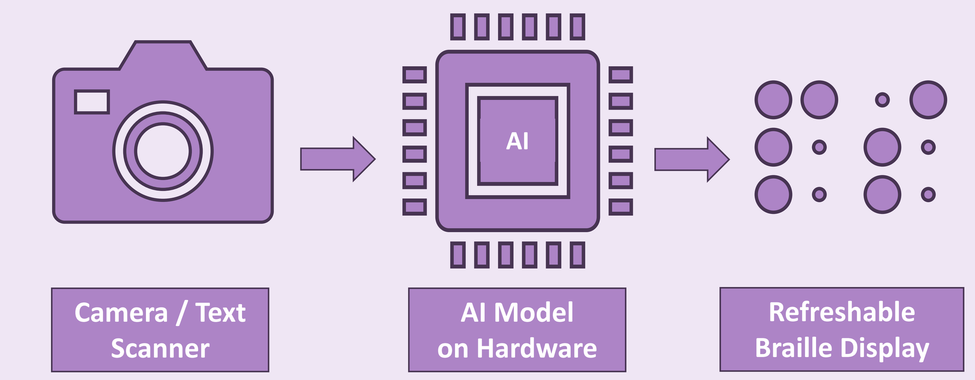
Problem:

Existing solutions face challenges, such as high retail cost, lack of physical-text recognition, limited real-time translation speed, inaccurate translation, concerns about user privacy, and a lack of portability for use in different environments.

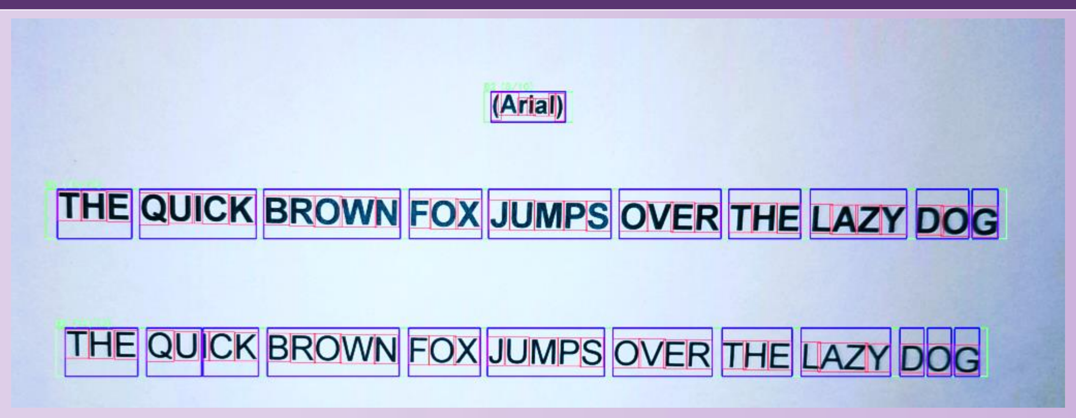


Objective:

Address gaps in the market by developing a device capable of capturing printed text using a high-resolution camera, performing real-time optical character recognition through onboard artificial intelligence on an FPGA, and presenting the output through a fabricated refreshable braille display.



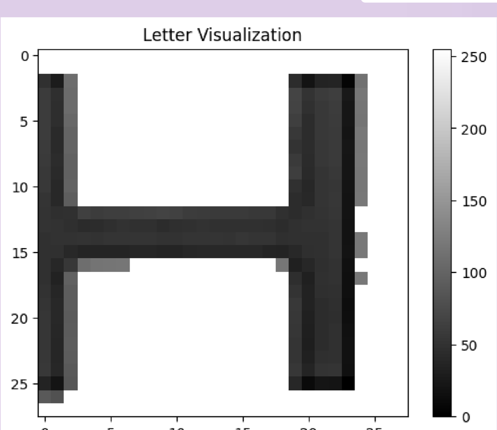
Camera Cropping Pipeline



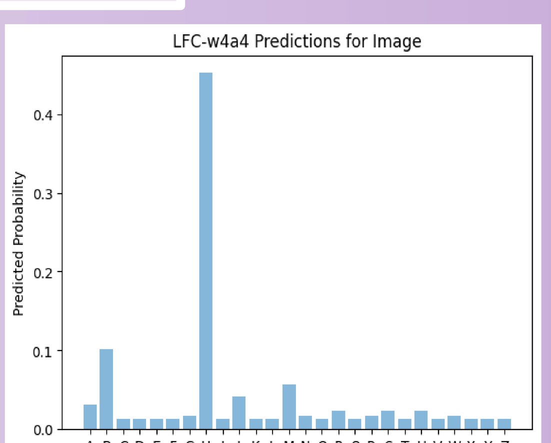
Letter Cropping AI on Pynq Z2 SoC Latency	
EAST AI	Redesigned Lightweight
1-2 Min	2-3 Sec

AI Classification Pipeline

Software Simulation (Brevitas)

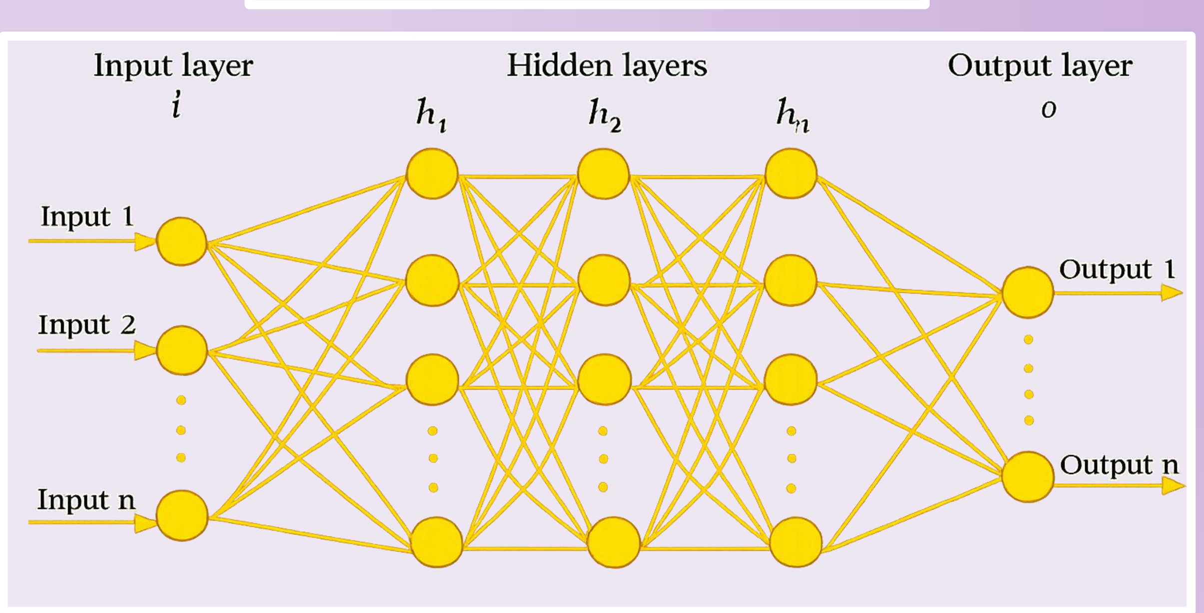


Input to the Neural Nets

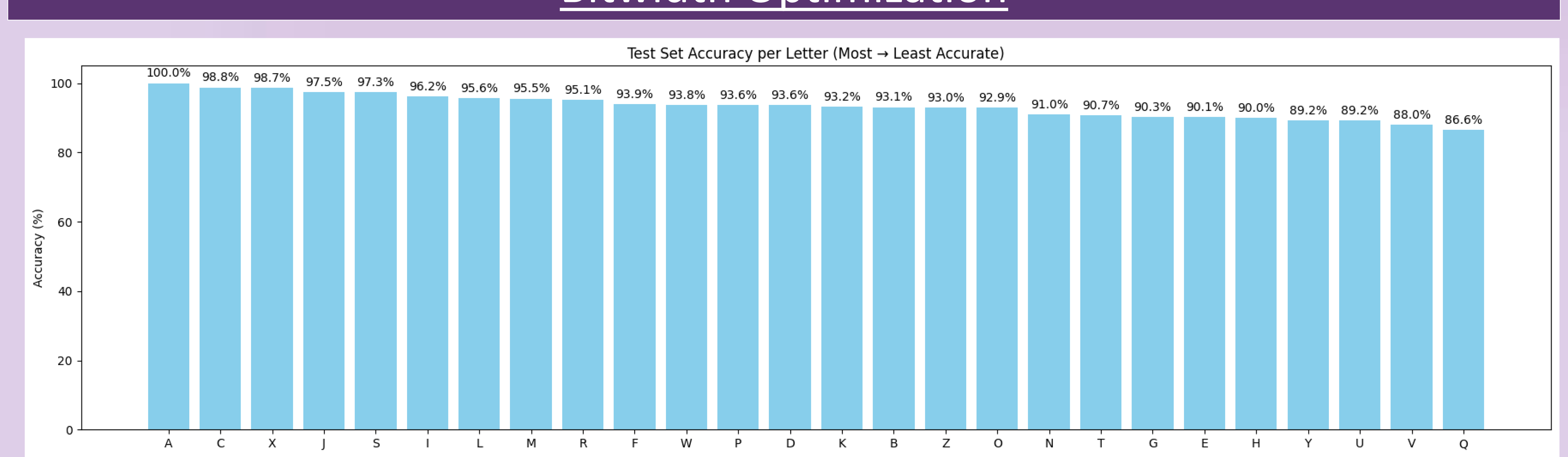


Output from the Neural Nets

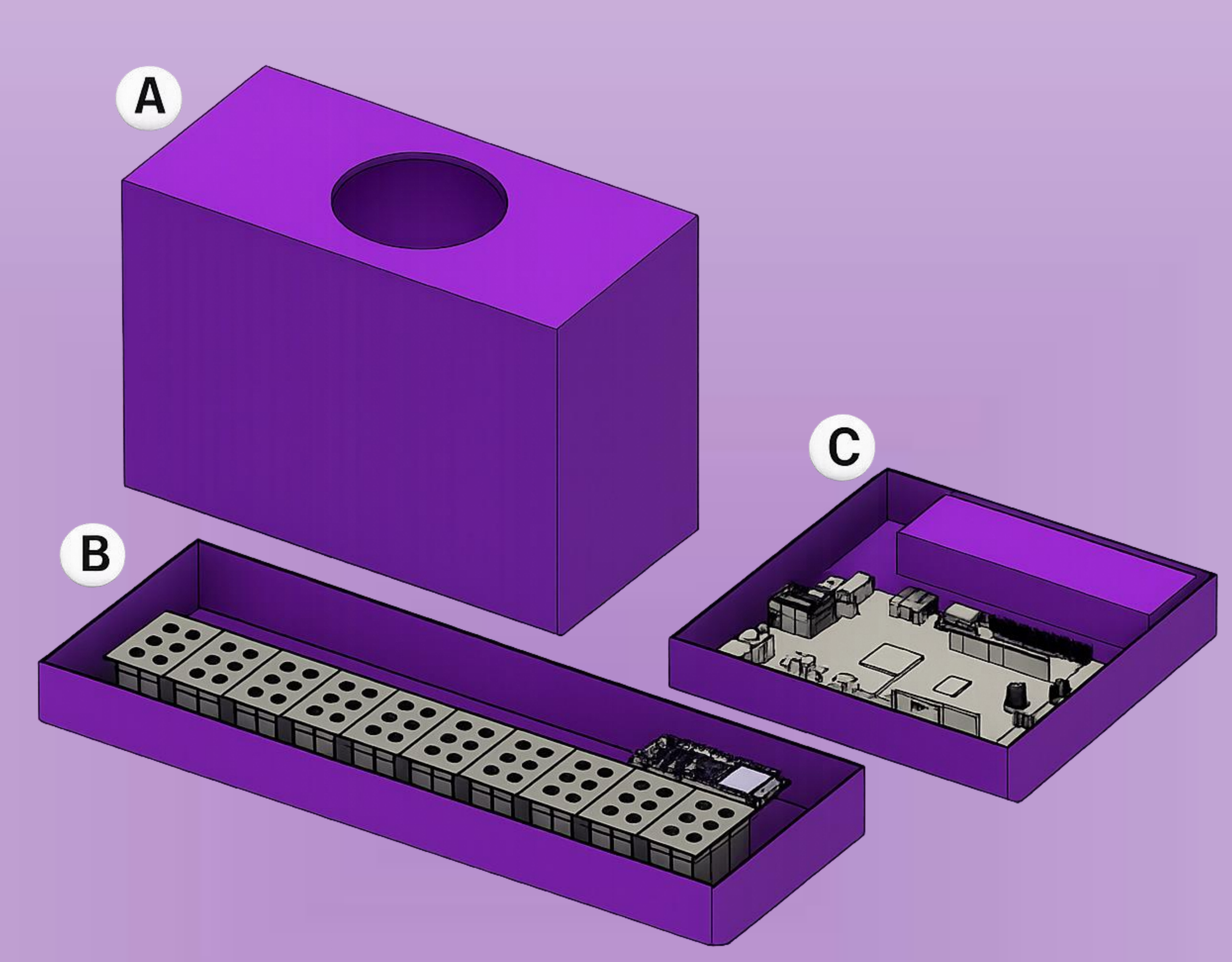
Quantization ONNX → FINN → HLS



Bitwidth Optimization



3D Model



3D Model Description

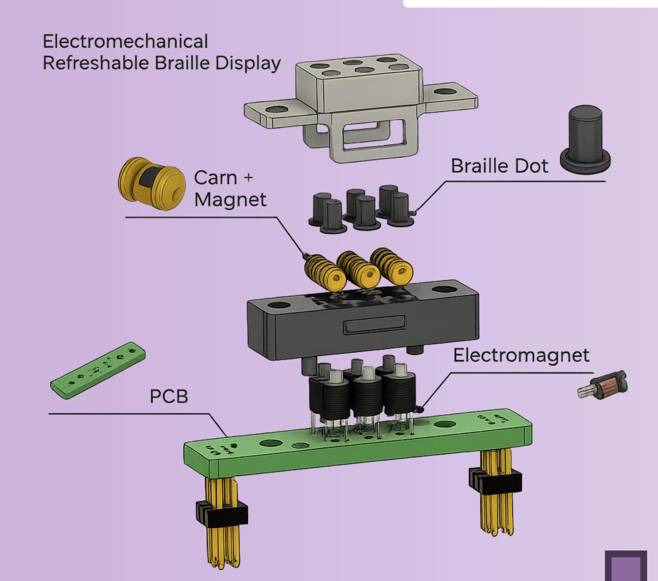
A: Camera enclosure for optical text capture.

B: Module support platform that houses the braille cell array, responsible for tactile output generation.

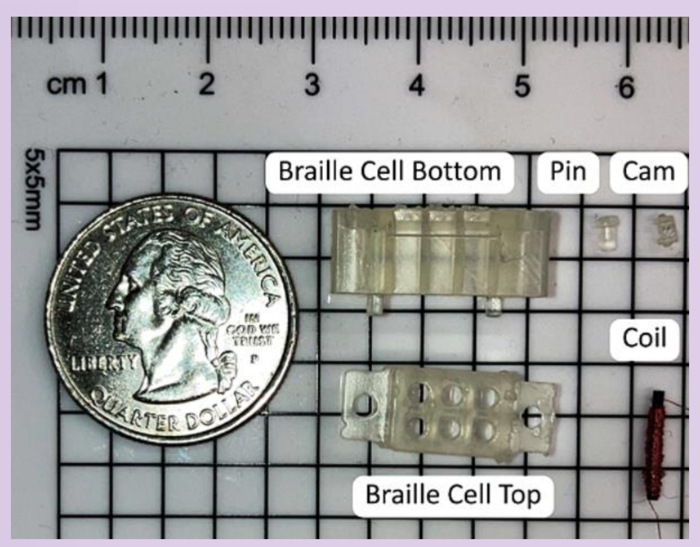
C: Control and processing unit that houses the FPGA and battery, which powers and manages the entire device.

Braille Display Design Iterations

First Iteration – Unsuccessful

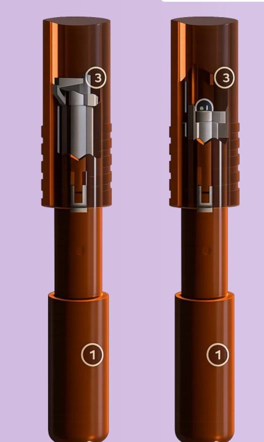


Hackaday.io Project Reference

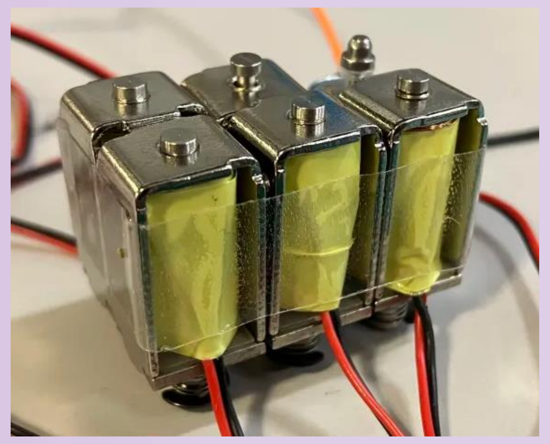


Braille Cell Components Sizing Respective to Quarter

Second Iteration – Current Efforts

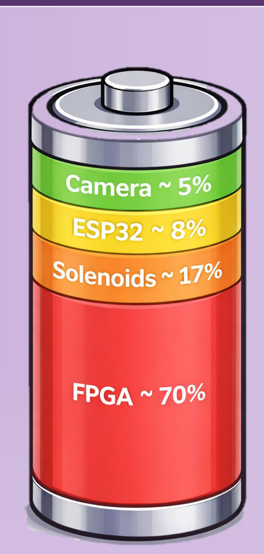


Extended Retracted



6-pin Solenoid Array

Power



Using a 3S LiPo, 11.1V and 2200 mAh:

- Estimated Watt Hours with 25% Margin = **15 Wh**
- Estimated System Power Usage = **11.36 W**
- Estimated System Run Time = **2.1 Hours**

Power usage is minimized through:

- PWM Control of Actuators is possible via Pen Mechanism
- Control of On/Off States for Key Components

Solenoid Motherboard