TEAM PIXEL-PAC

REAL TIME MONOCULAR DEPTH ESTIMATION ON EDGE AI DEVICE

VIVEK CHOUDHRY:

- Trained various hybrid models based on references from **Adabins** and **DepthAnythingV2**
- Depth Estimation Model : **CNN based model** with **MULTI HEAD ATTENTION** trained with **KNOWLEDGE DISTILATION**
- CI/CD Deployment : **GITHUB AND DOCKER**

SHWETANK SHEKHAR:

- Successfully **built, configured, and deployed** a **custom 6.15.0-rc7 PREEMPT_RT kernel** specifically for the Raspberry Pi 5 platform.
- Configured advanced kernel parameters for **real-time performance**, including **NO_HZ_FULL, a 1000 Hz timer, the performance CPU governor**, and **PPS/NTP support** features.
- Architected a **complete inference pipeline** that **integrates pi camera input, GPIO-based visual and audio alerts,** and **live visual feedback** on an HDMI display **in Console Log Environment**.

RATISH R.A:

- Curated and **preprocessed a 50GB KITTI subset** with **ground truth depth for scalable training**.
- Built a **multi-process, memory-efficient pipeline** for r**eal-time knowledge distillation**.
- Developed a PyTorch–TensorFlow bridge for seamless **cross-framework training.**
- Exported the model for fast inference and visualization on new data.
- Designed and integrated a lightweight MobileNet-based encoder-decoder with a 64-bin AdaBins module for accurate and efficient monocular depth estimation.

AMRIT S S:

- **3D CAD Design** for **Hardware Mounting**. Ran fitment **simulations** to **validate heat clearance.**
- Performed **Air circulation trajectories** for best cooling.
- Compared **multiple RTOS options**, helped **finalize and validate the PREEMPT_RT Kernel.**

SOFTWARE

- Model deployed using **Tensorflow-Lite**
- Developed lightweight version of Adabins with an inference time on raspi 5 of **650ms,**
- **CNN based** architecture with **Multi head self attention** in deep layers for inter-channel information relay
- **Linear Regression** to map the raw **depth map** to **aligned depth map**
- The inference time on raspberry pi for ***tflite*** model was **115ms/10.45FPS**
- Model trained for **300 epochs** using knowledge distillation for **~12000 images**,
- Using **silog loss** and **Learning rate scheduler** results in the least score
- Pipeline for ***CI/CD deployment*** and **unit testing** with Github and Dockers

HARDWARE

Model: Raspberry Pi 5 Model B Rev 1.1

- **System on Chip (SoC): Broadcom BCM2712**
- **CPU: 2.4GHz quad-core 64-bit Arm Cortex-A76**
- **RAM: 8GB LPDDR4X-4267 SDRAM**
- **Storage: 64GB SanDisk microSD card**
- **Cooling: Active Cooler**
- **Camera: Raspberry Pi Camera Module 3**
- **Primary Display: HDMI Display**
- **Active Warning System: GPIO based Visual(LED) & Auditory(buzzer) warning system**

Operating System & Kernel Details

- **Operating System: Raspberry Pi OS (64-bit), based on Debian Bookworm.**
- **Kernel Version String: 6.15.0-rc7-v8-16k-NTP+**
- **Kernel Type: Custom compiled with PREEMPT_RT (Full Real-Time Preemption).**
- **Architecture: aarch64 (64-bit).**
- **Build Method: Natively compiled on the Raspberry Pi 5.**
- **Key Kernel Configurations :**
  - **Full Real-Time Preemption (CONFIG_PREEMPT_RT=y)**
  - **Timer Frequency set to 1000 Hz (CONFIG_HZ_1000=y)**
  - **Full Dynamic Ticks (CONFIG_NO_HZ_FULL=y)**
  - **Default CPU Frequency Governor set to "performance"**
  - **Kernel PPS (Pulse Per Second) timing support (CONFIG_NTP_PPS=y)**
  - **PPS client support for GPIO (CONFIG_PPS_CLIENT_GPIO=y)**