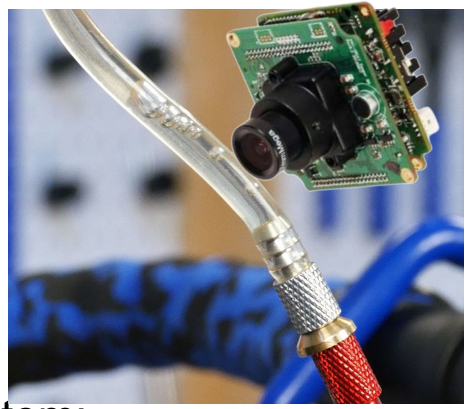
Project Proposal

TTL AI - Thomas Keyes, Tiger Zhang, Landon Campbell

Idea and Explanation



Camera-based Edge-AI:

Raspberry Pi 5 with Hailo-8L NPU to build an edge-AI vision system:

-Detects and tracks air bubbles in hydraulic-fluid lines (mountain bike brakes)

-On-device processing for real-time performance, privacy, and zero cloud dependency

-INT8 deployment (quantization), with model compression to achieve low latency and power efficiency

-MCU-only would provide insufficient processing power

Technicals, Application, Platform

Technical Objectives:

- **Sizing accuracy**: ±0.05 mm error for bubbles ≥ 0.30 mm
- **Detection F1**: ≥ 0.97 at 60–120 fps
- **Latency**: ≤ 50 ms capture→decision; ≥ 30 fps overlay
- **Void fraction**: MAE ≤ 0.02 (1-s window)
- **Robustness**: F1 ≥ 0.90 under vibration/lighting variation

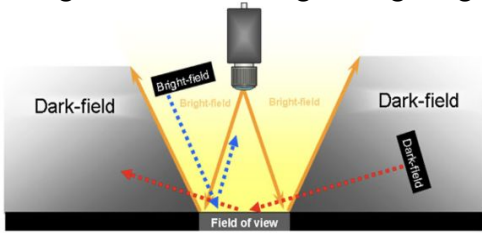
Software Pipeline (Classical CV baseline):

1. **Background subtraction → blur → threshold → morphology**
2. **Connected components → area, circularity, centroid → diameter (px→mm)**
3. **Centroid tracking → velocity (mm/s)**
4. **Per-second metrics: count (Hz), diameter, velocity, void fraction, state**

ML Enhancement (optional): INT8 UNet-lite (256×256) on Hailo-8L for robust segmentation

Output: JSON telemetry + video overlay

Dark-field side lighting: LED ring/arc at 30-60° grazing angl



Team Roles, Road Map (Simplified)

Name	Role	Responsibility
Landon Campbell	Team lead	Planning, repo/docs, integration, risk & compliance, performance profiling
Thomas Keyes	Hardware	Camera/lens selection, lighting & polarization, clamp/shroud design, calibration
Tiger Zhang	Software	CV pipeline, optional UNet-lite training & INT8 deploy, test plans, benchmarking
Week	**Milestone**	**Deliverable**
2	Proposal	Slides + GitHub Presentation (/docs + issues)
3	Initial Rig Assembly (Hardware Integration)	CAD Clamp + side-LEDs + camera connection; labeled clips
Nov. 20	Midterm Presentation	Slides + classic CV baseline metrics
5	INT8 model on Hailo	Segmentation mask → metrics; latency/power numbers
6	Full Integration and Testing	Vibration/light tests; calibration drift report
Dec. 18	Final Presentation	Report, demo, GitHub archive