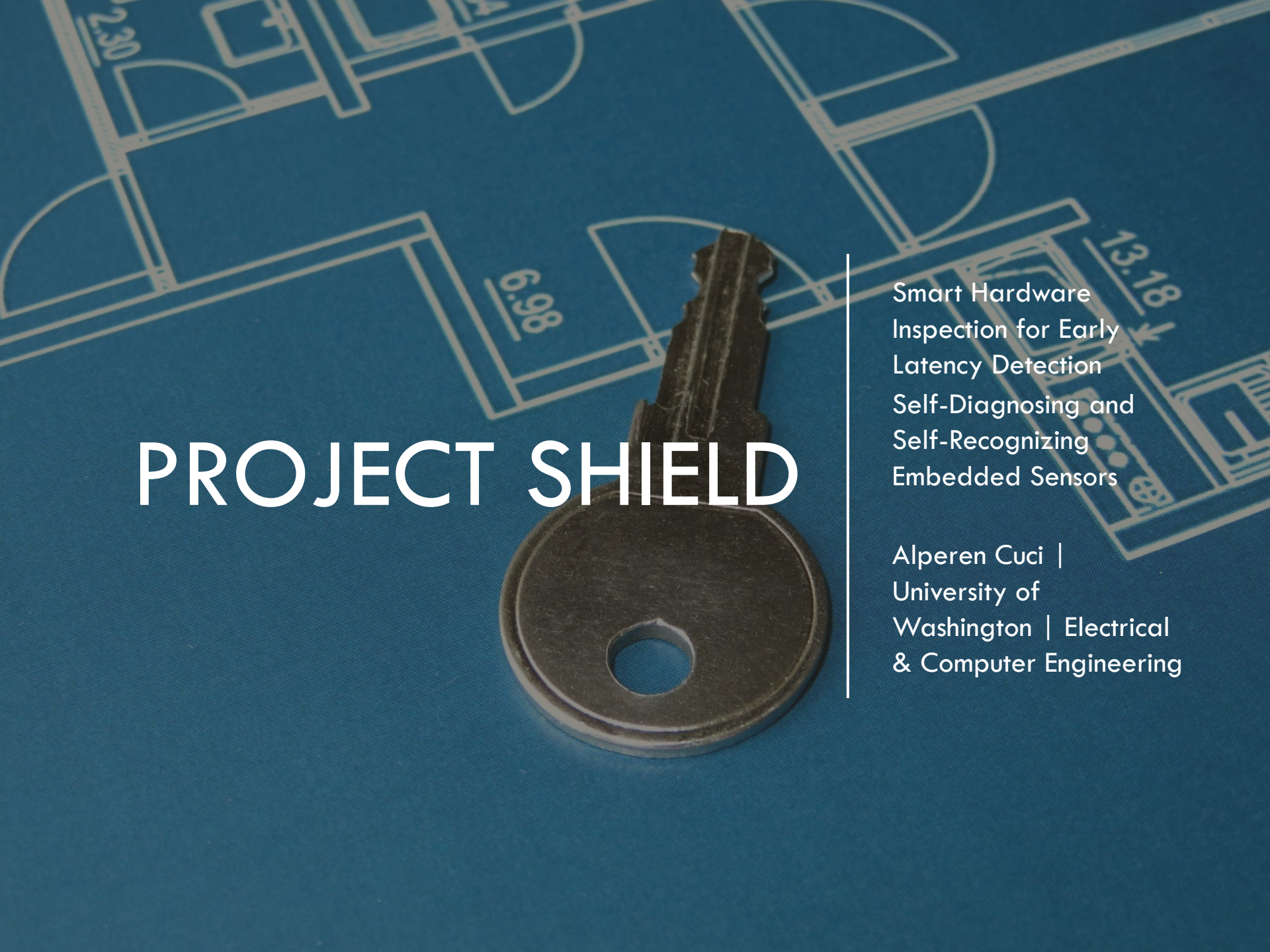


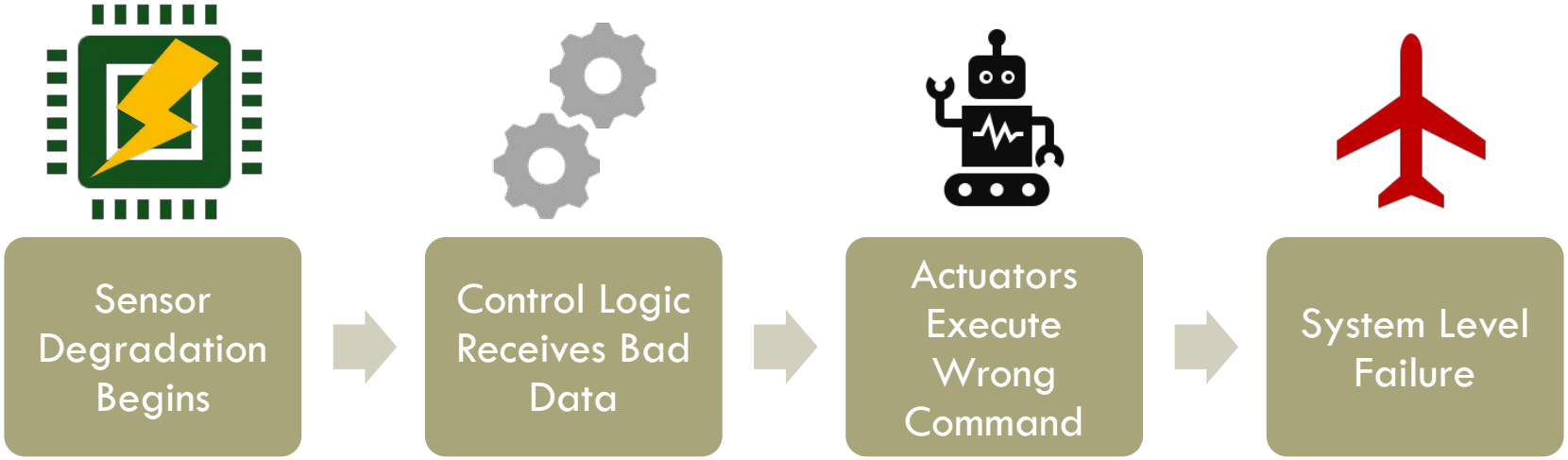
PROJECT SHIELD

Smart Hardware Inspection for Early Latency Detection

Self-Diagnosing and Self-Recognizing Embedded Sensors

Alperen Cuci | University of Washington | Electrical & Computer Engineering

THE PROBLEM



Current systems detect “after” failure,
SHIELD can predict degradation before failure occurs

MOTIVATION

Today: Post-Failure Detection

Threshold alerts or human diagnosis after failure

Limitation: Late or Expensive Intervention

Redundancy and Downtime increase cost and risk.

SHIELD: Predict Before Failure

On-device forecasting & auto-recognition enable prevention

From uncertainty to reliability — SHIELD makes sensors self-aware.

THE NEW CHALLENGE

In modular systems, knowing what sensor you're reading is as critical as knowing if it's healthy.

IoT and UAV systems often lack metadata

Misconnection or tampering can cause misinterpretations

No embedded framework exists to identify sensor type from its signal output alone.

RESEARCH OBJECTIVES

Autonomous Sensor Type Recognition

- Develop a lightweight algorithm capable of identifying sensor modality directly from raw signal characteristics to enable model selection.

Predictive Sensor Health Forecasting

- Design modality-specific degradation models that forecast bias drift, latency, and noise increase using IRNN/quantized LSTM architectures.

On-Device Intelligence for Embedded Systems

- Integrate recognition and forecasting modules into a unified TinyML framework optimized for low-power MCUs.

Cross-Domain Validation and Commercial Readiness

- Demonstrate generalization across aerospace, UAV, and medical devices to establish SHIELD's industrial viability.

SHIELD — THE SOLUTION

A universal, embeddable framework that both monitors sensor health and recognizes sensor type from raw signal patterns.

Core Capabilities:

1. Predictive Sensor Health Forecasting
2. Autonomous Sensor Type Recognition
3. On-Device Operation (TinyML, low power)

HOW IT WORKS — DUAL ARCHITECTURE

Two parallel paths:

- Health Forecasting: Residual modeling → Temporal degradation learning → TTF prediction
- Sensor Type Recognition: Spectral-temporal signature extraction → TinyML classifier → Modality ID

Shared preprocessing enables both real-time and low-power performance.

WHY IT MATTERS

- OEMs: Enables plug-and-play, self-aware sensors
- UAVs/Robotics: Auto-detect and validate sensors
- Industry/MedTech: Ensures safety and compliance
- Defense/Research: Simplifies large-scale sensor integration

COMPETITIVE LANDSCAPE

Capability	Existing Solutions	SHIELD
Fault Detection	Thresholds / Redundancy	Predictive
Embedded ML	Cloud-based	On-device
Sensor Type ID	Manual labeling	Autonomous
Hardware Overhead	High	Lightweight

MARKET OPPORTUNITY

- Edge AI + TinyML market > $80B by 2030
- SHIELD = reliability layer for UAVs, Aerospace, Industrial IoT, MedTech
- Licensing potential for OEMs & MCU vendors

INTELLECTUAL PROPERTY & MOAT

- Novel residual + temporal + signal-signature fusion
- Patent potential:
  - Embedded Prognostics Architecture
  - Autonomous Sensor Modality Identification
- Built-in interpretability + low compute cost

TRACTION

- Prototype on STM32 + Raspberry Pi
- Detects bias drift, latency, and noise in IMU & pressure sensors
- Phase 1 research: sensor modality recognition feasibility
- Aligns with DoD SBIR and FAA reliability initiatives

BUSINESS MODEL & ROADMAP

Phase 1: Academic validation (2024–25)

Phase 2: CoMotion IP filing + OEM pilot

Phase 3: SDK licensing (embedded PHM modules)

Phase 4: Full SHIELD Suite (health + type recognition)

THE ASK

Seeking CoMotion mentorship & support to:

File dual patent protection

Build pilot partnerships (aerospace, medtech, robotics)

Develop commercialization strategy for SDK and hardware kits

Funding for the prototype