VITISH 2024
(SIH Internal Hackathon)

TITLE PAGE

- **Problem Statement ID – SIH25122**
- **Problem Statement Title- Student Innovation (Portable Cyberdeck for Disaster Management)**
- **Theme- Disaster Management**
- **PS Category - Hardware**
- **Team ID- VIT-791**
- **Team Name: TrailBlazers**

IDEA TITLE

- **Idea Title:** Student Innovation (Hybrid Search & Rescue System for Disaster Management)
- **Proposed Solution:**
  - **Problem:** During a disaster, traditional communication infrastructure is often destroyed, making it difficult to locate individuals trapped in debris. Conventional surveillance systems are unreliable and lack proactive detection in these chaotic environments. A pressing need exists for a reliable, low-cost solution that can operate without internet connectivity to aid in search and rescue efforts.
  - **Solution:** We are building a portable cyberdeck that functions as a hybrid search and rescue system. It combines RF signal intelligence, depth sensing, and multi-channel communication to locate individuals and coordinate rescue teams in disaster zones. This affordable solution provides real-time detection of both human presence and RF signals from buried devices.
  - **How it addresses the problem:** The system provides proactive detection by using RF signals from devices like mobile phones to pinpoint the general location of a survivor, even through debris. It then uses depth-sensing technology to provide a high-resolution 3D map of the area to confirm the person's exact physical location. For communication, it can send data to satellites without an internet connection and communicate with other similar devices in a mesh network for coordinated search efforts.
  - **Innovation and uniqueness:** The core innovation is the Sensor Fusion Logic, which combines RF signal detection with depth-based motion tracking to eliminate false positives and ensure high-accuracy survivor location. The system's ability to operate completely offline using satellite and peer-to-peer communication makes it uniquely suited for disaster scenarios where internet and cellular networks have failed. It provides a low-cost, scalable, and self-sufficient solution for emergency

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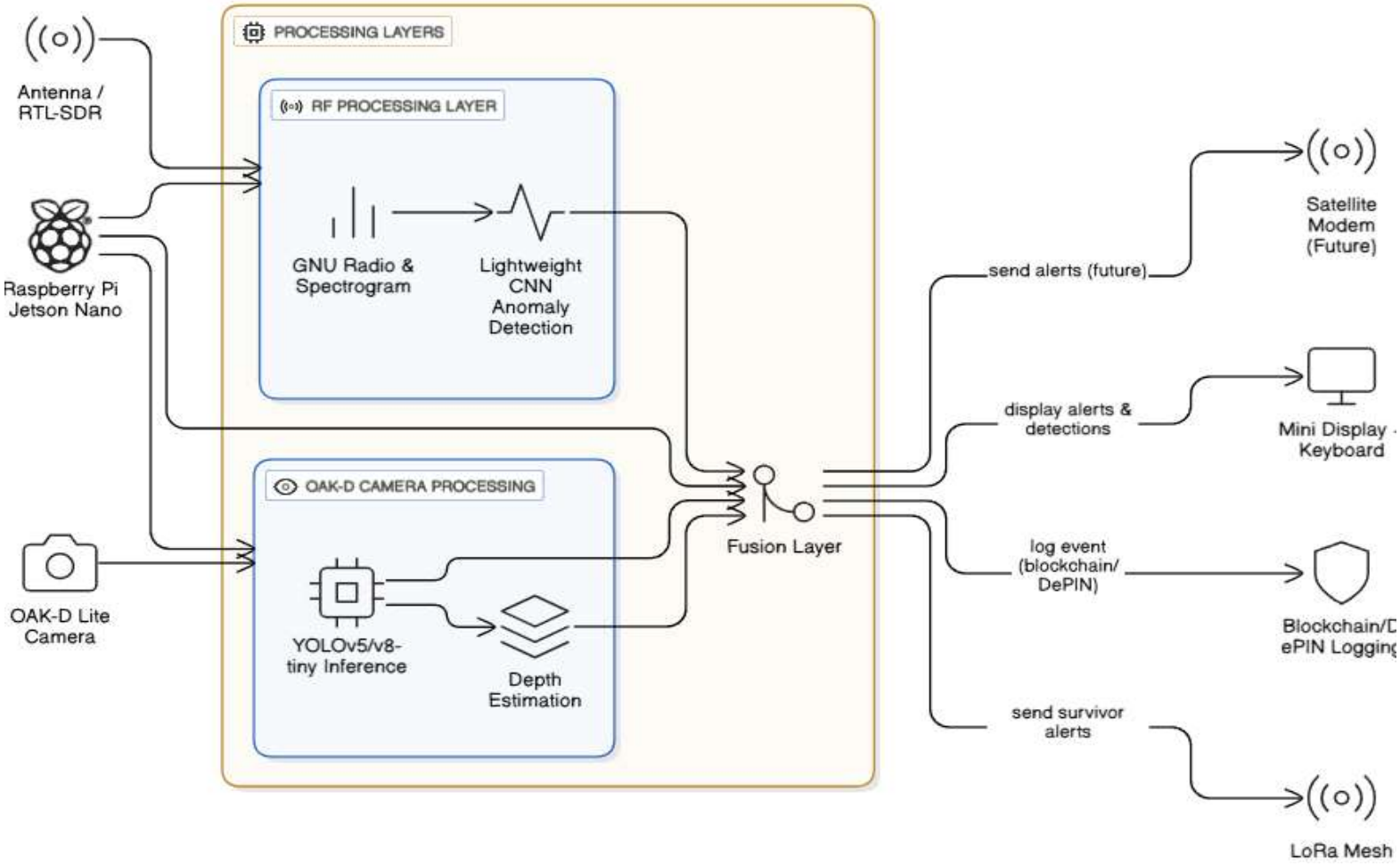
TECHNICAL APPROACH

- **Technologies to be used:**
  a. **Hardware:** Low-cost, high-performance SDR hardware like an RTL-SDR dongle or HackRF One, a depth-sensing camera such as the OAKD, a controller board like a Raspberry Pi 4 or Jetson Nano for on-device processing. For communication, the system would incorporate modules for satellite and peer-to-peer communication.
  b. **Software/AI:** The system uses Python frameworks, OpenCV with Depth APIs for motion tracking, and open-source tools like GNU Radio and SDR# for signal processing.
  c. **ML Models:** YOLOv5 for human/person detection and tracking using the OAK-D lite.. CNN based RF anomaly detection trained on spectgram images for identifying potential survivor related transmissions.
- **Methodology and process for implementation:**
  a. **RF Signal Acquisition:** The SDR captures raw data from the surrounding RF spectrum, scanning for signals from mobile devices, GPS, Wi-Fi, and other distress signals.
  b. **RF Anomaly Detection Module:** Preprocessed signals (spectrograms) are passed through a MobileNet SSD model, which is trained to classify human-related signal types (e.g., normal phone activity) as potential signs of a survivor.
  c. **Depth Sensing Module:** A depth-sensing camera monitors the physical space, using background subtraction and motion tracking to detect "human-like silhouettes" even if partially obscured by debris.
  d. **Sensor Fusion & Decision Logic:** Both modules feed into a central Decision Engine. An alert is generated only when both a human-related RF signal and a human-like form are detected together within a time window.


Antenna / RTL-SDR
Raspberry Pi Jetson Nano
OAK-D Lite Camera
PROCESSING LAYERS
RF PROCESSING LAYER
GNU Radio & Spectrogram
Lightweight CNN Anomaly Detection
OAK-D CAMERA PROCESSING
YOLOv5/v8-tiny Inference
Depth Estimation
Fusion Layer
send alerts (future)
Satellite Modem (Future)
display alerts & detections
Mini Display · Keyboard
log event (blockchain/ DePIN)
Blockchain/D ePIN Logging
send survivor alerts
LoRa Mesh

FEASIBILITY AND VIABILITY

Feasibility:
Leverages low-cost hardware (RTL-SDR, OAK-D, Raspberry Pi/Jetson Nano) and lightweight AI models for edge processing.
Satellite & D2D integration is complex but supported by existing libraries/APIs.
Challenges:
Detecting low-power RF signals in noisy environments.
Integrating multiple communication protocols without latency or interference.
Minimizing false positives.
Mitigation Strategies:
Sensor fusion with dual-confirmation logic for accuracy.
Incremental testing and modular integration.
Use of open-source libraries to simplify communication integration.
Viability:
Technically, operationally, and economically feasible.
Moderate risk, mainly from signal detection and multi-protocol complexity.

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IMPACT AND BENEFITS

Potential impact on the target audience: This product can revolutionize disaster response by providing a fast, reliable, and affordable tool for search and rescue operations. It will enable rescue teams to locate survivors more quickly and efficiently, drastically improving outcomes during a crisis.

Benefits of the solution:

- **Saves Lives:** Enables rapid, accurate detection of survivors in collapsed structures and debris, significantly reducing search time.
- **Operational Independence:** The ability to communicate via satellite and peer-to-peer networks ensures the system remains operational even when all local communication infrastructure has failed.
- **Cost Efficiency:** The project is estimated to be "70% cheaper than traditional AI surveillance setups," making it a scalable solution for government agencies and NGOs involved in disaster management.
- **Improved Coordination:** Enables a mesh network among rescue teams for real-time data sharing and coordination of efforts.

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RESEARCH AND REFERENCES

RF Signal Detection and Classification for Search and Rescue

- **A RESCUE RADAR SYSTEM FOR THE DETECTION OF VICTIMS TRAPPED UNDER RUBBLE BASED ON THE INDEPENDENT COMPONENT ANALYSIS ALGORITHM**
  - **Source:** Journal of Electromagnetic Waves and Applications
  - **Link:** https://www.jpier.org/ac_api/download.php?id=11061206
- **CNN-Quantized Based RF Signal Identification for UAV Disaster Navigation**
  - **Source:** ResearchGate
  - **Link:** https://www.researchgate.net/publication/392592322_CNN-Quantized_Based_RF_Signal_Identification_for_UAV_Disaster_Navigation
- **Smart Search System of Autonomous Flight UAVs for Disaster Rescue**
  - **Source:** National Center for Biotechnology Information (NCBI)
  - **Link:** https://pmc.ncbi.nlm.nih.gov/articles/PMC8537596/
- **System to Detect Human Being Buried Under the Rubble during Disaster**
  - **Source:** International Journal of Advanced Research in Innovation and Technology (IJARIIT)
  - **Link:** https://www.ijariit.com/manuscripts/v3i3/V3I3-1337.pdf**OAK-D Camera and Sensor Fusion**
- **Towards Autonomous Drone Racing without GPU Using an OAK-D Smart Camera**
  - **Source:** MDPI Sensors Journal
  - **Link:** https://www.mdpi.com/1424-8220/21/22/7436
- **Evaluation of a Sensor System for Detecting Humans Trapped under Rubble: A Pilot Study**
  - **Source:** MDPI Sensors Journal
  - **Link:** https://www.mdpi.com/1424-8220/18/3/852
- **Hybrid Mode Sensor Fusion for Accurate Robot Positioning**
  - **Source:** PubMed
  - **Link:** https://pubmed.ncbi.nlm.nih.gov/40431803/

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1. **Kindly keep the maximum slides limit up to six (6). (Including the title slide)**
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