# An AI-Driven Thermodynamics Based IOT Sensor Network for the Ultra-Early Detection of Wildfires Without Line of Sight View of Fire

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The most significant weakness and vulnerability in the wildfire response chain lies in the early detection/reaction phase. The physics of wildfire growth are exponential. Any reduction in response time can yield similarly exponential benefits. In this work I focused on detecting a wildfire in its incipient stage. Existing wildfire detection technologies focus on detecting either “flame” or “smoke”, which are often obscured or absent in the earliest stages of wildfire development. I developed a novel sensor network that leverages refractive index gradients in transparent media to detect the “heat” signature of small wildfires. The system employs a camera followed by a cross-correlation filter highlighting differences in the scene that result from refractive light variations caused by the heat plume. These extracted features are then fed into an AI model that uses probabilistic classification to determine whether a detected heat plume is indicative of a fire. A Tensor-Processing-Unit(TPU) was included allowing re-training of a 50-layer Neural Network on our edge device after deployment greatly boosting its robustness. Conducted numerous field tests at various distances including with small fires having flame lengths of <6-inches without any line-of-sight view of flame. To assess ability to sense wildland fire in its’ incipient phase; authentic, fully cured, dead fuels of less than ¼ inch diameter were ignited. For a video frame-rate of ~5fps, detection accuracy >84% was achievable up to ~300ft, and at a frame-rate of ~50fps >71% up to ~600ft. This work represents a significant advancement in AI-enabled wildfire detection and offers promising opportunities for improving early response times and mitigating the devastating impacts of wildfires.

**Awards Won:**