TECHNICAL SUMMARY

The FLARE-Sat uses a Raptor Photonics Owl 1280, a compact, space qualified VIS–SWIR camera that operates from 0.6 to 1.7 micrometers. The sensor features a 1280 × 1024 InGaAs array with 10-micrometer pixels and thermoelectric cooling, allowing it to detect fires and heat sources through smoke, haze, and darkness. Its proven reliability in low Earth orbit and low power consumption make it ideal for a multi-lens, multi-satellite constellation designed for real-time wildfire detection and verification.

HOW IT WORKS

Each satellite carries a revolving three lens turret optimized for SWIR imaging. The system includes a 70 millimeter wide sweeper, a 750 millimeter mid-range confirmer, and a 1500 millimeter high resolution verifier. The satellite slowly rotates using magnetorquers to scan large regions with the wide lens. When a hotspot is detected, the system automatically switches to a longer focal length lens to capture detailed imagery for confirmation. Machine learning algorithms process the data to verify if the signal is a fire, and additional satellites can image the same location for higher confidence and accuracy.

WHY SWIR INSTEAD OF TRADITIONAL INFRARED

Traditional mid and long wave infrared systems such as NASA’s FIRMS, which use MODIS and VIIRS, detect thermal emissions only from hotter sources and at lower resolution, between 375 meters and 1 kilometer per pixel. SWIR detects both reflected and emitted light, allowing it to identify smaller or cooler fires earlier. This enables FLARE-Sat to detect fires as small as 3 to 9 meters across. SWIR also penetrates smoke and haze more effectively, and when combined with post process machine learning and multi-satellite verification, it greatly reduces false positives while providing accurate day and night fire monitoring across the globe.

Key Formulas Used

Ground Sample Distance $(GSD) = \frac{(H \times p)}{f}$
Total area scanned per frame $(Swath) = GSD \times Pixel\ Count$

H = 550,000 meters (satellite altitude)
p = 1×10^{-5} meters (pixel size)

70 mm (Wide Sweeper):
Covers 100 × 80 km swaths per frame, approximately 12,800 km².
Detects only large fire clusters or bright thermal anomalies.
Acts as a search and cue sensor for the constellation.

$$GSD = \frac{550{,}000 \times 1 \times 10^{-5}}{0.07} = 78.57\ m/pixel$$

$$Swath_{width} = 78.57 \times 1280 = 100{,}570\ m \approx 100\ km$$

$$Swath_{height} = 78.57 \times 1024 = 80{,}440\ m \approx 80\ km$$

750 mm (Mid-Range Confirmer):
Covers 9 × 7 km with 7 m pixel resolution.
Detects and identifies individual active fires or concentrated hotspots.
Ideal for distinguishing controlled burns from wildfires.

$$GSD = \frac{550{,}000 \times 1 \times 10^{-5}}{0.75} = 7.33\ m/pixel$$

$$Swath_{width} = 7.33 \times 1280 = 9{,}382\ m \approx 9.4\ km$$

$$Swath_{height} = 7.33 \times 1024 = 7{,}507\ m \approx 7.5\ km$$

1500 mm (High-Res Verifier):
Covers 4.7 × 3.7 km with 3.7 m pixel resolution.
Can resolve small fires around 9 meters wide at 2.5 pixels per hotspot.
Used for confirmation and high-confidence classification.

$$GSD = \frac{550{,}000 \times 1 \times 10^{-5}}{1.5} = 3.67\ m/pixel$$

$$Swath_{width} = 3.67 \times 1280 = 4{,}698\ m \approx 4.7\ km$$

$$Swath_{height} = 3.67 \times 1024 = 3{,}759\ m \approx 3.8\ km$$

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