SEARCH & RESCUE · ROBOTIC PLATFORM

Crawler Debris System — Tracked Search-and-Rescue Robot

A tracked (tank-type) robotic search-and-rescue platform that detects survivors in post-disaster debris using thermal imaging.

Robotics | Thermal Imaging | Embedded | Tracked Platform | Search & Rescue

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Category: Search & Rescue — post-disaster survivor detection

Platform: Tracked robot · thermal imaging · embedded system

1. Project Summary & Concept

The Crawler Debris System is a tracked (tank-type) robotic platform designed to locate survivors trapped under rubble after earthquakes, collapses and similar disasters. Its primary task is to enter debris zones that are dangerous or inaccessible for humans and, using its onboard thermal camera, sense the body heat of living beings and report their location to the operator. Its tracked drive lets it move over rough, unstable ground; it is teleoperated through an embedded control system.

Design Goals

- Reliable motion over debris/rough terrain (tracked drive)
- Survivor detection in dark, smoky and dusty environments via thermal imaging
- Live video and location relay to the operator
- Compact, rugged body able to enter tight spaces

2. Why a Tracked Platform?

A debris environment consists of rubble, rebar, broken concrete and irregular surfaces. Compared with wheeled platforms, a tracked (tank-type) drive offers clear advantages here:

- **Large contact area:** low ground pressure → moving without sinking on loose/unstable ground.
- **Obstacle clearing:** ability to climb rubble and step-like obstacles.
- **High traction:** grip on sloped and slippery surfaces.
- **Roll-over resistance:** balance thanks to a low centre of gravity.

3. Survivor Detection with Thermal Imaging

The core of the system is thermal imaging, which distinguishes living beings in the debris from their surroundings. Because the human body radiates a different temperature from its environment, potential survivors stand out in the thermal image based on a temperature threshold. Advantages of this method:

- **Independent of visibility:** works in darkness, smoke and dust (unlike a normal camera).
- **Fast scanning:** instantly reveals heat signatures over a wide area.
- **Combined view:** thermal + normal camera used together for verification.

4. System Architecture (Embedded Hardware)

Subsystem	Task
Embedded controller	Manages sensors/motors, processes video and commands
Track motors + driver	Independent drive of the two tracks (differential drive, spin-in-place)
Thermal camera	Survivor body-heat detection
Normal camera	Visual verification / navigation for the operator
Communication / telemetry	Live video and data relay to the operator station
Power system	Battery + regulation (independent power for field work)

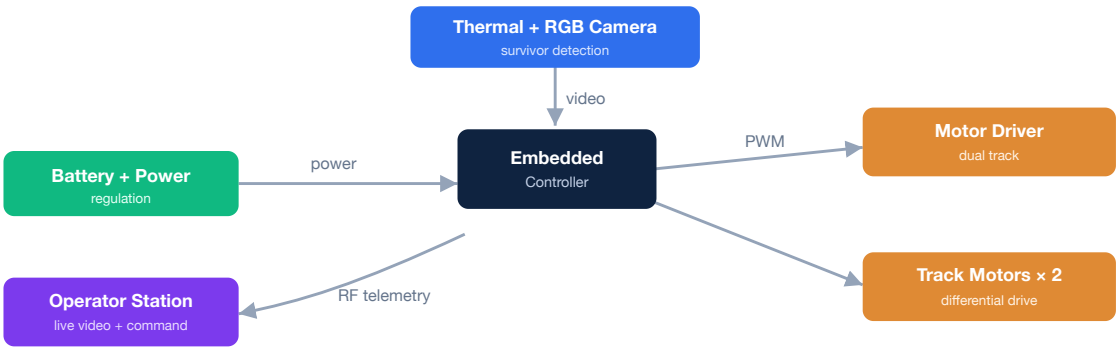

Figure 1. System architecture: the embedded controller is the hub; the thermal + RGB camera provides video and the battery provides power; the motor driver drives the two tracks differentially and communicates with the operator station over RF telemetry.

5. Control & Operation

- **Teleoperation:** the operator drives the vehicle remotely using the live camera feed.
- **Differential drive:** turning and spin-in-place manoeuvres via the speed difference of the two tracks.
- **Survivor marking:** heat signatures detected by the thermal camera are reported to the operator.
- **Durability:** dust/impact-protected body and wiring.

Hardware List	
Embedded controller	ESP32 (Wi-Fi/BT) + low-level motor control
Thermal camera	MLX90640 (32×24 thermal array) — survivor heat signature
RGB camera	OV2640 — operator vision / verification
Track motors	12 V DC geared motor × 2 (differential)
Motor driver	Dual-channel H-bridge (BTS7960, ~43 A)
Communication	915 MHz RF telemetry + Wi-Fi (live video)
Power	3S/4S Li-ion pack + 5 V/12 V regulation
Body	Aluminium/ABS chassis, tracked drive, IP-protected enclosure

6. Mechanical Design & Test

The platform is designed with a low centre of gravity and wide track contact so it advances steadily over debris terrain. The main target/achieved performance figures are given below.

Parameter	Value
Dimensions (L×W×H)	≈ 40 × 28 × 20 cm
Weight	≈ 4.5 kg
Climbable obstacle	≈ 12 cm (close to track height)
Max. slope	≈ 30°
Thermal detection range	≈ 5 m (human body heat)
Run time	≈ 45 min

On the software side, candidate survivor regions are marked in the thermal image using a temperature threshold (≈ 30–36 °C human range), verified with the RGB image, and reported to the operator as a location/alert. Differential drive enables spin-in-place turns and manoeuvring through narrow gaps.

> *Field/debris test photos and live detection screenshots can be added to the project archive.*