

Executive Summary

MavPark is a portable smart parking detection system designed to reduce the time spent searching for available parking on campus. During peak hours at the University of Texas at Arlington, limited parking availability leads to congestion, frustration, and wasted time.

The system uses a camera connected to a Raspberry Pi to capture images of a parking lot. These images are transmitted through a cellular connection to a Jetson Nano, where a computer vision model detects whether parking spots are occupied or available in real time. The results are displayed on a user-friendly interface, allowing drivers to quickly identify open spaces.

Unlike traditional parking systems, MavPark does not require fixed infrastructure or WiFi, making it portable, low-cost, and easy to deploy. By combining edge computing, secure communication, and real-time detection, MavPark provides a scalable and practical solution to improve parking efficiency on campus.

Background

Parking on a busy university campus is often inefficient and stressful, especially during peak hours when students and visitors spend extra time searching for open spaces. This can cause traffic congestion, wasted time, and late arrivals to class or campus activities. At UTA, quickly identifying available parking is a common challenge that affects daily mobility and convenience.

Traditional smart parking solutions can require expensive sensors and permanent infrastructure. MavPark addresses this problem by exploring a more portable and cost-effective approach using computer vision. The system analyzes a live camera feed to determine parking space availability and presents that information through an interactive map-based frontend, helping users locate open spots more efficiently.



Figure 1. Crowded UTA parking lot during peak hours, illustrating the challenge of quickly finding available parking.

Project Setup

MavPark uses a distributed edge-computing architecture with two main components: a Raspberry Pi camera node and a Jetson Nano processing server. The Raspberry Pi connects to a camera and a USB LTE dongle with a SIM card for internet access without WiFi, while the Jetson Nano, connected through WiFi or Ethernet, handles system processing.

System Architecture & Hardware

- Distributed edge-computing system
- Raspberry Pi (camera node) + Jetson Nano (processing server)
- Pi connected to camera (USB/CSI)
- USB LTE dongle with SIM card provides cellular internet
- No WiFi required for deployment
- Jetson Nano connected via WiFi or Ethernet

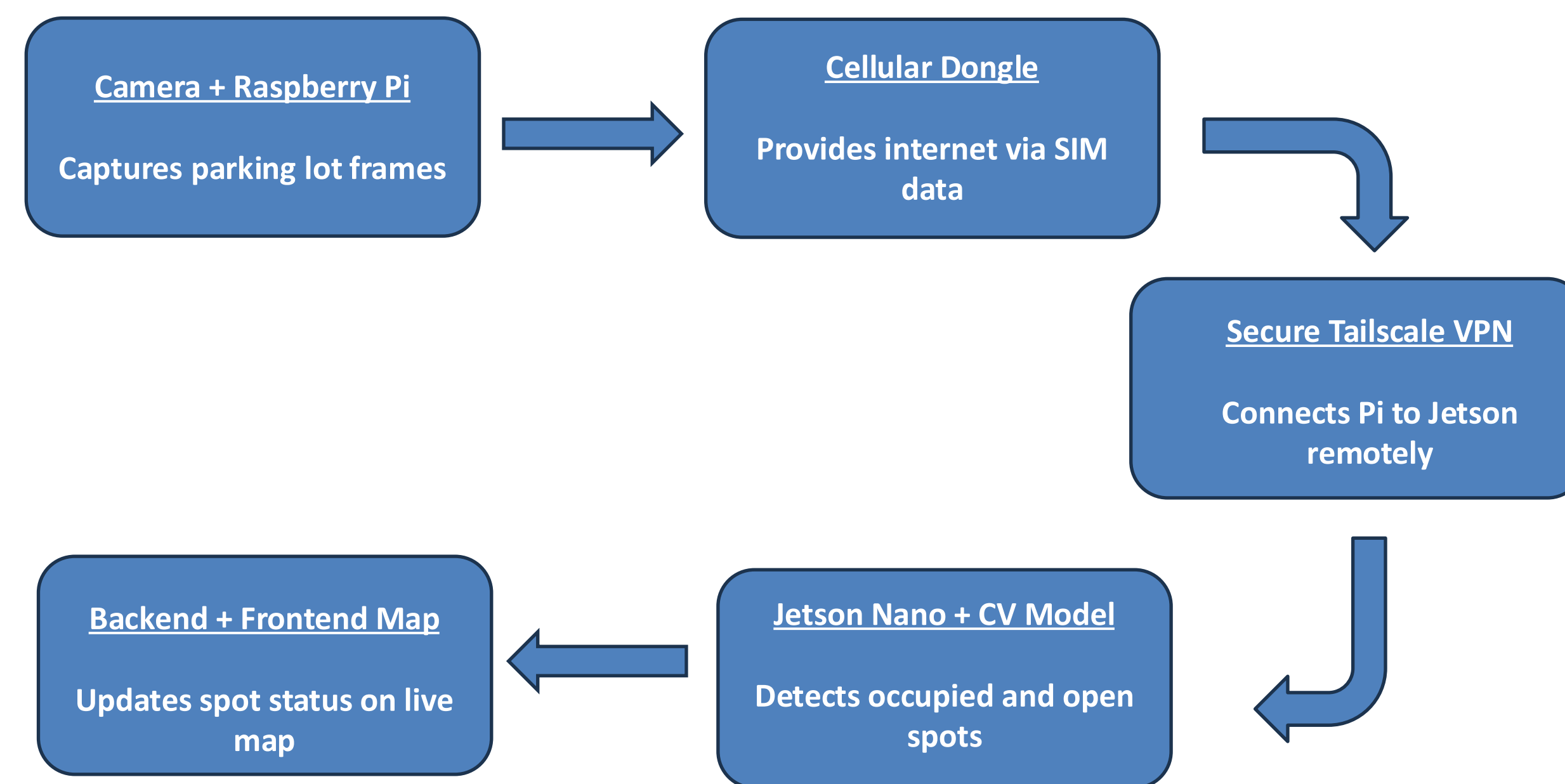
Connectivity, Data Flow & Design Rationale

- Tailscale VPN creates secure virtual network
- Devices communicate using virtual IPs (same network effect)
- Pi captures and compresses images using OpenCV
- Images sent via HTTP through VPN to Jetson Nano
- YOLO/SAHI model detects occupied vs available spots
- Results returned as structured data
- Cellular + edge processing → portable, low latency, no cloud dependency

Integration & Integration

MavPark combines a live camera system, computer vision model, backend processing, and interactive frontend to provide real-time parking availability. A Raspberry Pi with a connected camera captures images of the parking lot, while a cellular dongle gives the device direct internet access without requiring WiFi. Using a secure Tailscale VPN connection, frames are sent to a Jetson Nano for inference, where the model determines which parking spots are occupied or available.

These results are then linked to unique parking space identifiers in the backend and displayed on the frontend through a Google Maps satellite view with a custom lot overlay. Available spaces are marked with green indicators, allowing users to quickly view open spots in an intuitive and accessible format.



Results

The MavPark prototype successfully demonstrated real-time parking detection using a Raspberry Pi and Jetson Nano connected through a cellular network. Images were reliably transmitted via Tailscale VPN without requiring WiFi. The YOLO-based model accurately identified occupied and available parking spots, achieving near real-time performance. The system was validated through live testing and integration with a user interface for parking visualization.

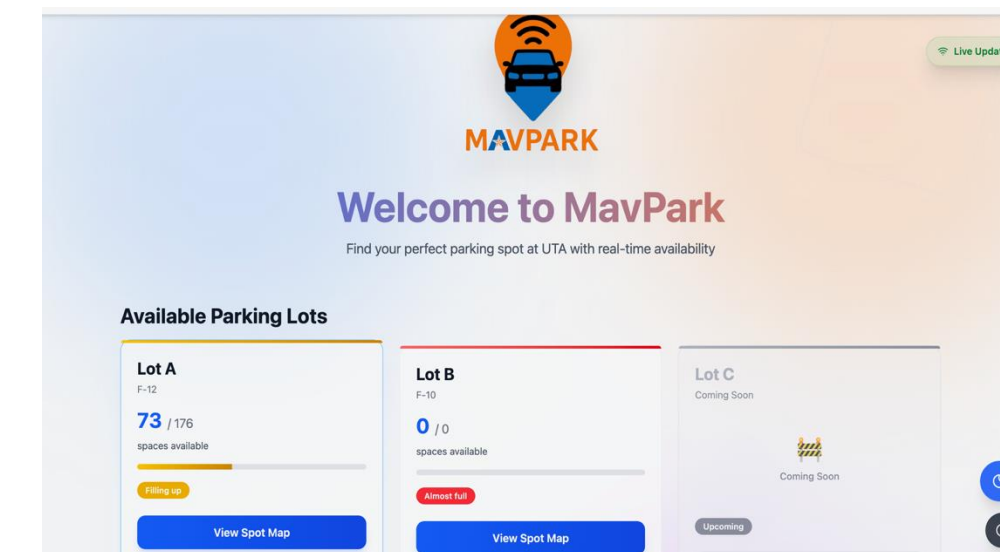


Fig: live parking availability interface

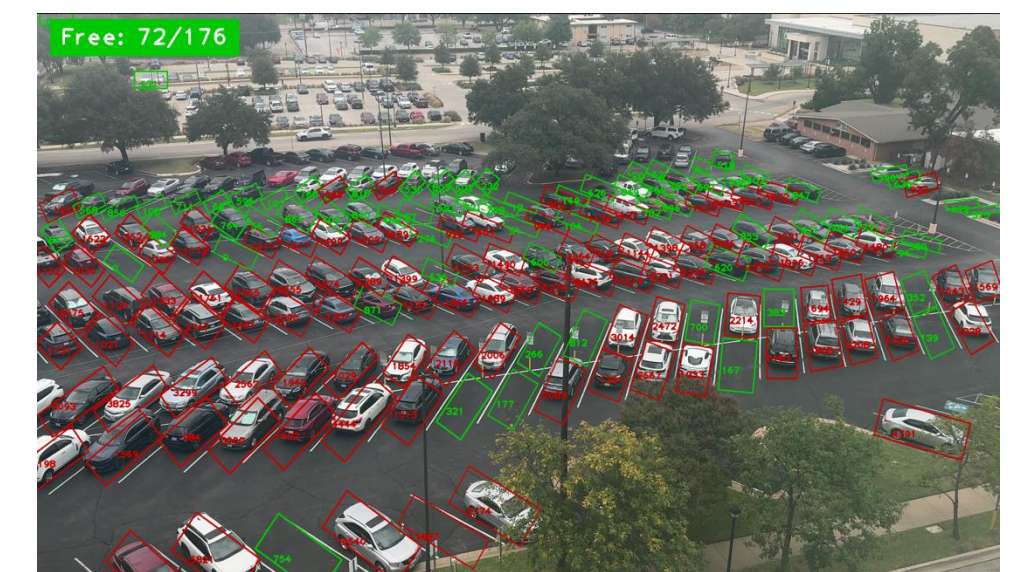


Fig: Real-time vehicle detection using YOLO model

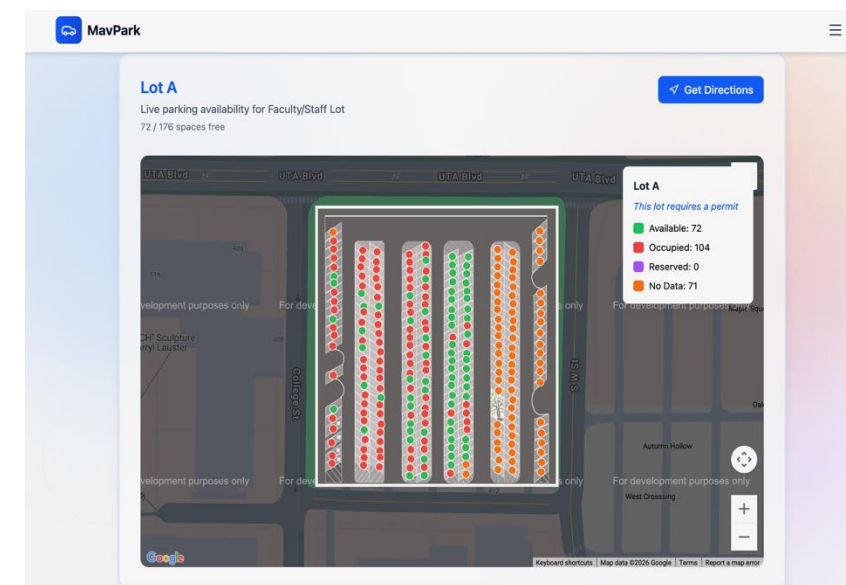


Fig: Visualization of available and occupied parking spots

Conclusions

MavPark demonstrates the potential of computer vision as a practical and flexible approach to smart parking at the University of Texas at Arlington. By integrating portable hardware, secure communication, backend processing, and an intuitive frontend, the project shows how parking availability can be identified and displayed in near-real time without relying on costly embedded sensor infrastructure.

Overall, the project aligned well with its goal of improving parking visibility in a way that is accessible, scalable, and suited to real campus conditions. MavPark also highlights the value of connecting hardware, intelligent detection, and user-centered design into one system to address a common challenge faced by UTA students.

As parking demand continues to be a major issue on campus, UTA would benefit from more innovative and efficient solutions like MavPark. As a senior design project, MavPark serves as a strong proof of concept for how smart campus technology can improve convenience, reduce frustration, and create a better overall parking experience.

References

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