Team B6 - EyeSPy

Neelansh Kaabra Michael Lang Varun Rajesh

Our product

A portable, inexpensive Camping Perimeter Security System

Use Case

- Early warning to campers as to what might be approaching their campsite
- 50m range gives enough time to take appropriate action
- Complete 360 degree coverage of the campsite
- 3 days of usable runtime

Continuous Streaming

6 camera streams

240p camera streams

10 FPS streams

720p HD Display

24 hour run time

Portable Camera Nodes

Weather Resistant

500g Weight

Fully Wireless

Night Vision

50m Range

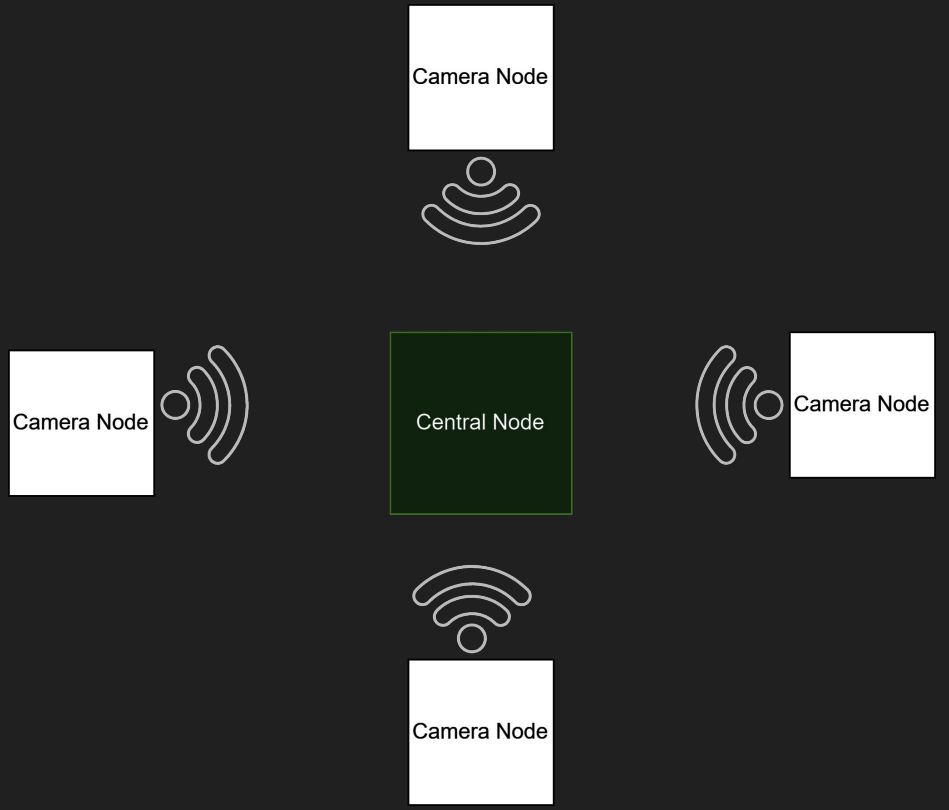
Reduced Costs

< $50 Camera Nodes

< $ 150 Central Node

System Overview

- Remote Camera Node
  - Wireless video transmission
- Central Node
  - Decodes video streams
  - Displays to an HD monitor
- How do we...
  - Remote Compute Platform
  - Central Compute Platform
  - Wireless Protocol
  - Wireless Efficiency



Camera Node Platform

	CC3200	RPi 0 W	ESP8266	ESP32
Clock Speed	80MHz x1	1 GHz x1	160 MHz x1	240 MHz x2
RAM	256 kB	512 MB	80kB	536 kB
Cost	$50	$15	$8	$2.24
Power Consumption	~720 mW	~2500 mW	~600 mW	~660 mW

Central Node Platform

	RPi 4 W	ESP32	RPi 0 W	ECP5 FPGA
Clock Speed	1.5GHz x4	240 MHz x2	1 GHz x1	400 MHz x1
RAM	4 GB	536 KB	512 MB	32 MB
Cost	$55	$2.24	$15	$60
Power Consumption	~8000 mW	~660 mw	~2500 mw	~600 mw

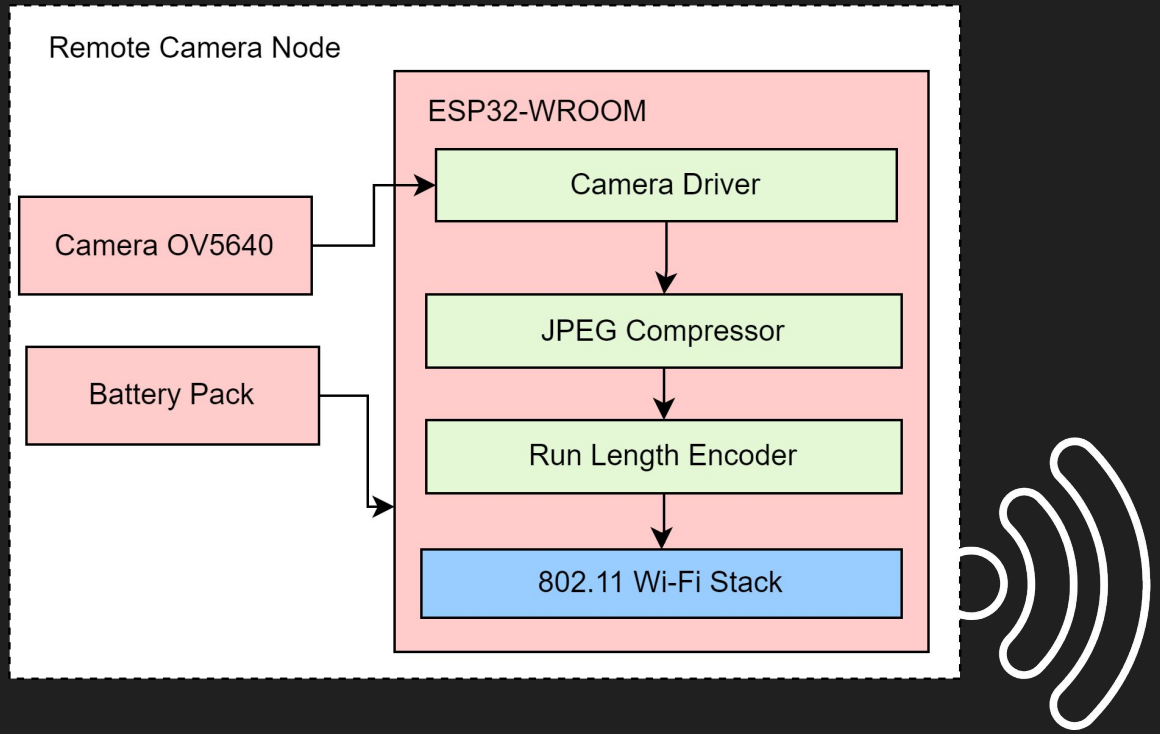
Wireless Communication Methods

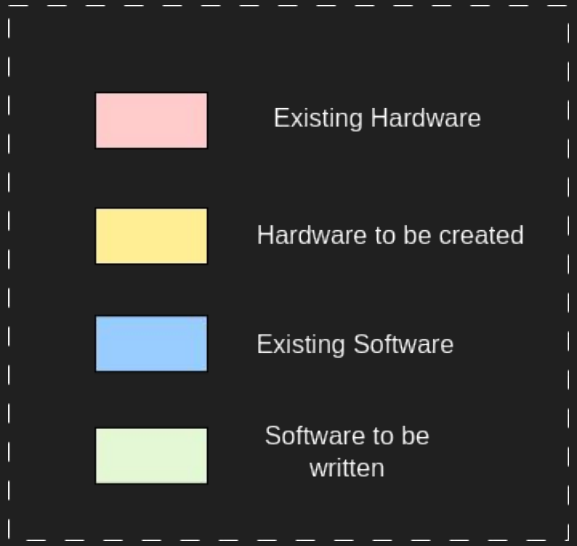
	Bluetooth LE	ESPNow	LoRA	2.4 GHz Wi-Fi
Throughput	2 Mbps	54 Mbps	250 kbps	150 Mbps
Range	50 m+	50 m+	200 m+	50 m+
License	Not Needed	Not Needed	Not Needed	Not Needed
Extensibility	Excellent	Poor	Good	Excellent

Compression Algorithm Comparison

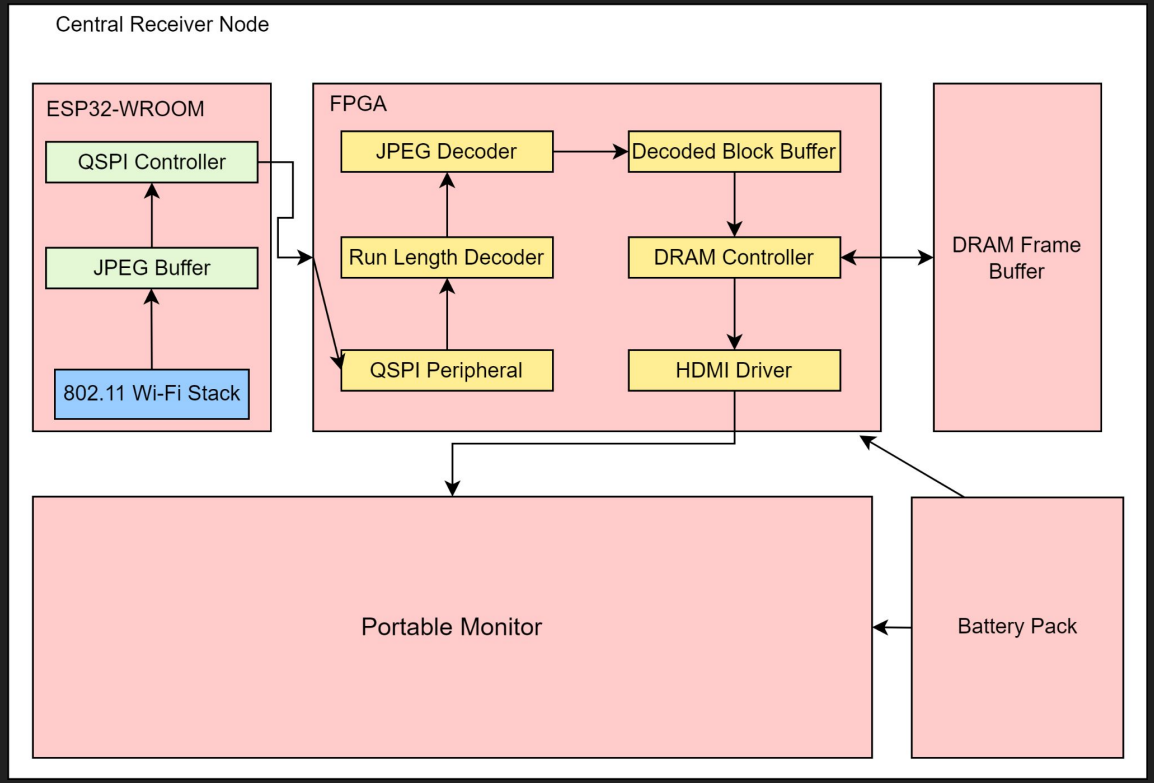
	Deltas	H.264	MPEG-2	JPEG
Compute	Very Low	Very High	High	Medium
Complexity	Very Low	Very High	Very High	Medium
Efficiency	1:1 to Infinity	2000:1	10:1	10:1
Robustness	Low	High	High	High

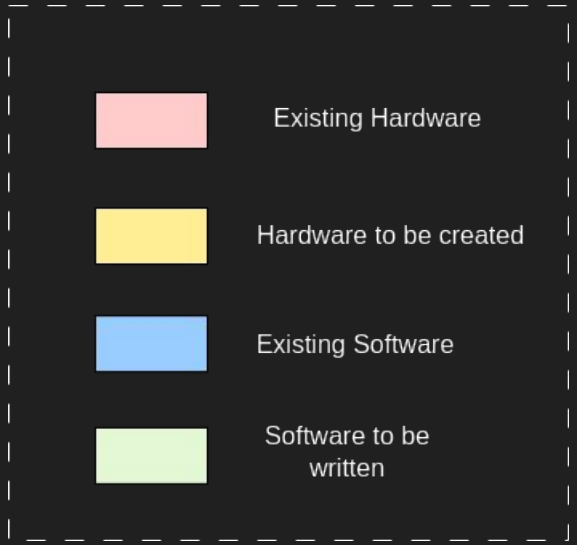
Remote Camera Node





Central Receiver Node





Testing & Verification

- **Run Length:** ensure camera nodes can run for 24 hours on battery
  - Run multiple tests starting at different times of day and conditions
  - Exercise IR functionality and impact on battery life

- **Wireless Streaming:** measure transmitted and received frame counts
  - Run multiple tests at 50m range with varying obstructions
  - Run tests for 1 hour and ensure < 10% frame loss

- **Display Driving:** ensure monitor detects stable and clear HDMI input
  - Drive display for 24 hours and ensure < 0.1% dropped frames
  - Monitor frame rate from display diagnostics

Testing & Verification

- **Performance:** measure throughput of compression and decompression
  - Run algorithms on ~100 outdoor images and actual camera feed
  - Ensure compression takes < 100ms
  - Ensure decompression takes < 16ms
  - Target 5:1 compression ratio

- **Scalability:** ensure above tests pass with at least 6 camera nodes
  - System must work with 6 cameras before considering scaling up
  - Retest with 8, 10, and then 12 camera nodes to determine system limitation

Remote Camera Node	2/5/24	4/22/24	77	0%
Buy and Reseach Hardware	2/5/24	2/9/24	4	100%
Tool Chain Setup	2/10/24	2/16/24	6	100%
Write JPEG Encoder	2/17/24	2/23/24	6	80%
Finish Camera Driver	3/11/24	3/18/24	7	0%
ESP Wi-Fi setup - TX	3/19/24	3/26/24	7	0%
Slack	3/27/24	4/22/24	25	0%
Receiver Node - ESP32	2/5/24	4/22/24	77	0%
Buy and Reseach Hardware	2/5/24	2/9/24	4	100%
Tool Chain Setup	2/10/24	2/16/24	6	100%
ESP Wi-Fi setup - RX	2/17/24	2/23/24	6	0%
Write JPEG Buffer	3/11/24	3/18/24	7	0%
Quad SPI Controller	3/19/24	3/26/24	7	0%
Slack	3/27/24	4/22/24	25	0%
Receiver Node - FPGA	2/5/24	4/22/24	77	0%
Tool Chain Setup	2/5/24	2/9/24	4	100%
Quad SPI Peripheral	2/10/24	2/16/24	6	100%
JPEG Decoder	2/17/24	2/23/24	6	20%
DRAM Controller	2/24/24	3/1/24	7	100%
HDMI Driver	3/9/24	3/15/24	6	30%
IP Integration - Write	3/16/24	3/22/24	6	20%
IP Integration - Read	3/23/24	3/29/24	6	20%
IP Integration - Full	3/30/24	4/5/24	5	20%
Slack	4/6/24	4/22/24	16	0%