Bus Stop Occupancy Tracker

Subtitle: Real-time Crowd Monitoring for Smarter Public Transport

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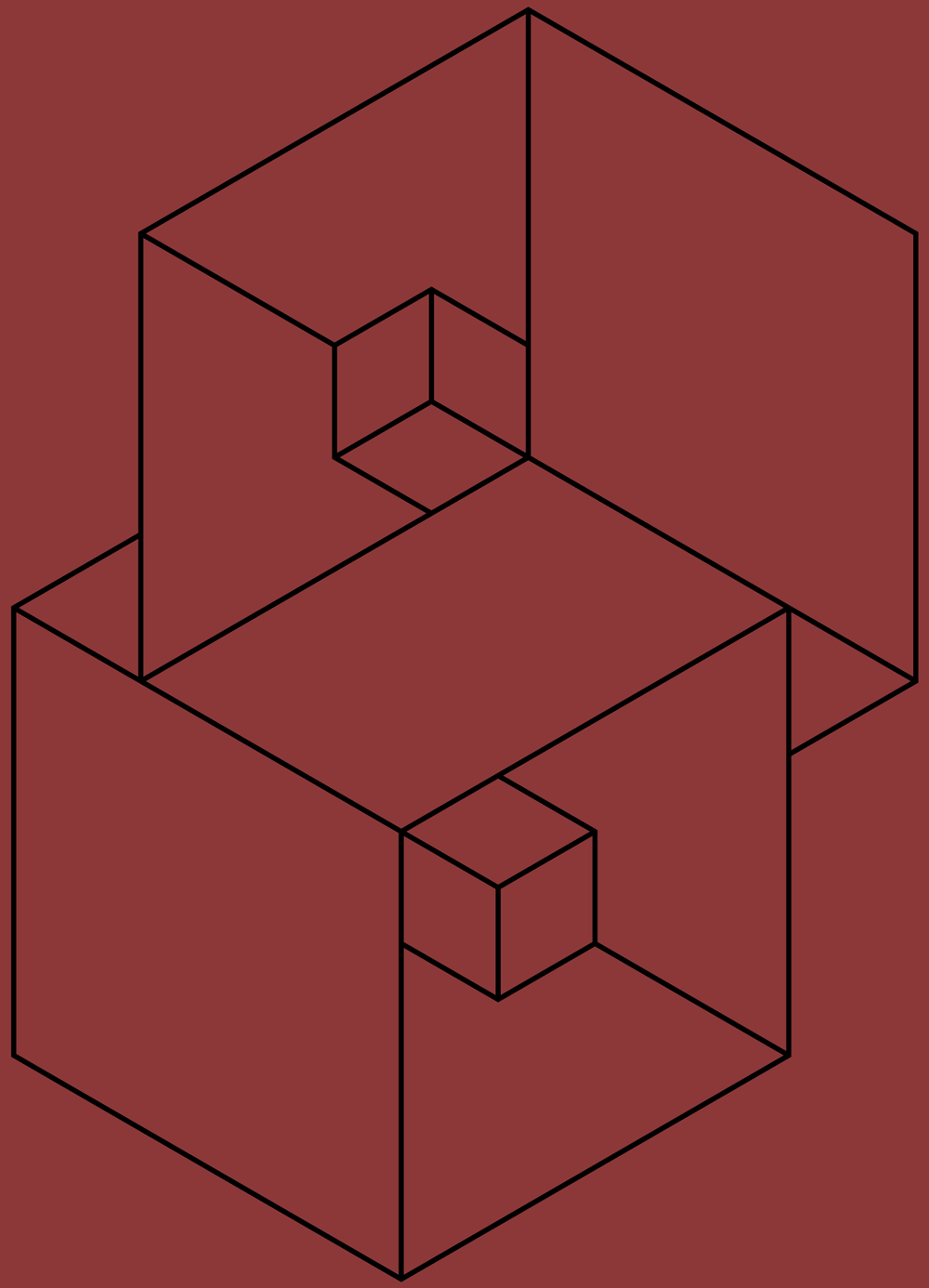
Chitkara University India & Deakin University Australia

Problem Statement

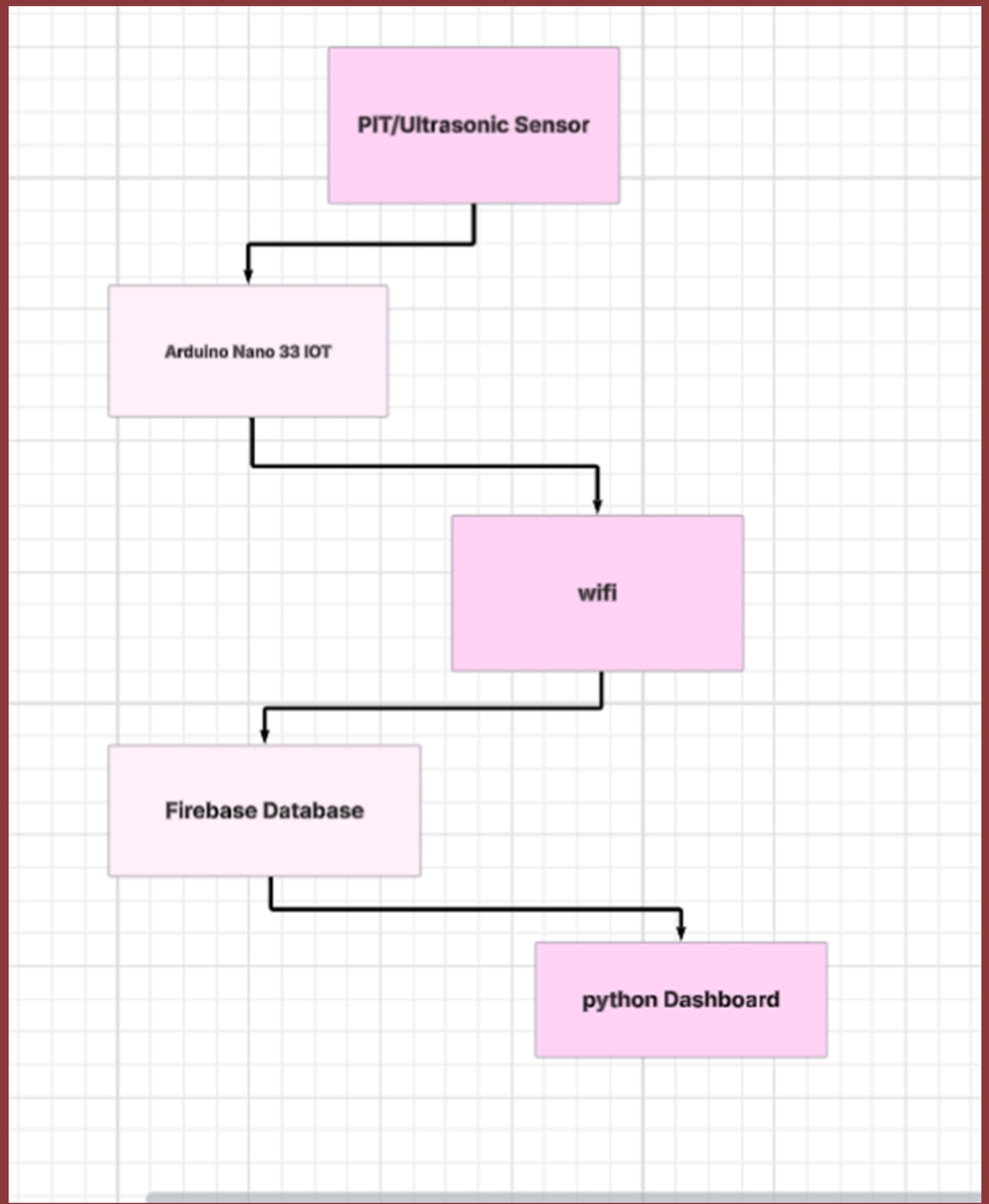
Title: The Urban Challenge

- Overcrowding at bus stops causes delays, discomfort, and safety issues
- Current solutions (CCTV, GPS apps, manual counts) are expensive, slow, or violate privacy
- Need for a real-time, privacy-preserving, and cost-effective crowd monitoring system



Existing Methods

- CCTV Surveillance: Expensive to install and maintain; raises privacy concerns.
- Manual Surveys: Labor-intensive and slow; provides outdated, non-real-time data.
- Mobile GPS Apps: Risk to user privacy; depends on user participation, which is often low.



Proposed Solution

- IoT-based system using PIR and Ultrasonic Sensors
- Connected via Arduino Nano 33 IoT
- Sends data to Firebase and visualizes on Plotly Dash dashboard

Research Methodology

Mixed-Method Study:
Combined quantitative analysis (sensor-based occupancy counts) and qualitative feedback (user interviews and surveys) to get a complete view of system performance and user acceptance.

Pilot Testing:
Conducted 20 sessions in a simulated bus stop environment to mimic real-world conditions like varying crowd sizes and movement patterns. Compared sensor data with manual counts to assess accuracy.

Ethical Focus:
Designed with a privacy-by-design approach. The system avoids collecting any personal or visual data. Emphasis was placed on usability and user trust, ensuring the solution is acceptable and non-intrusive for the public.

System Architecture

Hardware: PIR sensor, Ultrasonic sensor, Arduino Nano 33 IoT
Software: Firebase, Python, Plotly Dash
Total cost: <$80 AUD

Hardware Cost Estimation

Component	Vendor	Estimated Cost (AUD)
Arduino Nano 33 IoT	Core Electronics	$45
PIR Sensor	Amazon	$10
Ultrasonic Sensor	SparkFun	$5
Power Supply	Jaycar	$15

Results - Quantitative

Accuracy: 92%
False positives: 5%
Missed counts: 3%
Low-cost + high performance = scalable solution

Results – Qualitative

Phrase	Code
"Helped me avoid crowded stops"	Application
"Felt reassured knowing crowd levels"	Impact
"Would prefer SMS alerts too"	Improvement Suggestion
"Good for campus shuttles"	New Application
"Non-invasive, no privacy concerns"	Ethical Strength

High Satisfaction: Most users rated the system 4/5 or higher.

Appreciated: Real-time crowd info, privacy protection, and ease of use.

Suggestions: Add SMS alerts and mobile app for better accessibility and convenience.

Task Description	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Problem Identification And Literature Review								
Hardware Selection & Budgeting								
System Architecture Design								
Sensor Integration								
Firebase Integration								
Dashboard Development								
System Testing & Data Collection								
Data Analysis, Report Writing, and PPT presentation								

Project Timeline & Future Scope

Implementation Plan:

- Prototype Testing
- Campus Pilots (Q2 2025)
- City-wide Trials (Q4 2025)

Future Additions:

- Solar power
- Edge AI
- Mobile app integration

Conclusion

A scalable, ethical, and practical solution for public crowd monitoring
Promotes safety, efficiency, and commuter satisfaction
Aligns with Smart City and Sustainable Development goals


Thank
you