Passive Design Strategies at Union Square Station

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Abstract/Narrative

As rising temperatures, poor air quality, and energy demands continue to affect New York City's subway system, there is a growing need for design strategies that improve environmental comfort in underground transit spaces. This research examines 14th Street–Union Square station as a case study for understanding how heat buildup, limited airflow, and uneven air quality impact user experience. 14th Street–Union Square is one of Manhattan's busiest and most complex subway stations, serving approx. 23,000,000 commuters annually and multiple train lines. Because the station operates across several underground levels, heat buildup, limited airflow, and air pollution can vary throughout platforms, mezzanines, and entrances. Through field observations, environmental monitoring, and architectural analysis, the study identifies areas where passive design can improve station performance. Proposed strategies include redesigned air-intake entrances, stack-effect ventilation, daylighting, vegetation, low-heat materials, and photochromic glazing. Together, these interventions explore how public architecture infrastructure can become more climate-responsive, comfortable, and energy efficient through passive design strategies.

Field Data

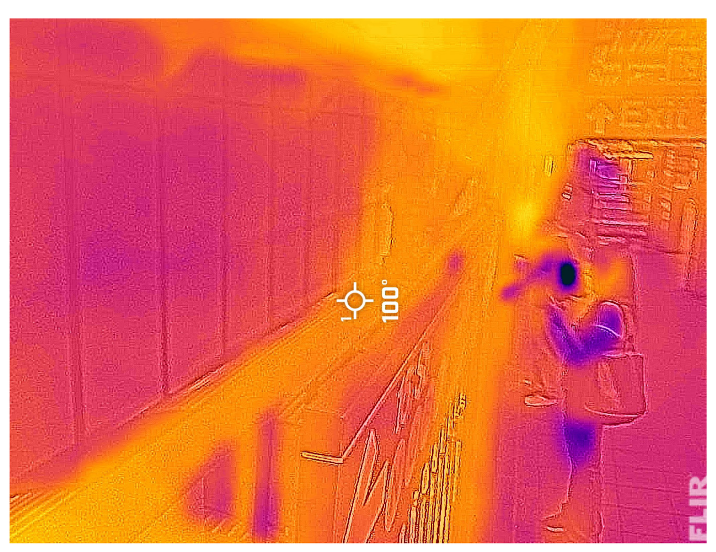

Figure 1.1: Top air exhaust of the 4/5/6 Train

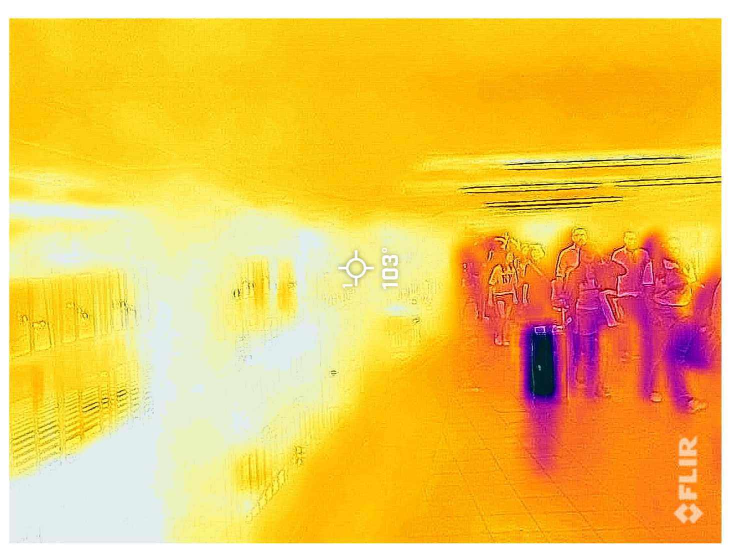

Figure 1.2: Recording heat at mezzanine

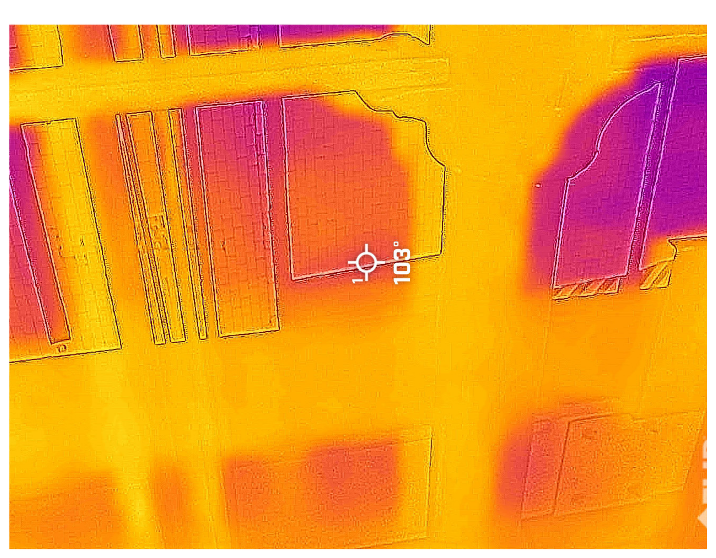

Figure 1.3: Ceiling of Mezzanine Platform Showing hot temp

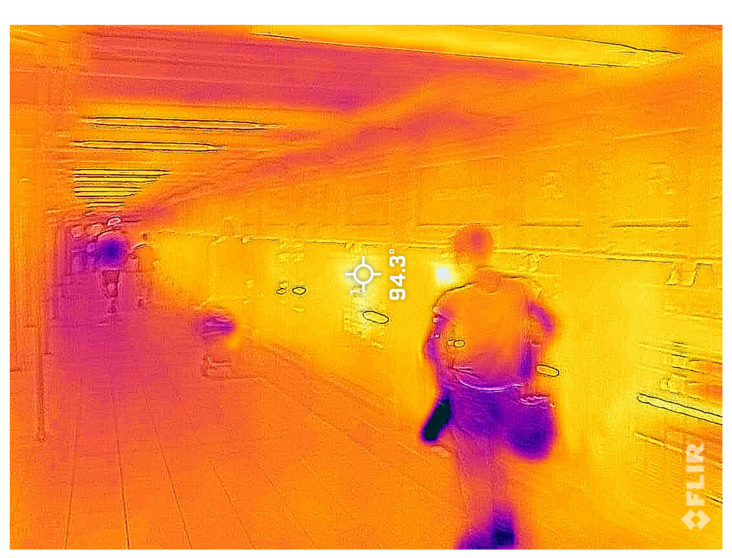

Figure 1.4: Recording heat at W/R/N/Q Platforms

Cool Temp *Warm Temp* *Hottest Temp*

Thermal Camera: Identifying heat emitted by objects

- Images show heat buildup at metal guardrails, ceiling areas, and train-adjacent surfaces.

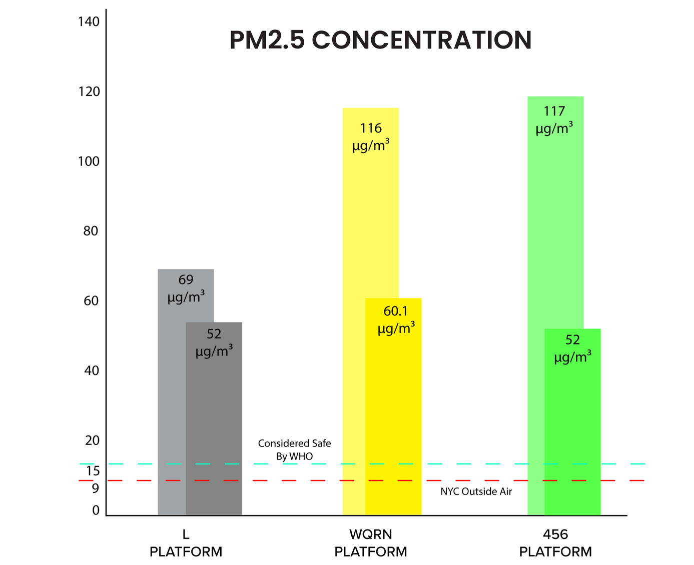

Figure 2.1: PM2.5 levels varied between Platforms and mezzanine areas. Highest Recorded 117 μg/m³

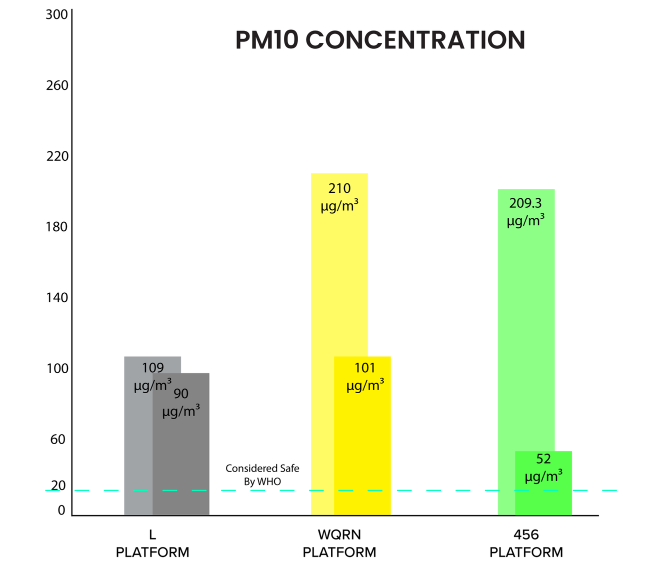

Figure 2.2: PM10 levels varied between Platforms and mezzanine areas. Highest Recorded 210 μg/m³

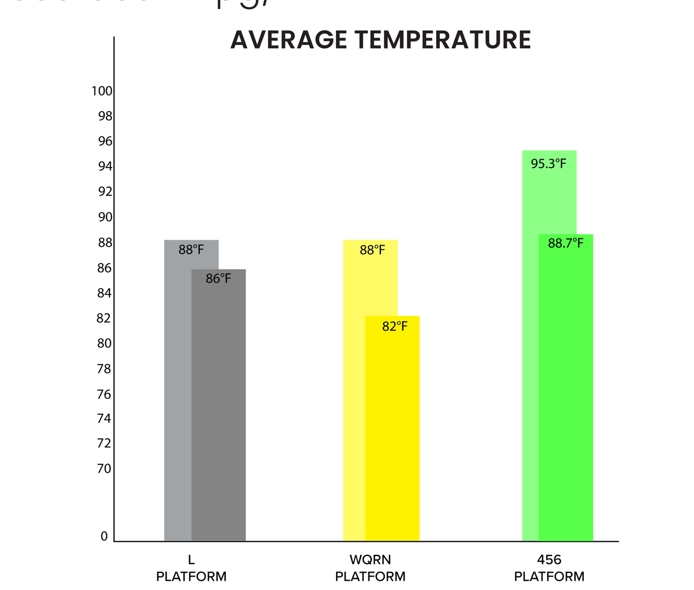

Figure 2.3: Platform 4/5/6 has the highest heat temperature recorded

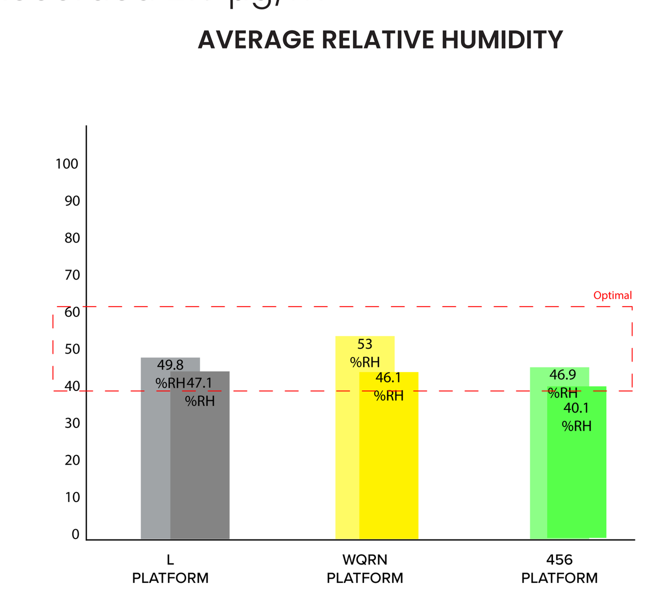

Figure 2.4: Humidity levels are optimal for all three train lines.

- Air quality readings varied across platform and mezzanine locations, suggesting uneven ventilation.

Methods

This research used a mixed-method approach combining field data, thermal imaging, photogrammetry, and architectural analysis to study environmental comfort at 14th Street–Union Square station. Data was collected on June 19, 2026 during afternoon peak rush hour across three platform and mezzanine locations using a Temtop Air Quality Monitor to measure PM2.5, PM10, particle concentration, CO2, HCHO, temperature, and relative humidity. Thermal imaging identified surfaces that store and radiate heat, including metal guardrails, train surfaces, and ceiling areas. Photogrammetry was used to document measurements and create a 3D model of the existing station. The data was then analyzed to identify poor ventilation and heat buildup, informing passive design strategies such as natural ventilation, stack-effect airflow, air-intake entrances, vegetation for shading, and photochromic glazing that adjusts tint in response to temperature.

Site Plan/Render/Diagram

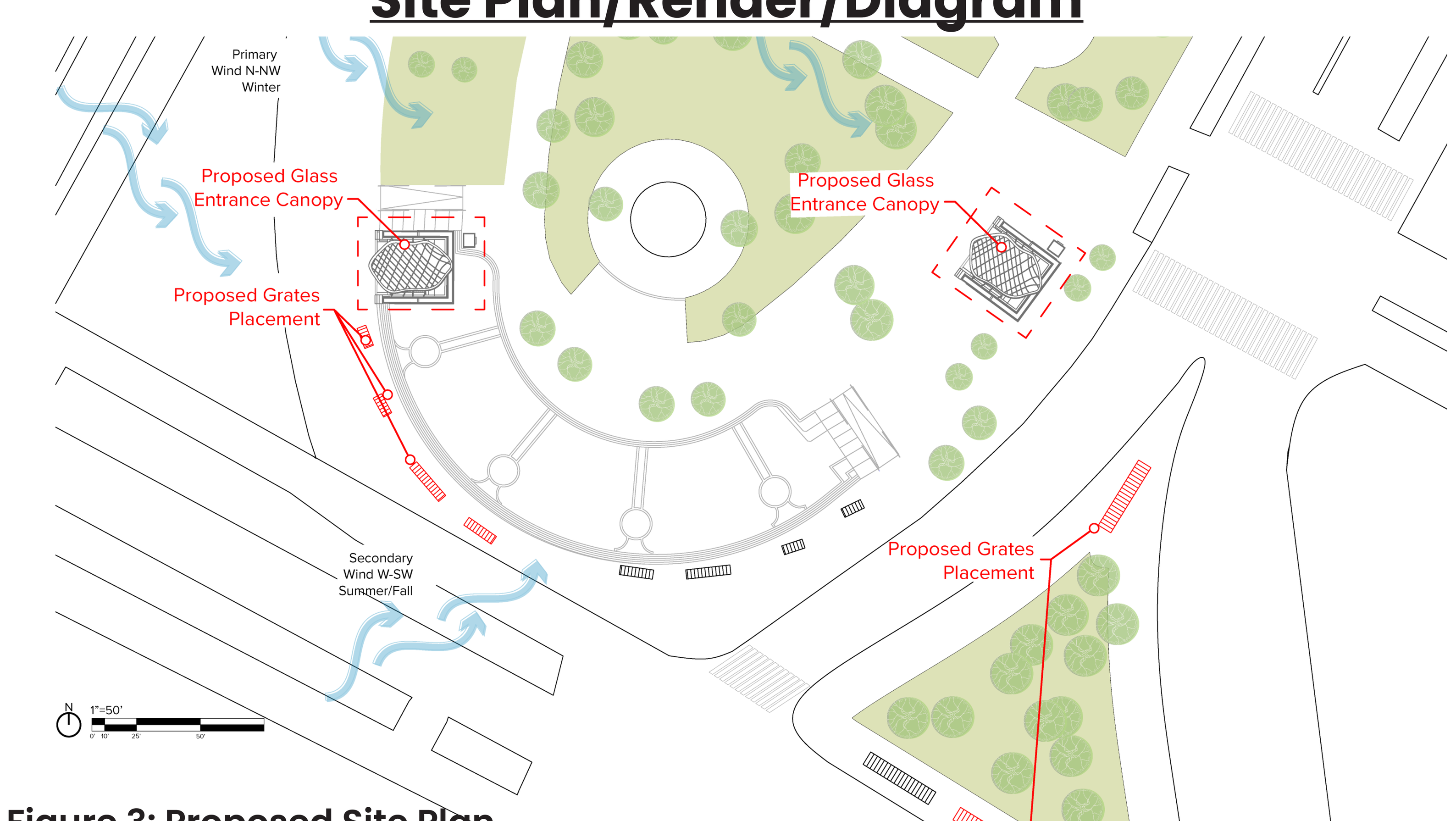

Figure 3: Proposed Site Plan

Figure 4.1: Proposed Canopy Perspective View

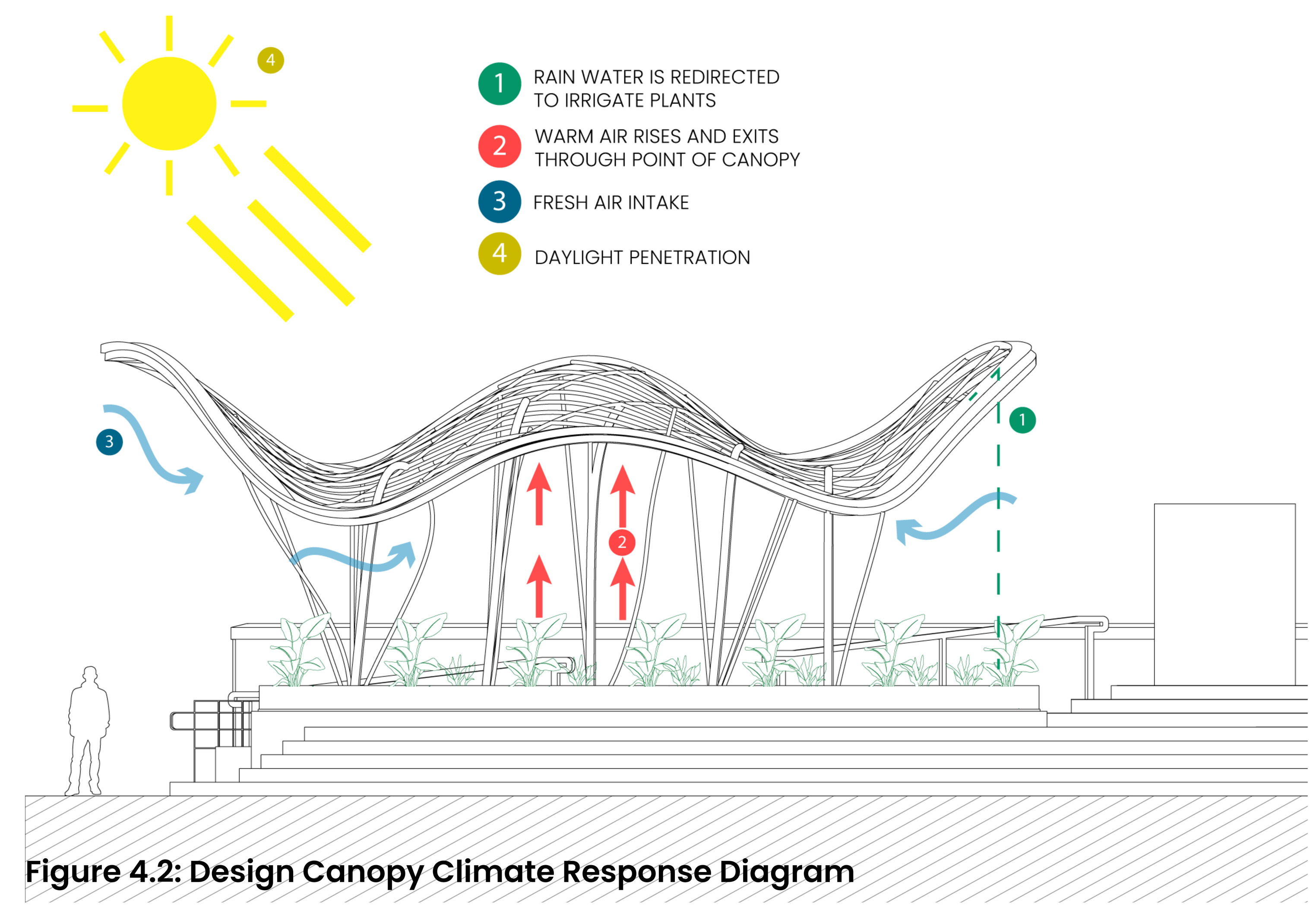

Figure 4.2: Design Canopy Climate Response Diagram

- The proposed canopy geometry and stack-effect strategy respond directly to heat buildup and limited airflow.

Conclusion

This research shows that environmental discomfort at Union Square station is connected to heat retention, limited airflow, and uneven air quality. The proposed entrance canopy uses stack-effect ventilation to release warm air while drawing in fresher air at the station entrance. Photochromic glazing increases daylight while helping control solar heat gain, and vegetation around the entrance supports cooling through shading and evapotranspiration. Together, these passive strategies offer a sustainable approach to improving thermal comfort, air movement, and the overall commuter experience in underground transit spaces.

References

- Health Canada. (2025). Guidance for improving subway air quality. Government of Canada.
- Decker, M. (2025, September 26). MTA explores geothermal cooling to combat intense heat on NYC subway platforms. Hoodline
- Wen, Y., Leng, J., Shen, X., Han, G., Sun, L., & Yu, F. (2020). Environmental and health effects of ventilation in subway stations: A literature review. International Journal of Environmental Research and Public Health, 17(3), 1084.
- Iowa Environmental Mesonet. (n.d.). Wind rose plot for NYC: New York City Central Park, NY. Iowa State University. https://mesonet.agron.iastate.edu/sites/windrose.phtml?network=NY_ASOS&station=NYC

ENVIRONMENTAL AND ARCHITECTURAL CONDITIONS IN THE NYC SUBWAY – QUEENSBORO PLAZA STATION

CSTEP Summer 2026, Department of Architecture

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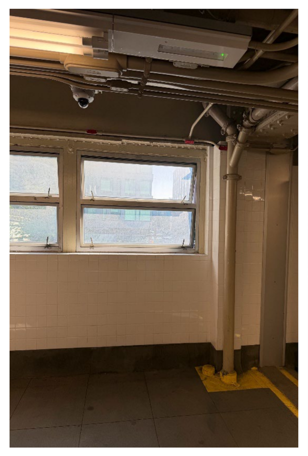
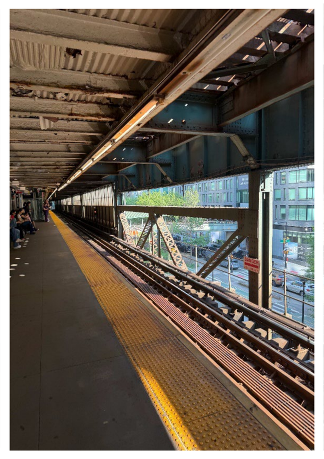
Abstract : Summer heat accumulation in MTA subway stations creates uncomfortable conditions for thousands of daily commuters and can negatively affect rider comfort, health, and the overall transit experience. According to the Regional Plan Association in its report *From Summer of Hell to Summer of Extreme Subway Heat (2019)*, temperatures on New York City subway platforms have been measured as high as 101°F during extreme summer heat, highlighting the urgent need to better understand heat accumulation and improve station design. This research investigates heat accumulation, temperature conditions and thermal comfort experienced by commuters at Queensboro Plaza station in New York City to identify the environmental factors contributing to excessive heat and evaluate opportunities for improving thermal comfort. The study combined on-site observations, temperature measurements, and analyses of wind patterns, shading conditions, heat Island effects, station geometry, and construction materials to better understand the station's environmental performance. The findings provide a foundation for developing architectural design strategies that can reduce heat buildup, improve passenger comfort, and contribute to more resilient, sustainable, and climate-responsive transit environments.

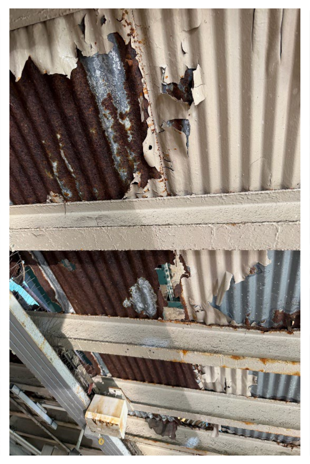
Existing Station Conditions

- Opened in 1917 (over 100 years old)
- Two-level elevated platforms
- Upper platform exposed to direct sunlight
- Heavy daily commuter traffic

06/12 2:00 PM – 3:30 PM

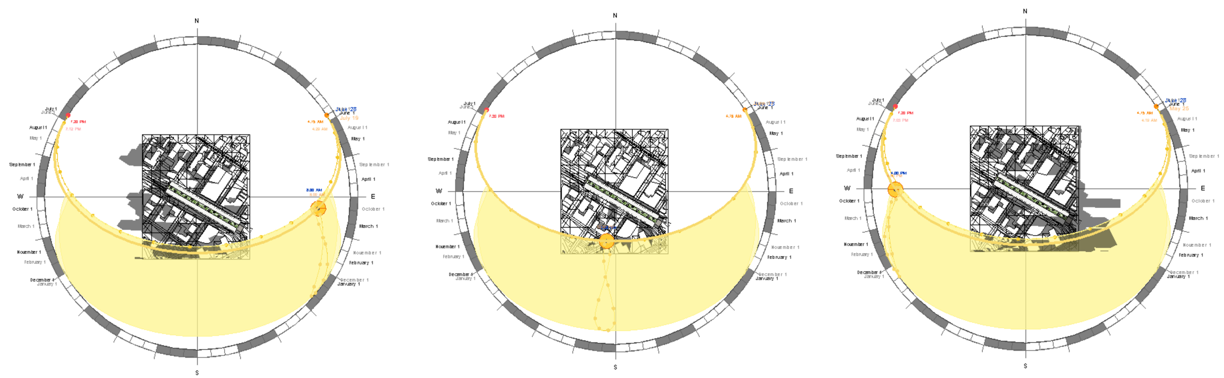

Windows of Lobby


Platform 1 Open/Enclosure


Damage Ceiling


Platform 2 Open

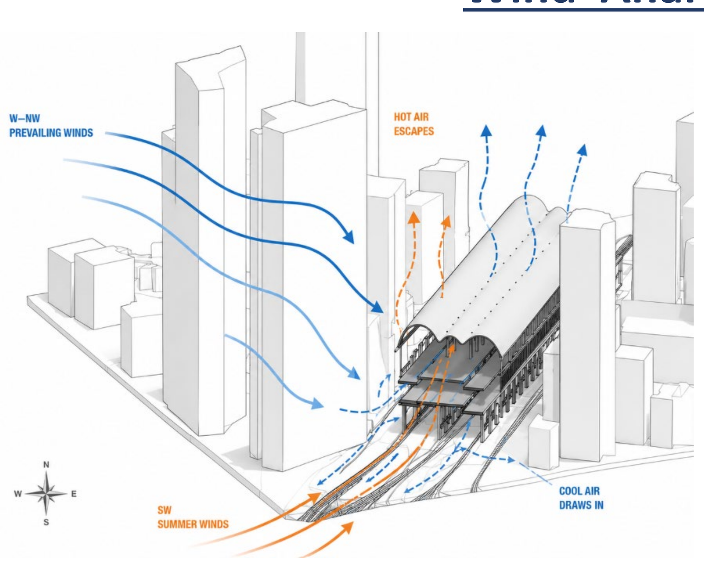
Sun Analysis


06/20 - 8:00 AM 06/20 - 12:00 AM 06/20 - 4:00 AM

Designed by J.Trujillo & B.Fernandez via Revit

- Investigated the sun path throughout the day.
- Identified peak heat exposure hours.
- Evaluated areas of direct sunlight and shade.
- Analyzed solar exposure to improve thermal comfort.

Wind Analysis



Designed by J.Trujillo & B.Fernandez via Revit & InDesign

Prevailing Wind

- West–Northwest (W–NW) for most of the year.
- In summer, southwest (SW) winds bring warmer, more humid air.

Station Problems

- Direct Sun
- Train Braking
- Human Body Heat
- Aging Steel Structure
- Poor Air Circulation

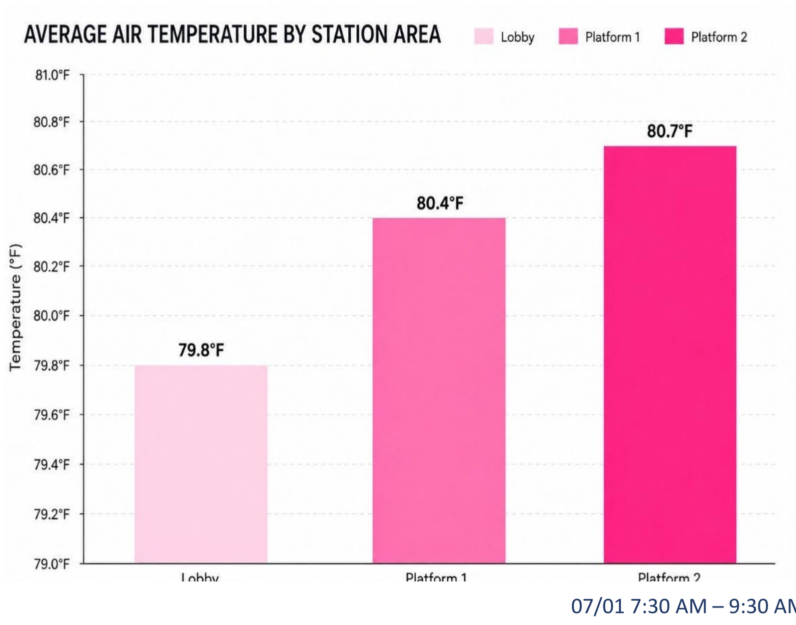
Bibliography

- Metropolitan Transportation Authority (MTA)
- National Oceanic and Atmospheric Administration (NOAA)
- U.S. Environmental Protection Agency (EPA)

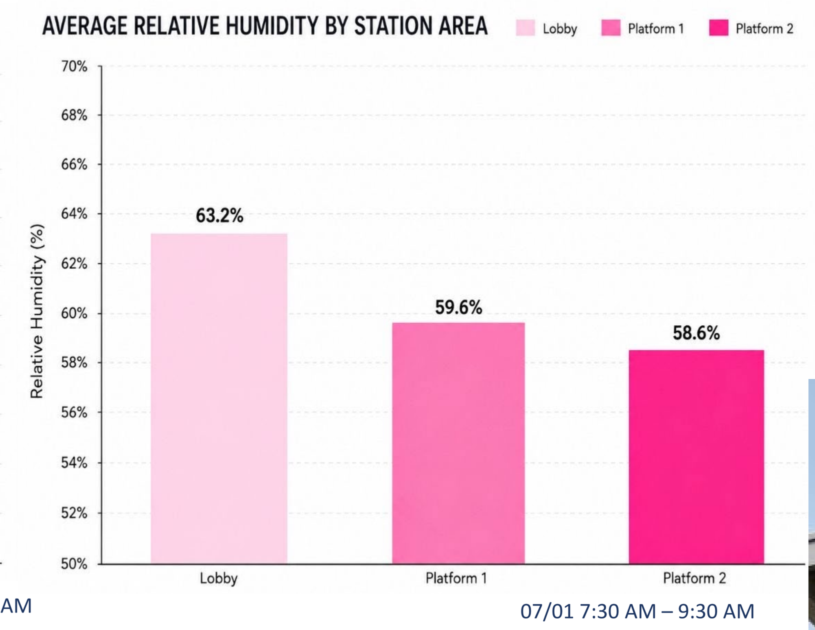
References

- Regional Plan Association. *From Summer of Hell to Summer of Extreme Subway Heat* (2019).
- NYC OpenData. GIS and Land Use Data.

Methods & Data

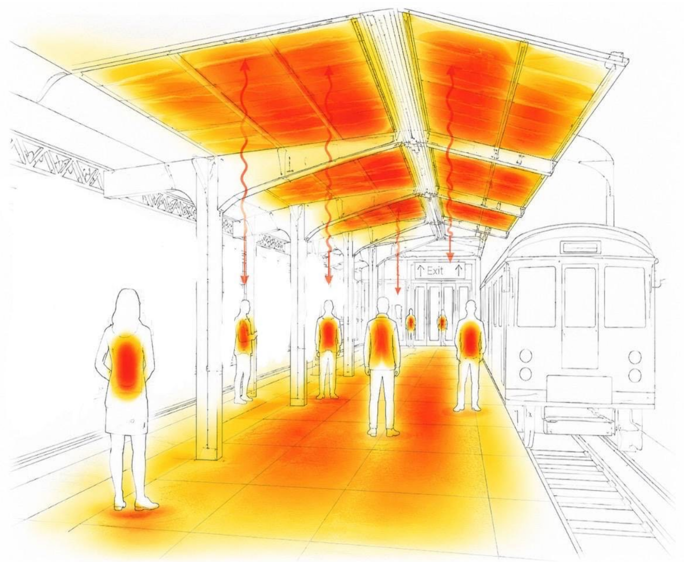


07/01 7:30 AM – 9:30 AM



07/01 7:30 AM – 9:30 AM

Temperature, humidity, and air quality were measured at each station level using a Temtop Air Quality Monitor. Platform 2 was the hottest due to direct sun exposure and heat-absorbing materials, while the Lobby had the highest humidity because of limited airflow.


Temperature Diagram


Level 2 Platform – Thermal Image 07/01 7:30 AM – 9:30 AM

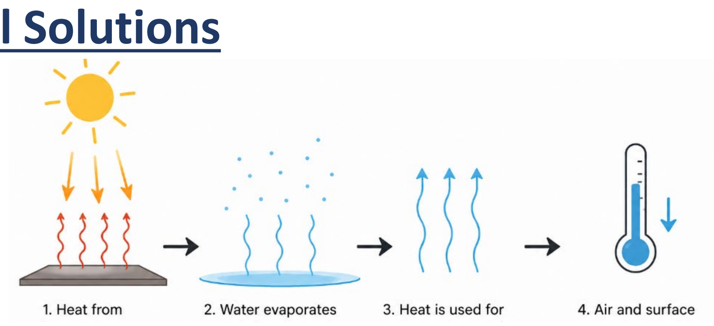

People Thermal 07/01 7:30 AM – 9:30 AM


Level 1 Platform – Thermal Image 07/01 7:30 AM – 9:30 AM

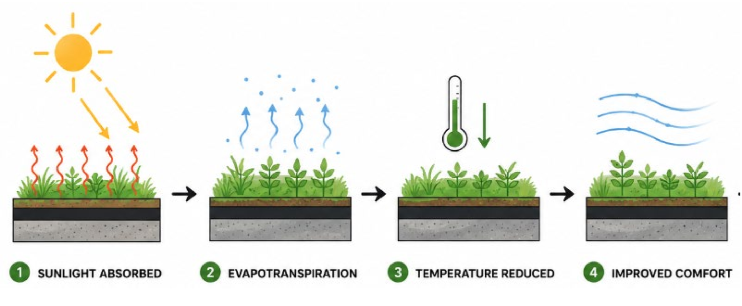
A thermal camera was used to identify surface temperatures throughout the station. The analysis showed that the roof, railings, and upper platform reached the highest temperatures due to direct sunlight and heat-absorbing materials

Environmental Solutions

Water System: Cools the surrounding air through evaporation, reduces heat, and improves commuter comfort

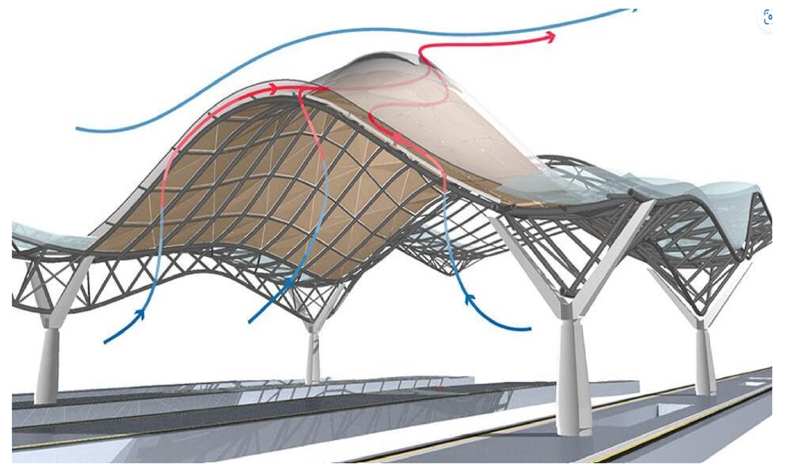


Green Roof: Reduces roof heat absorption, lowers temperatures inside the station, provides insulation, and manages rainwater.



Proposal Design

- Curved roof geometry Extended overhangs covering train's
- Open structure for Platforms 1 & 2
- Central waterfall for evaporative cooling
- Green roof and rainwater reuse system


Roof Geometry


Upper Platform Elevation Rendering

Designed by J.Trujillo & B.Fernandez via Revit and rendered/enhanced using (AI Chat GPT)


Site Context Model

Designed by J.Trujillo & B.Fernandez via Revit and rendered/enhanced using (AI Chat GPT)

WHY DOES OUR DESIGN WORK?

Problem	Design Response	Benefit
Direct sunlight	Curved reflective roof	Reduces solar heat gain
Lack of shade	Extended roof overhang	Provides shade for trains and platforms
Heat trapped	Roof openings	Releases trapped hot air
Poor airflow	Open Level 1 structure	Increases natural ventilation
Hot roof surface	Green roof	Lowers roof temperature through natural cooling
High air temperature	Waterfall system	Cools the air through evaporative cooling

Conclusion

This research demonstrated that heat accumulation at Queensboro Plaza is primarily caused by direct solar radiation, heat-absorbing materials, train braking, and limited roof ventilation. The proposed architectural design responds to these environmental conditions by increasing shade, improving natural ventilation, reducing heat buildup, and enhancing commuter comfort while maintaining an open and sustainable station.

Future Work

- Evaluate long-term maintenance of the water and green roof systems.
- Investigate durable, cost-effective, high-performance materials.
- Validate the design through environmental simulations and real-world testing.
- Collect additional on-site measurements to improve design accuracy..

CITY TECH
Department of Architecture

Sustainable Design Strategies To Improve Environmental Conditions At 191st Street MTA

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Diamonique Watson, PM, Con Ed (MS Columbia SPS, B.Tech 2019) Jean-Pierre Demerieux Gomez, BIM Technical Specialist, (B.Tech 2019)

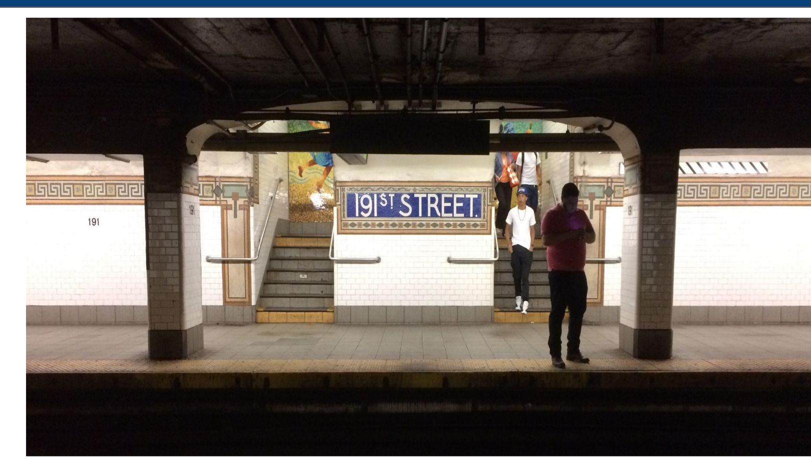
ABSTRACT

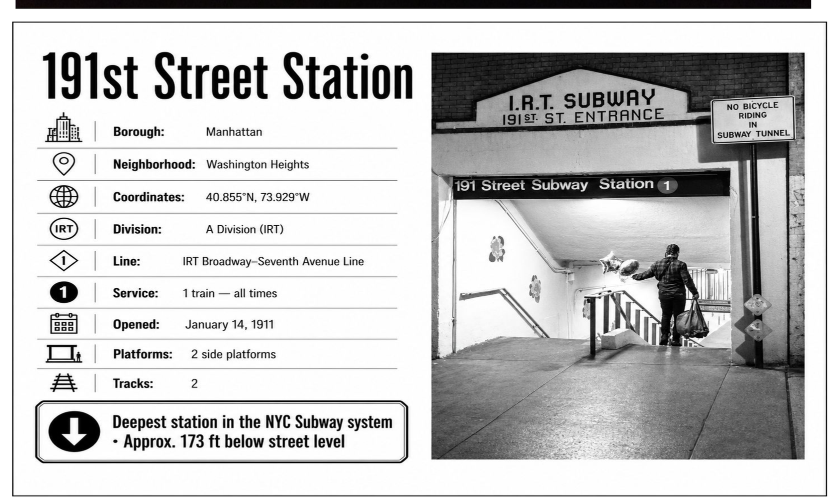
Summer in New York City intensifies the already harsh environmental conditions inside deep-tunnel subway stations, where heat and pollution accumulate far beyond street-level levels. At the 191st Street station, these factors combine to create an underground environment that challenges both commuter comfort and respiratory health.This project examines environmental conditions at the 191st Street subway station and identifies sustainable design strategies to reduce air pollution and improve passenger well-being. The station's deep-tunnel layout, limited ventilation, and high train frequency contribute to elevated levels of particulate matter (PM2.5), heat buildup, and stagnant airflow. Using observational analysis and environmental research, this study evaluates how tunnel geometry, platform configuration, and material surfaces influence the movement and accumulation of pollutants. Findings show that poor airflow circulation allows ferrous PM2.5 from brake dust, rail friction, and tunnel debris to remain suspended, increasing commuter exposure. To address these issues, the project proposes sustainable interventions such as forced ventilation system (FVS), enhanced filtration, angled ceiling panels to guide airflow, platform screen doors, and the use of moisture absorbing materials control humidity. These strategies demonstrate how targeted design improvements can create healthier, more resilient subway environments, particularly in deep stations like 191st Street.

INTRODUCTION

Station Profile: 191st Street Station is served by the 1 train and is known as the deepest station in the NYC Subway system. It sits in Washington Heights, where the land rises sharply from the Hudson River toward St. Nicholas Avenue.

Unique Topography: The station has two entrances at very different heights. The lower entrance is about 78 ft above sea level and connects through a 1,000 ft pedestrian tunnel. The upper entrance is about 220 ft above sea level, creating a 142 ft elevation difference before passengers even reach the platform.Main Environmental Issues: The platform is about 173 ft below street level, buried inside Manhattan schist bedrock. Because it is so deep, there are no windows, no natural ventilation, and very limited fresh air movement. Heat from trains and passengers gets trapped, and brake dust/PM2.5 can build up.





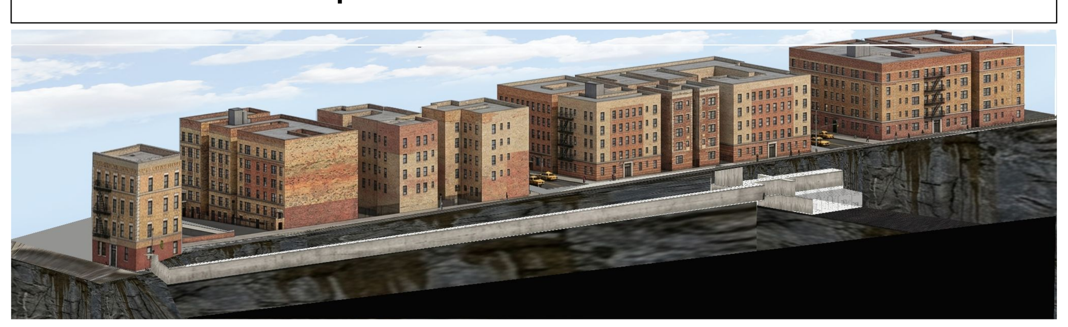


FIG 1.1 3D SECTION OF STATION LAYOUT

METHODOLOGY AND FINDINGS

We visited 191st Street Station and collected environmental data on June 29, 2026. We measured air quality, temperature, humidity, and particle levels at platform level to understand the existing conditions passengers experience.
Instruments Used: We used an air quality sensor to record PM2.5, PM10, CO_2, particle count, temperature, and humidity. We also used a FLIR thermal camera to see where heat collects on the platform, tunnel walls, ceiling, and elevator area.
LiDAR Scanning + Modeling: We used an iPhone Pro LiDAR scanner to create a 3D scan of the station. This helped us record the actual platform geometry, ceiling height, wall surfaces, and spatial dimensions. Our drawings and models were based on this measured station data.
Research Review: Alongside our fieldwork, we reviewed subway air quality research and case studies. These studies showed that brake dust and wheel wear are major sources of PM2.5, and that better ventilation is one of the main ways to improve underground air quality.
Design Development: Using the sensor readings, thermal images, LiDAR scans, and research, we developed architectural strategies to improve ventilation, airflow, and comfort at 191st Street Station. Our goal was to respond directly to the problems we observed on site.
Finding 1 Temperature:
The platform was the hottest zone in the station. The pedestrian tunnel and elevator shaft were much cooler, and the tunnel was even cooler than the outdoor air on the same day. This shows that cool air already exists inside the station, but it is not reaching the platform.
Finding 2 Air Quality by Zone:
Air quality was better in the tunnel and elevator areas compared to the platform. These zones are farther from the tracks and less affected by train movement and brake dust. The platform had the worst air quality in the station.
Finding 3 Train Movement Increases Pollution:
Air quality became worse when trains approached the station. As trains slowed down and braked, particulate levels increased quickly. This confirms that brake dust is a major source of PM2.5 at platform level.

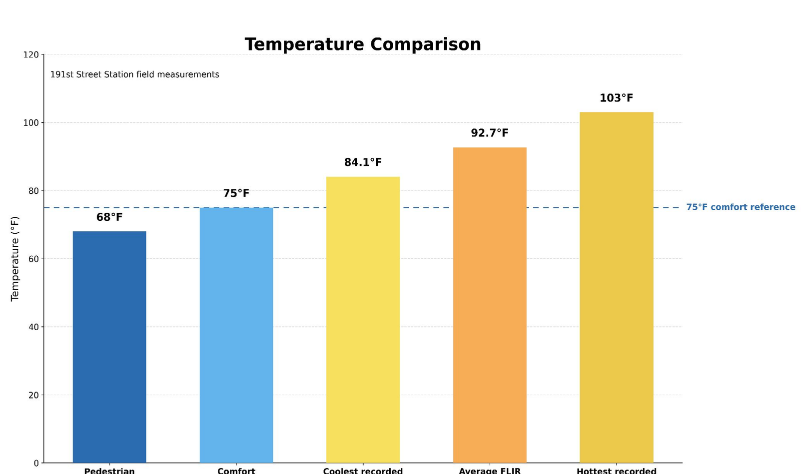


FIG 2.1 Temperature Data June 29, 2026

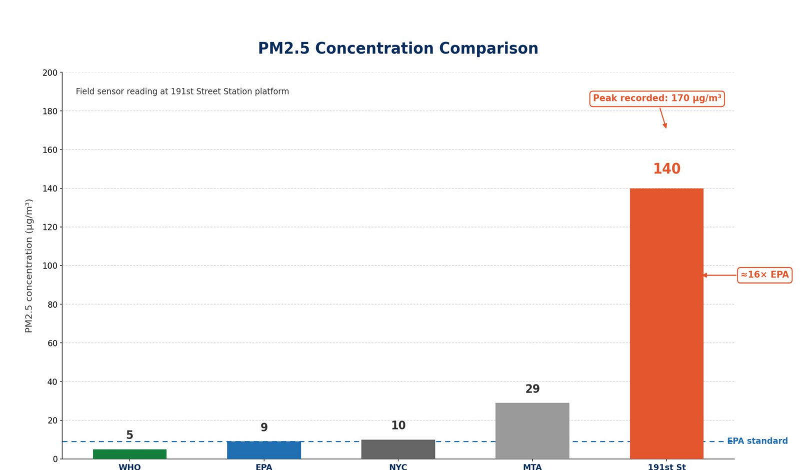


FIG 2.2P M 2.5 Data June 29, 2026

EXISTING CONDITIONS DIAGRAMS

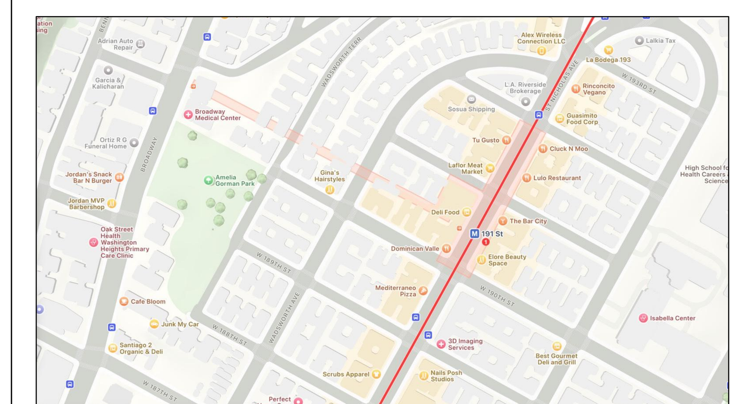


FIG 3.1 SITE PLAN

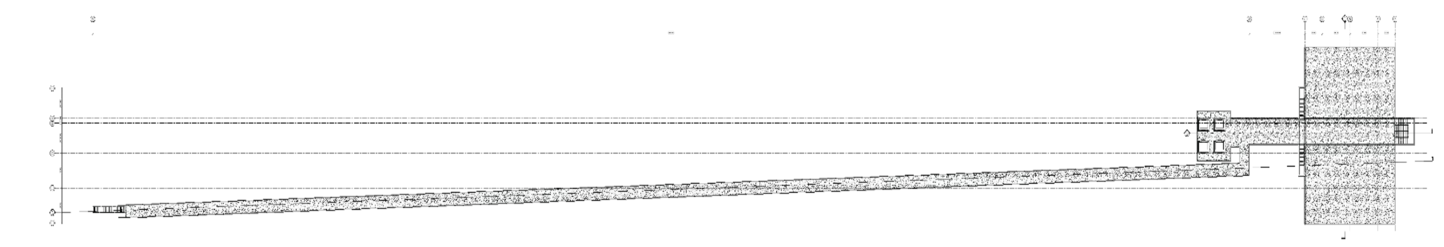


FIG 3.2 PLAN

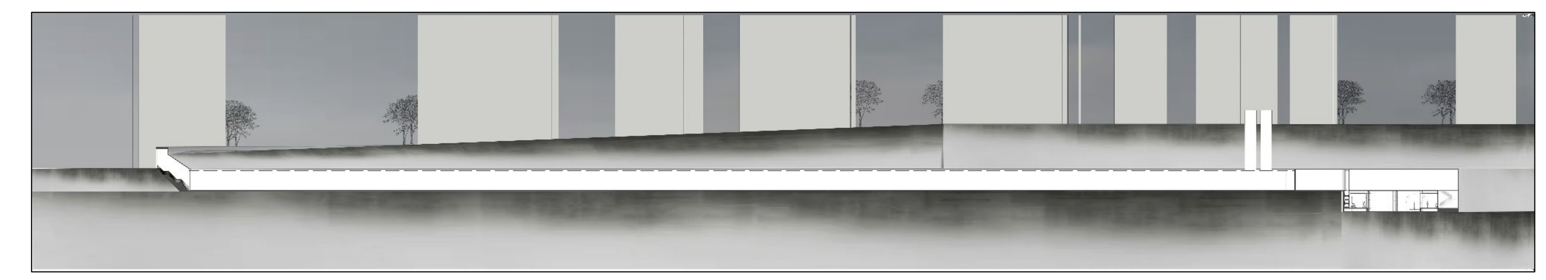


FIG 3.3 LONG SECTION

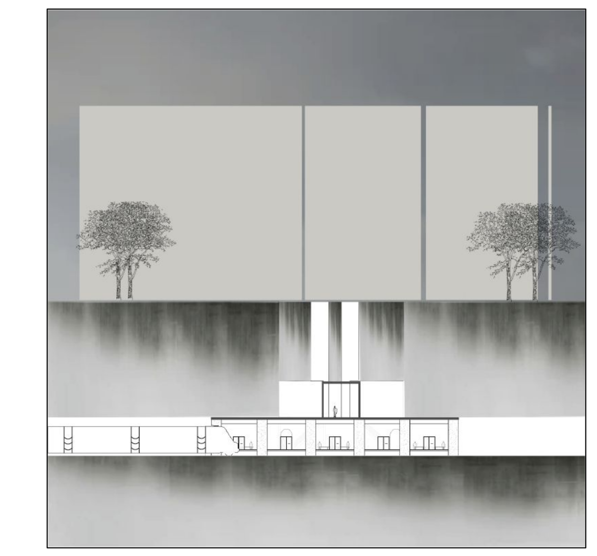


FIG 3.4 SHORT SECTION

CONCLUSION AND DESIGN STRATEGIES

After analyzing our field measurements, we concluded that cooling 191st Street Station should focus on removing trapped heat and controlling PM2.5 exposure, rather than relying only on a conventional HVAC system. The station already has cooler air in the pedestrian tunnel and elevator shaft, but the platform remains hot because heat collects near the low ceiling with no natural escape path. Our proposal uses a combined system: the Forced Ventilation System extracts hot air from the platform, angled ceiling deflectors guide that air toward exhaust paths, and geothermal heat rejection transfers the collected heat into the surrounding ground or bedrock. This approach is supported by the MTA's current investigation of geothermal cooling for deep stations on the 1 line, including 168th Street and 181st Street. Platform Screen Doors protect waiting passengers from PM2.5 and brake dust, while in-train magnetic filtration captures iron-rich particles at the source. Together, these strategies create a cleaner, cooler, healthier, and more sustainable station environment.

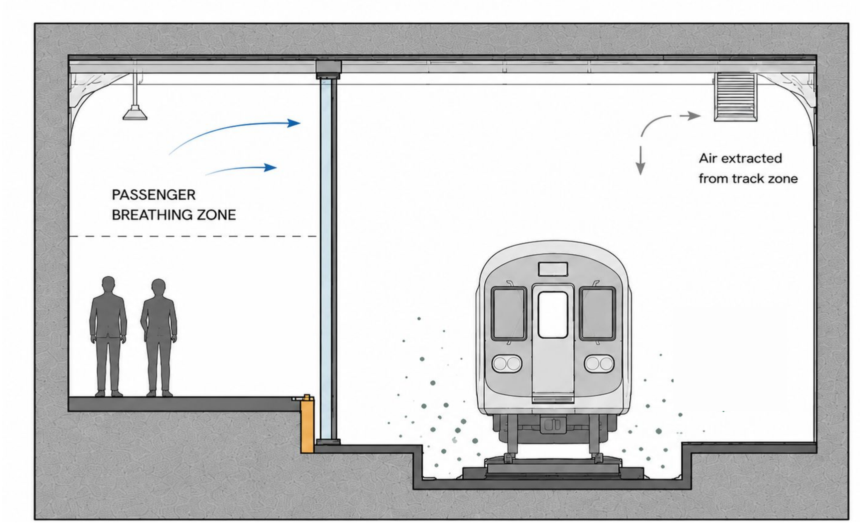


FIG 4.1 Platform Screen Doors (PSD) Plan view:
Install glass barriers between the platform and track zone to reduce passenger exposure to brake dust, PM2.5, tunnel air, and train-generated pollution. Designed by student researchers via Adobe Revit and Enhanced using ChatGpt

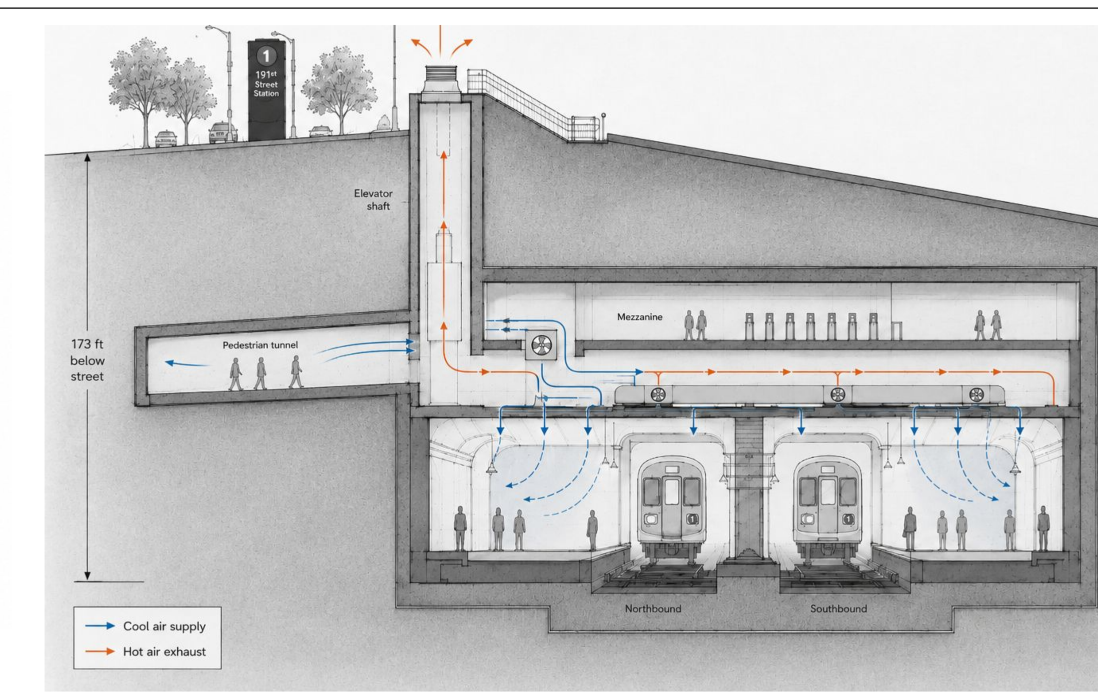


FIG 4.3 Forced Ventilation System (FVS)
Use fans to move the naturally cooler air from the pedestrian tunnel and elevator shaft down to the platform, improving comfort without relying only on outside air. Designed by student researchers via Revit and Enhanced using ChatGpt

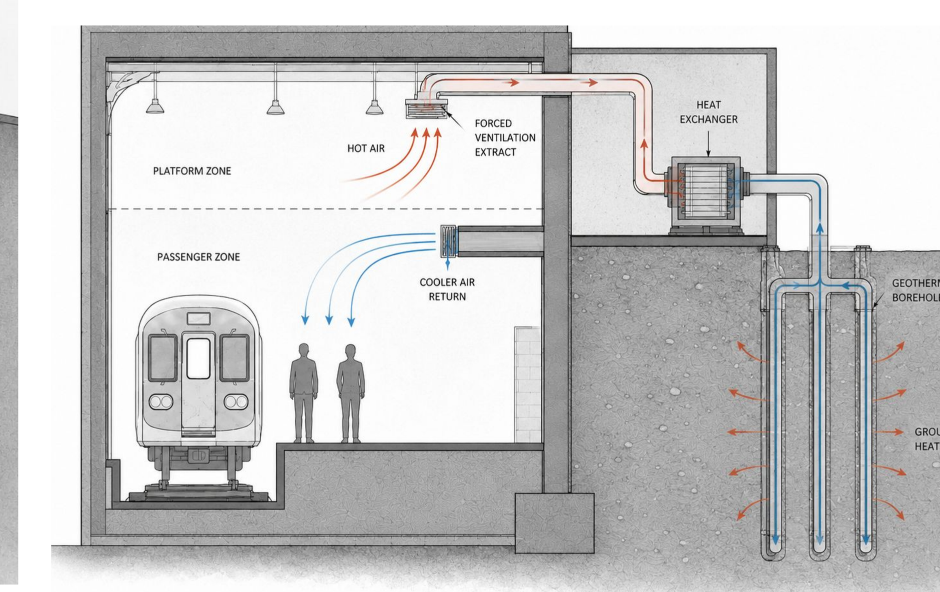


FIG 4.5 Geothermal Cooling By Heat Rejection
extracting hot air from the platform, transferring that heat into a geothermal loop, and rejecting it into the surrounding bedrock. Designed by student researchers via Adobe Illustrator and Enhanced using ChatGpt

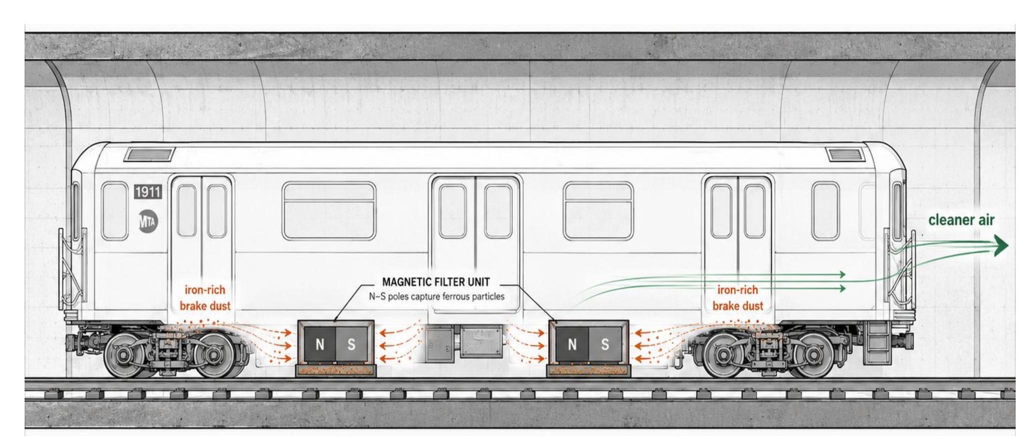


FIG 4.2 In-Train Magnetic Filtration
Capture iron-rich brake dust directly on the train using magnetic filters before the particles spread into the platform air. Designed by students via Adobe Revit and Enhanced using ChatGpt

FIG 4.4 Angled Ceiling Deflectors
Add passive angled panels to the low platform ceiling to push trapped hot air toward exhaust paths and guide cooler tunnel air down to passengers. Designed by student researchers via Adobe Illustrator and Enhanced using ChatGpt

FIG 4.5 Proposed Station Platform Design Render,
All Strategies Combined

REFERENCES:

1. Health Canada. (2022). *Guidance for improving subway air quality*. Government of Canada. https://www.canada.ca/content/dam/hc-sc/documents/programs/guidance-for-improving-subway-air-quality/subway-guidance-en.pdf
2. Wen, Y., Leng, J., Shen, X., Han, G., Sun, L., & Yu, F. (2020). Environmental and health effects of ventilation in subway stations: A literature review. *International Journal of Environmental Research and Public Health, 17*(3), 1084. https://doi.org/10.3390/ijerph17031084
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USE OF UNIVERSAL ROBOTS UR3e AND MACHINE VISION FOR AUTOMATED PALLETIZING

Brian Candela • Gabriela Bernales • Anthony Glenn
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ABSTRACT

This research examines the growing role of collaborative robots in modern manufacturing and their ability to safely interact with human workers Universal Robots are used to explore manufacturing operations such as material handling and automated assembly. We investigated how robot programming and safety features contribute to industrial processes. This research also highlights the importance of integrating robotics into K-12 and higher education. To prepare the next generation of engineers, technicians, and educators.

INTRODUCTION

Collaborative Robots, commonly known as cobots, are designed to work safely alongside human operators. Unlike traditional industrial robots, cobots require less safety fencing and are easier to program.

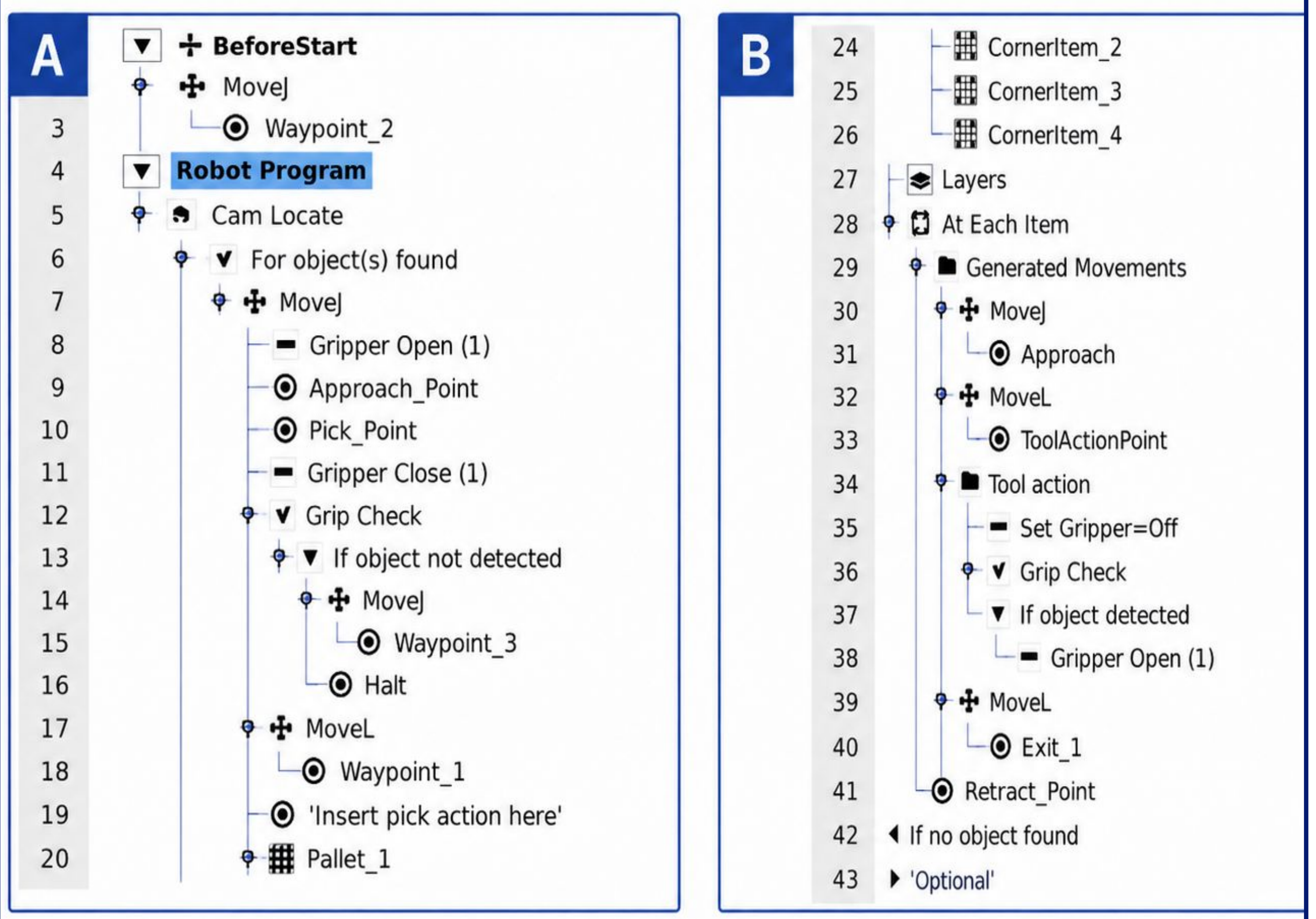
Universal Robots UR3e is a six axis collaborative robot widely used for: Pick and play operations, Assembly, packaging and palletizing

DISCUSSION

Collaborative robots provide a flexible alternative to traditional industrial automation. The combination of machine vision, human-robot collaboration, flexible programming, and safety systems allows cobots to operate safely and efficiently in manufacturing environments.

This project demonstrates how students can learn modern manufacturing techniques while developing programming, engineering, and problem-solving skills

PROGRAM TREE (POLYSCOPE-5)



⚠ Safety caution / The Movement of the UR3 can be sudden

OBJECTIVES

- Learn UR3 programming using Polyscope 5
- Understand palletizing operations
- Train the Robotiq Wrist Camera
- Detect blocks arranged in a grid
- Pick and place objects autonomously
- Study collaborative robot safety standards
- Explore real-world manufacturing applications

MATERIALS

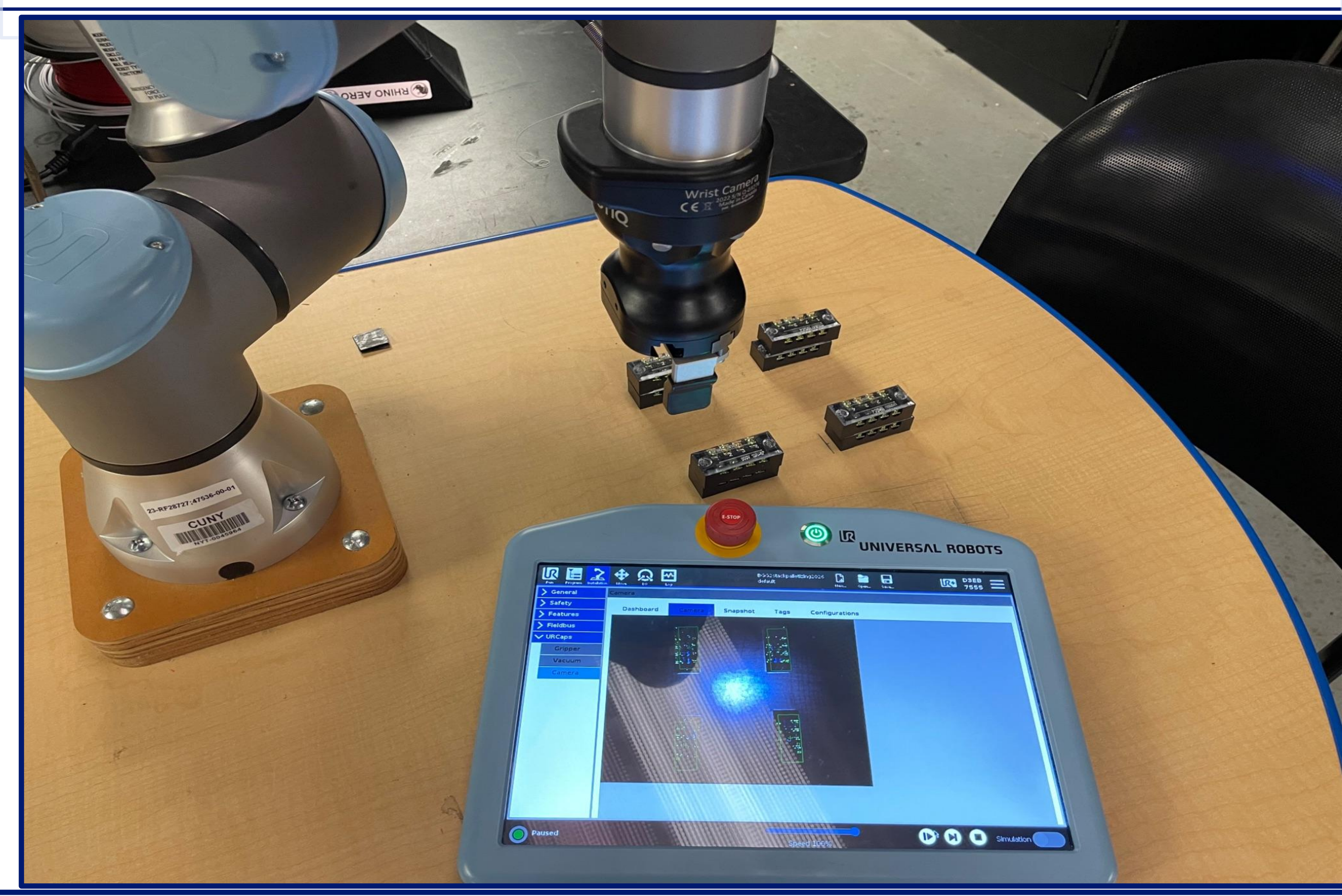
Universal Robots UR3e
Robotiq Wrist Camera
Grid of blocks
Teach Pendant
Control Box

RESULTS

The UR3 collaborative robot, equipped with the RobotiqWrist Camera and programmed in Polyscope, performs an intensified model task confirmed automated part identification and palletizing operations. The UR3e was tested by professional engineers and placed in a real-world application field to demonstrate performance, speed, and accuracy. Each item on the workcell including the workstation safety camera, pick and blocks, and places in the correct position on the pallet. The robot program was developed to (1) move to the scan position. (2) Capture an image. (3) Identify the location of each block. (4) Pick the block from its original position, and (5) Place it in the appropriate pallet location. After each movement, the robot was performed a re-check to maintain and repeat the process until all four big layers and all four form sets were identified. Errors to ensure correct detection and and accurate placement. The results show that the UR3e can reliably detect and handle objects using machine vision while following a safe, accurate workflow. The integration of the Robotiq Wrist Camera improved detection and enabled real-time adjustments, demonstrating the efficiency gains possible in collaborative manufacturing environments. These findings confirm that collaborative robots like the UR3e are effective for automating repetitive material handling tasks and can support small and medium-sized manufacturers increasing productivity while maintaining workplace safety

CONCLUSION

The UR3e collaborative robot equipped with the Robotiq Wrist Camera successfully performed automated pick and grid stacking palletizing tasks. System testing validated object detection, accuracy, safety performance, and real-time improvements. The integration of thye vision camera improved detection performance and reduced manual intervention, while use of Polyscope programming enabled efficient workflow and code traceability. UR3e is an effective solution for automating repetitive material handling tasks and manufacturing a safe environment.



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DriveReplyAI

An AI-Assisted Mobile Application for Driver Safety and Accessibility

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CUNY NYC College of Technology, Software Engineering Technology

ABSTRACT

Distracted driving remains a leading cause of roadway accidents. **DriveReplyAI** is an Android application that uses artificial intelligence and voice technologies to enable hands-free text messaging. Incoming SMS messages are read aloud, AI-generated reply suggestions are created using a **Large Language Model (LLM)**, and users can navigate and send responses through **voice commands.**

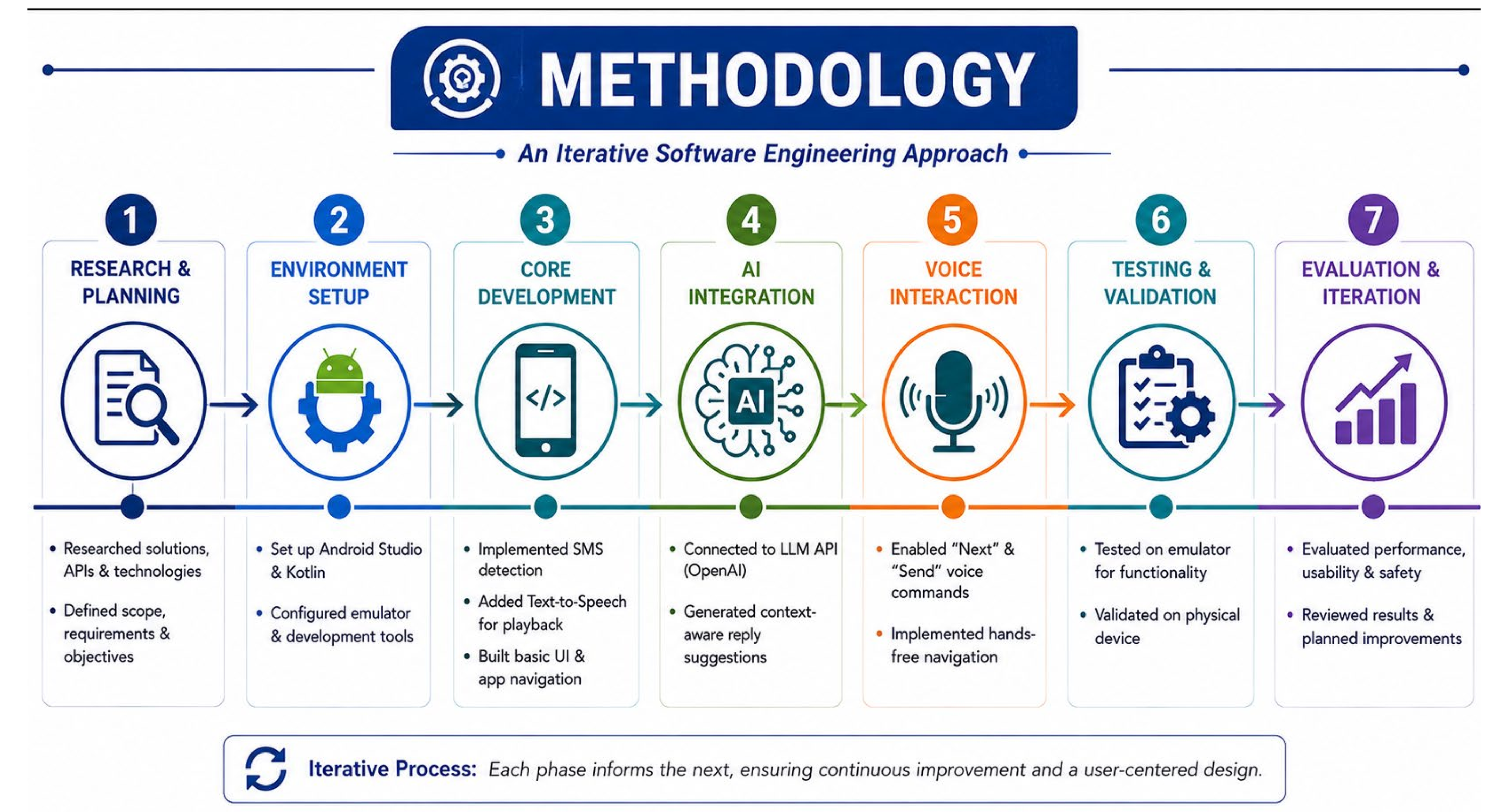
The prototype, developed in Android Studio using Kotlin, successfully integrates SMS detection, Text-to-Speech, Speech Recognition, and AI-powered response generation. Future work will expand compatibility with additional messaging platforms and evaluate the application's effectiveness in improving **driver safety** and **accessibility**.

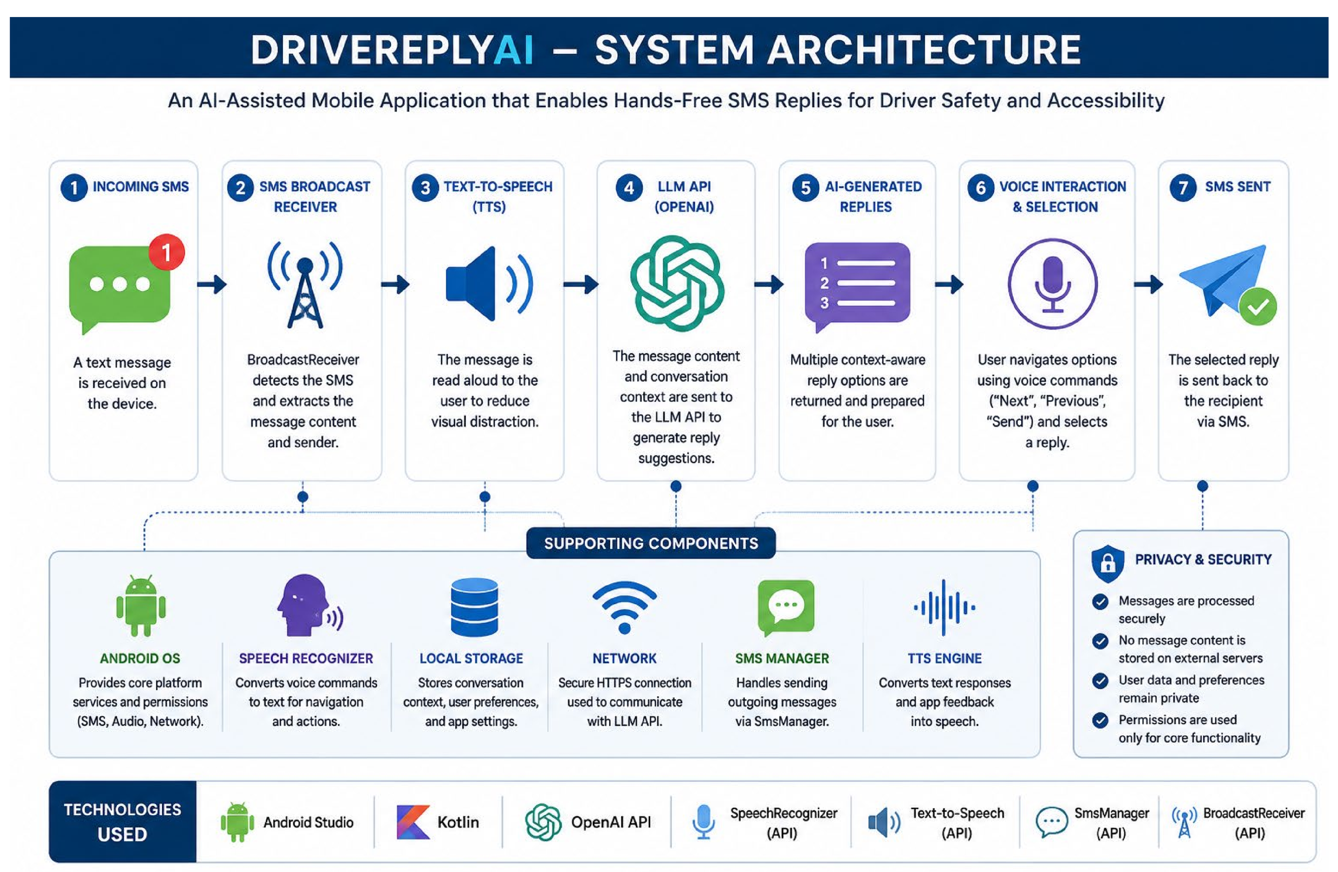
OBJECTIVE

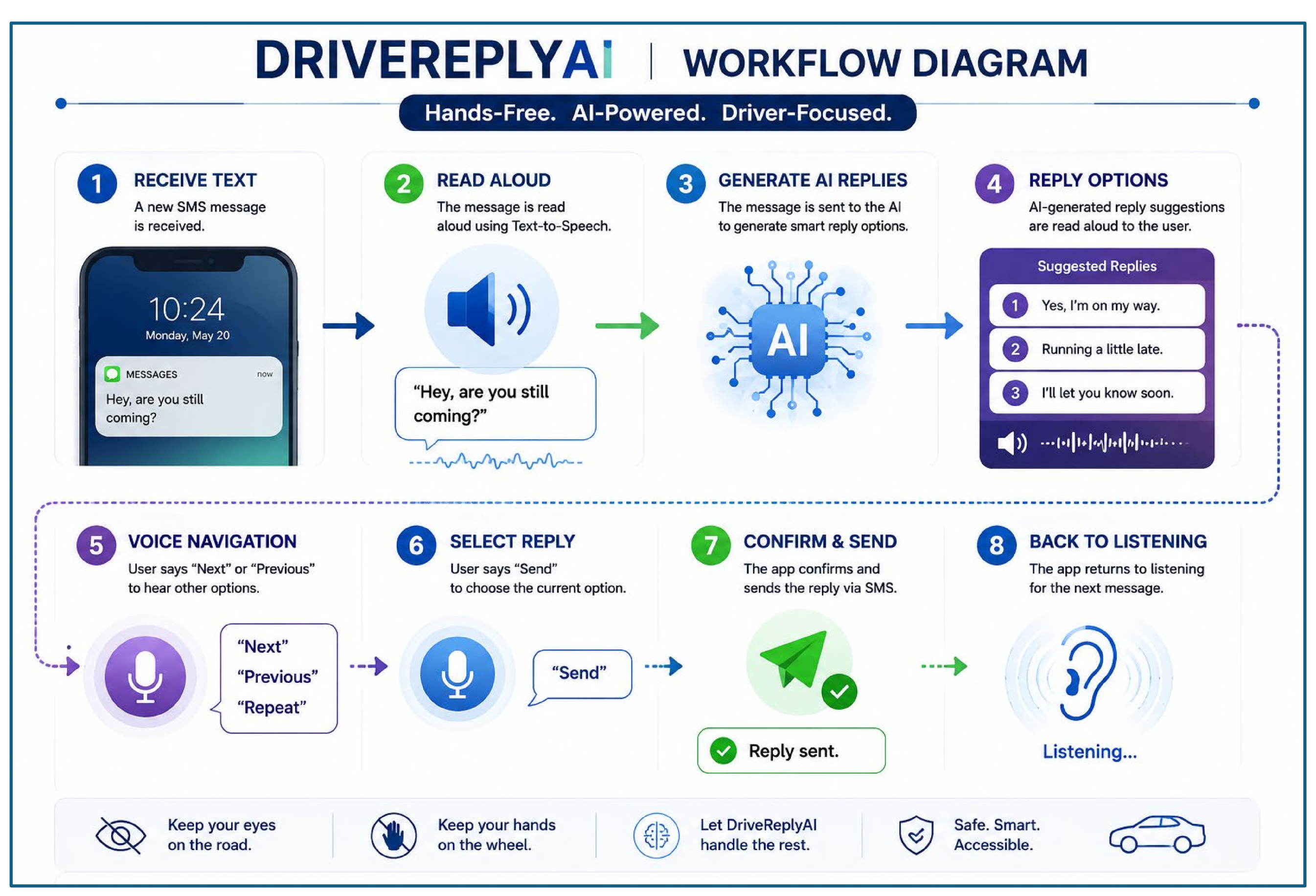
The primary objective of **DriveReplyAI** is to develop an intelligent, hands-free messaging assistant that promotes safer driving by reducing manual interaction with mobile devices.

Specific objectives include:

- Detect incoming SMS messages in real time.
- Read messages aloud using Text-to-Speech.
- Generate context-aware AI reply suggestions.
- Enable users to navigate reply options using voice commands.
- Send responses without requiring physical interaction with the phone.
- Improve accessibility for users with visual, mobility, or temporary physical limitations.







CURRENT PROGRESS/RESULTS

The **DriveReplyAI** prototype successfully demonstrates the core functionality of a hands-free AI messaging assistant.

Completed Features

✓ Incoming SMS detection
✓ Text-to-Speech message playback
✓ AI-generated reply suggestions
✓ Voice-controlled reply navigation
✓ Hands-free message transmission
✓ Emulator and physical device testing

Preliminary Results

Initial testing confirms that users can receive, review, and respond to text messages without manually interacting with their device after activation.

FUTURE WORK

Future development will expand DriveReplyAI beyond SMS while enhancing personalization, accessibility, and performance. Planned improvements include:

- Support for additional messaging platforms
- Personalized AI response generation
- Emergency response detection
- Wearable device integration
- Performance optimization and user evaluation

IMPACT & CONCLUSION

Improves Driver Safety
Reduces manual phone interaction through voice-controlled messaging.

Enhances Accessibility
Supports users with visual, mobility, or temporary physical limitations.

Demonstrates Practical AI
Applies LLM technology to solve a real-world communication challenge.

Acknowledgements
The author gratefully acknowledges **Professor X. Li**, the **Software Engineering Department at New York City College of Technology (City Tech)**, and the **CSTEP Summer Research Program** for their mentorship, guidance, and support throughout the development of **DriveReplyAI**.

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A MULTIMODAL BCI FOR ASSISTIVE ROBOTICS

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Faculty Advisor: Professor Farrukh Zia

Computer Engineering Technology Department & Electrical Engineering

New York City College of Technology

ABSTRACT

The Switch Interface Device for Assistive Technology Users is a non-invasive, AI-assisted assistive robotic arm designed to help individuals with severe motor impairments perform everyday tasks more independently. The system combines Electroencephalography (EEG) to interpret brain signals into robotic arm commands and Electrocardiography (ECG)/Photoplethysmography (PPG) to monitor heart activity and provide real-time health feedback. This project contributes a theoretical framework for multimodal biosignal fusion in assistive robotics, with AI modeling and hardware implementation.

INTRODUCTION

Millions of people live with motor impairments from conditions such as ALS, spinal cord injury, and stroke, many of whom cannot access traditional assistive devices that rely on residual physical movement. Existing single-input BCI systems are fragile: one degraded signal stops the device. This project proposes a multimodal biosignal control system that remains operational when one signal fails and adapts in real time to the user's changing physiological state.

HARDWARE DESIGN

EEG serves as the primary control method by collecting brain bio signals and using artificial intelligence to interpret them into commands that control the movement of the robotic arm. The ECG/PPG system monitors the user's heart activity by measuring heart rate, Heart Rate Variability (HRV), and heartbeat patterns. EEG measures the brain's electrical activity through scalp electrodes. During motor imagery (imagining a limb movement), the bio signals are acquired at key electrode positions C3, Cz, and C4 following the 10–20 international system, amplified, and filtered before AI processing.

ECG measures the heart's electrical activity through surface electrodes; PPG uses a fingertip light sensor as a lower-cost alternative. Both derive Heart Rate Variability (HRV) from beat-to-beat intervals — specifically SDNN, RMSSD, and LF/HF ratio — to continuously assess the user's physiological state. Unlike EEG, ECG/PPG does not control the arm directly. Instead it tells the system how to behave: high HRV means calm focus and full sensitivity; low HRV signals stress and simplifies commands; declining HRV over time indicates fatigue and raises confirmation thresholds. This real-time physiological awareness is what separates this system from static, fixed-behavior assistive devices.

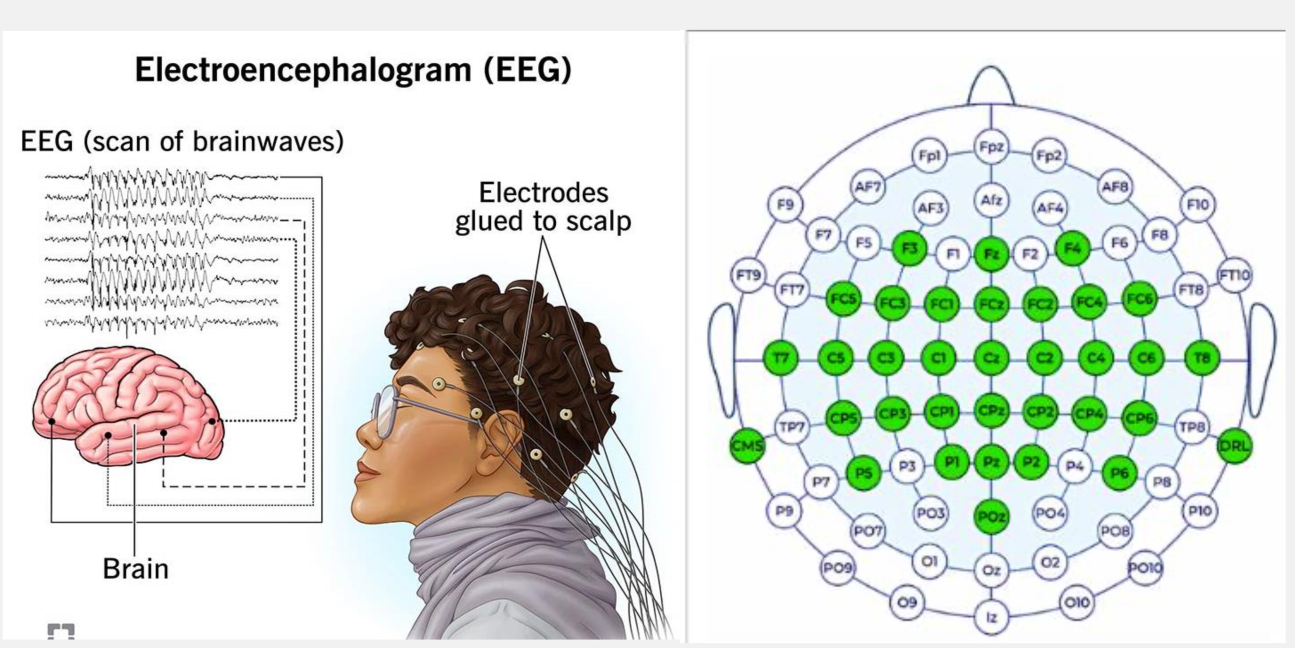

Fig 1. 10-20 System EEG electrodes placement

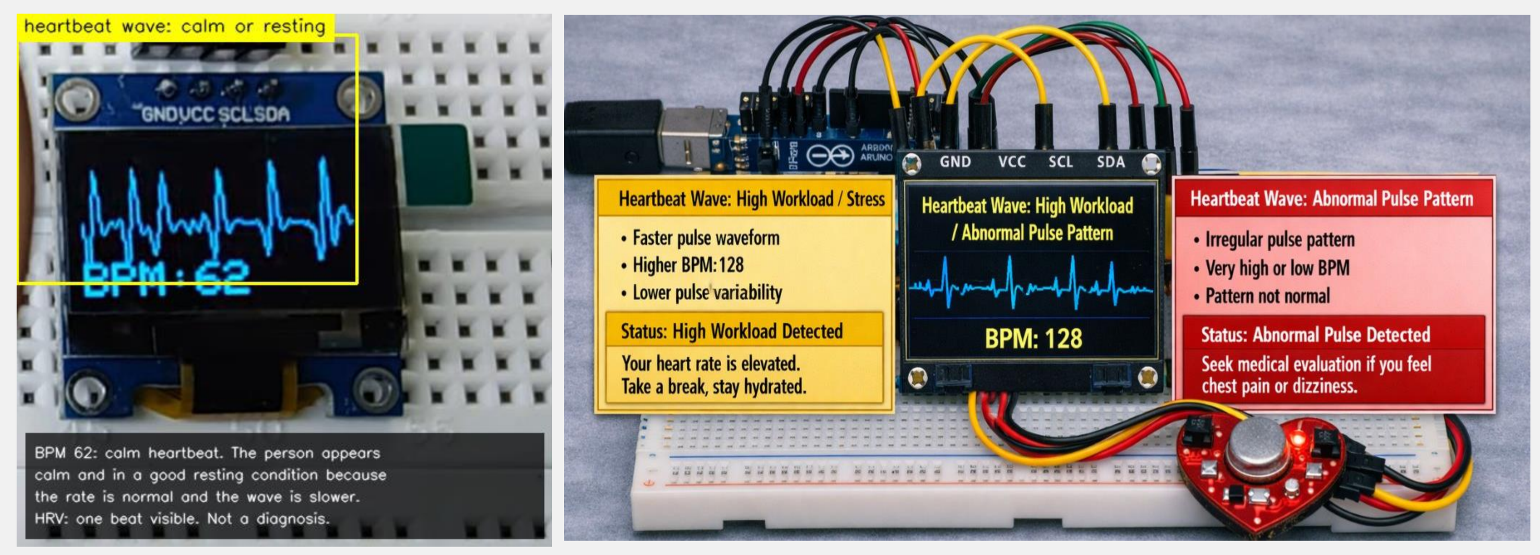

Fig 2. ECG/PPG monitor.

AI SOFTWARE DESIGN

EEG classification uses EEGNet for real-time motor intent detection and CNN-LSTM for temporal pattern verification across multi-second signal windows. ECG/PPG state monitoring uses Random Forest to classify current physiological state from HRV features and LSTM to track gradual trends over time. The use of Roboflow as an image-based classification layer — converting EEG and ECG/PPG signals into visual representations for AI analysis — is currently being explored as part of ongoing research.

The fusion layer combines EEG and ECG/PPG outputs into a single command using a weighted, rule-based strategy — adjusting sensitivity and confirmation thresholds based on EEG confidence and the user's physiological state. If one signal degrades, the system continues operating on the remaining input, ensuring the device never fully stops functioning.

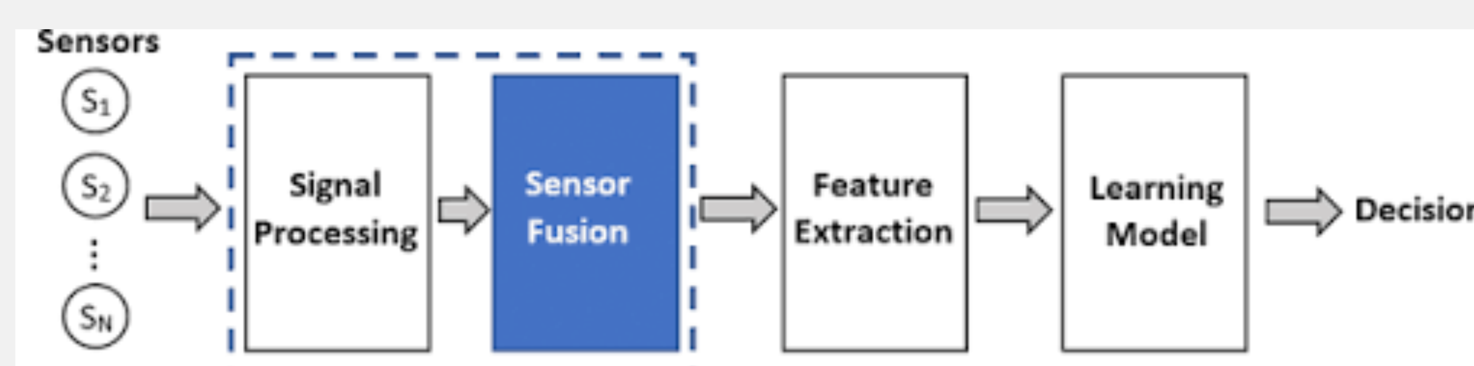

Fig 3. Fusion Layer Pipeline.

FUTURE PLAN

Future work on the Switch Interface Device for Assistive Technology Users could focus on integrating Electrooculography (EOG) with EEG and ECG/PPG to improve robotic arm control through eye movement–based confirmation and direction. Further development may also combine all signals into a more stable system and advance toward building a fully functional real-world assistive robotic arm.

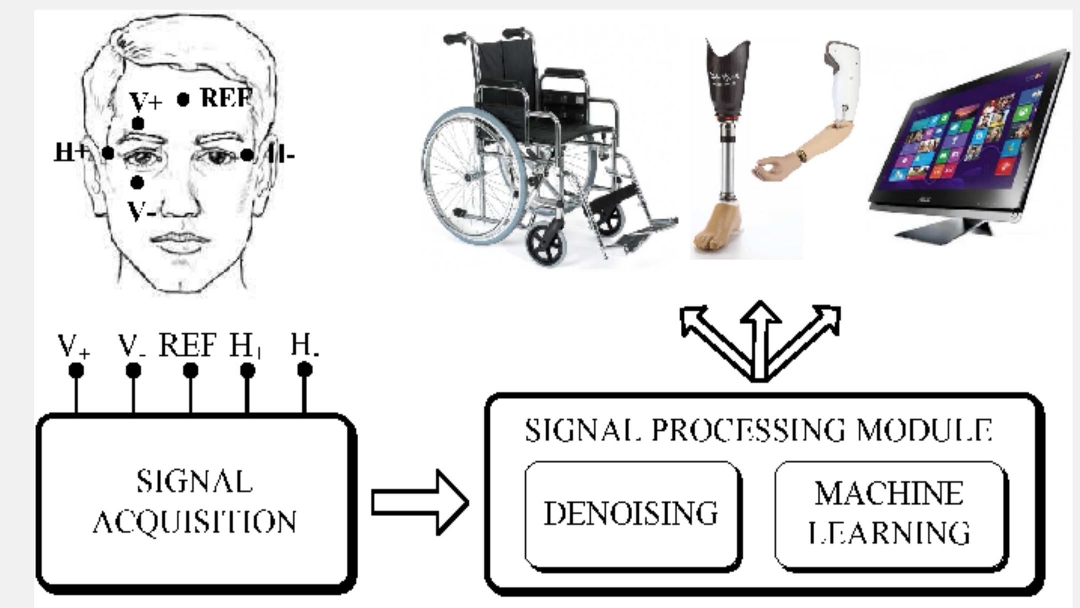

Fig 4. EOG signals integrated as safety feature of the system.

CONCLUSION

- The Switch Interface Device for Assistive Technology Users demonstrates how EEG and ECG/PPG biosignals can be combined with artificial intelligence to enable intelligent robotic arm control and real-time health monitoring for individuals with severe motor impairments.
- This project highlights how Electrical Engineering and Computer Engineering Technology can be used to develop accessible, adaptive assistive systems that promote independence, improve safety awareness, and support real-world interaction.

ACKNOWLEDGEMENTS

We are deeply grateful to Prof. Farrukh Zia for his invaluable mentorship, guidance, and continuous support throughout this project. We also sincerely thank the CSTEP Summer Research Program for providing us with the opportunity to develop and present this work, and the Roboflow platform for enabling us to design and train our own AI models, which made the intelligent aspects of this system possible.

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Cloud Security Assessment: Progress Software Vulnerabilities and IAM Controls

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Professor Ossama Elhadary

City Tech 21st Annual Poster Session

Department of Computer Systems Technology

Intro

Vulnerability exposure windows—the time between public vulnerability disclosure and the availability of a vendor-issued patch—are an important measure of vendor security responsiveness. While software vendors have improved coordinated vulnerability disclosure, it remains unclear whether exposure windows have consistently decreased over time. This study uses Progress Software as a case study to examine trends in vulnerability exposure window (the interval between public disclosure and the availability of a vendor-issued patch). Progress Software, the developer of widely deployed enterprise platforms such as MOVEit Automation and WhatsUp Gold, has been repeatedly targeted by ransomware groups including Cl0p due to several high-impact product vulnerabilities. Although prior research highlights exposure windows as a key indicator of vendor security responsiveness, the temporal trend of these windows has not been systematically analyzed for Progress Software specifically.

Methods

A case study approach was used to analyze four critical Progress Software vulnerabilities disclosed between May 2024 and April 2026: CVE-2024-4885, CVE-2024-6670, CVE-2026-4670, and CVE-2026-5174. Data were collected from the CISA Known Exploited Vulnerabilities (KEV) Catalog, Progress Software security advisories, the National Vulnerability Database (NVD), and independent security researcher reports. For each vulnerability, disclosure dates, patch release dates, CVSS scores, exposure windows, and confirmed exploitation data were collected. Exposure windows were compared across the four vulnerabilities to identify trends in vendor responsiveness over time.

Progress Software vulnerabilities' Analysis

CVE ID	Vendor / Product	Vulnerability Type	CVSS	Disclosure Date	Patch Date	Exposure Window	Real-world exploitation confirmed
CVE-2026-4670	Progress MOVEit Automation	Authentication Bypass	9.8	Apr 30, 2026	Apr 30, 2026	0 days	No (disclosed w/ patch)
CVE-2026-5174	Progress MOVEit Automation	Privilege Escalation	8.8	Apr 30, 2026	Apr 30, 2026	0 days	No (disclosed w/ patch)
CVE-2024-6670	Progress WhatsUp Gold	SQL Injection	9.8	Aug 30, 2024	Mid-Aug 2024	14 days	Yes (within hours of PoC release)
CVE-2024-4885	Progress WhatsUp Gold	Path Traversal → RCE	9.8	Apr 24, 2024	May 24, 2024	30 days	Yes (added to CISA KEV, exploited post-patch)

This table summarizes the four Progress Software vulnerabilities analyzed in this study and illustrates a clear downward trend in vulnerability exposure windows over time. The exposure window decreased from 30 days for CVE-2024-4885 to 14 days for CVE-2024-6670,ultimately reaching zero days for both MOVEit Automation vulnerabilities disclosed in 2026.These findings demonstrate substantial improvements in vendor responsiveness and coordinated disclosure practices. However, the exploitation of the 2024 WhatsUp Gold vulnerabilities despite available patches highlights that organizational delays in patch deployment continue to be a significant factor in enterprise cybersecurity risk.

Recommendations Based on Analysis

Priority	Action	Target
Critical	Patch MOVEit Automation to versions 2025.1.5, 2025.0.9, or 2024.1.8	CVE-2026-4670, CVE-2026-5174
Critical	Upgrade WhatsUp Gold to version 2024.0.0 or later	CVE-2024-6670, CVE-2024-4885
High	Implement automated patch management to reduce exposure window	All Progress Software products
High	Monitor for indicators of compromise (audit logs, network traffic)	All products
Medium	Review internet exposure of MOVEit and WhatsUp Gold installations	All products

Conclusion

This case study demonstrates that vulnerability exposure windows can be used to evaluate trends in vendor security responsiveness. Progress Software reduced its exposure windows from **30 days in 2024** to **same-day patch availability in 2026**, reflecting significant improvements in coordinated disclosure and patch management. However, the findings also show that enterprise risk is driven not only by vendor responsiveness but also by organizational patching delays. These results support the use of exposure-window analysis as a framework for evaluating vendor security practices and emphasize the importance of timely patch deployment and automated vulnerability management.

Results/Findings

Although Progress Software demonstrated improved vendor responsiveness through reduced exposure windows and same-day patch availability, organizations remain responsible for minimizing their own exposure by deploying security updates promptly. Automated patch management, continuous monitoring for indicators of compromise, and prioritization of internet-facing systems can significantly reduce the likelihood of successful exploitation after vulnerabilities are disclosed.

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LLM Applications in Software Vulnerability Detection: A Systematic Review

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1 - Abstract

Large language models (LLMs) have emerged as a promising approach to software vulnerability detection. Traditional static analysis tools match predefined syntactic patterns, which leaves them blind to complex, logic-based flaws that require understanding what the code actually means.
LLMs are appealing because they can reason about source code semantically, like a human reviewer, but at scale. This review surveys recent research on LLM-based detection, recording for each study the model used, the dataset employed, and the vulnerability types targeted. We find the field clusters around a few models **(GPT-3.5/4, CodeBERT-family)** and a small set of mostly **C/C++** datasets (BigVul, Devign), with newer work shifting toward hybrid and retrieval-augmented methods that add context to cut false positives.
Critically, the same model families report strong results when fine-tuned on familiar benchmarks but fall close to random under stricter evaluation, partly because LLMs still treat code as text rather than fully grasping its structure. We conclude that LLMs are valuable assistants that reduce triage time but remain brittle enough to require human-in-the-loop validation and that the field needs more diverse, standardized benchmarks before these results can be trusted in real-world security work.

2 - Methodology

We conducted a systematic literature review to learn about the use of Large Language Models (LLMs) for detecting software vulnerabilities by doing the following steps:

1 - Research Questions
- How are LLMs being used for software vulnerability detection?
- What data are commonly used to train LLMs for detection?
- What are the pros and cons of using LLMs for software vulnerability detection?

2 - Search Strategy:
- Searched three academic websites
  - **Google Scholar**
  - **ACM Digital Library**
  - **IEEE Xplore**
- Used the following keywords:
  - **"Large Language Models (LLMs)"**
  - **"Software Vulnerability Detection"**
  - **"Artificial Intelligence (AI)"**
- Initially identified 60 (20 per team member).
- Each team member reviewed 10 papers, resulting in 30 papers selected for detailed analysis.

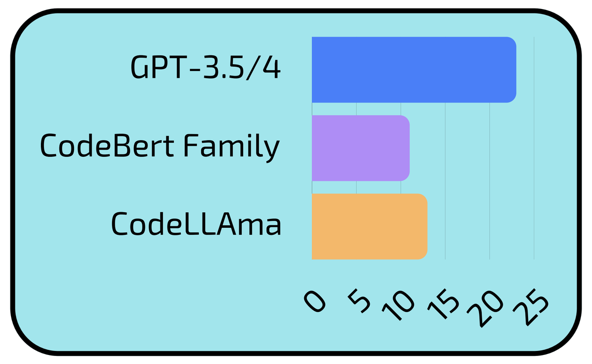
3 - Study Selection:
- Inclusion

reviewed each abstract, selected those related to our topic
- Exclusion

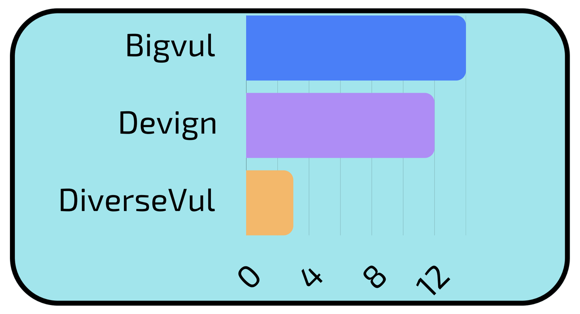
duplicate or unrelated studies

3 - Results

Across the reviewed studies, the field concentrates on a surprisingly small set of models and datasets. General-purpose models from the GPT family appear far more often than any other, followed by the encoder-based CodeBERT family and the code-specialized CodeLlama. This concentration means that much of what the field claims to know rests on a narrow experimental foundation.
Models tested most (across 30 papers)
Models tested most (of 30 papers)
- GPT-3.5 / GPT-4 11
- CodeBERT family 6
- CodeLlama 5



GPT's dominance is best read as a sign of accessibility rather than superiority: it can be prompted directly, without the fine-tuning that encoder models such as CodeBERT typically require, which lowers the barrier to including it in a study.
The dataset picture is even more concentrated, with two benchmarks accounting for most of the empirical evidence in
the entire field.
Datasets used:
- BigVul 7
- Devign 6
- DiverseVul 2



Both BigVul and Devign are built entirely from C/C++ open-source projects, so the field's evidence is heavily weighted toward memory-safety bugs in a single language family. The most-studied vulnerabilities follow directly from this: Buffer Overflow (CWE-119/120), Use-After-Free (CWE-416), and SQL Injection (CWE-89), alongside mixed or general
Common Weakness Enumeration (CWE) categories. Web-application flaws and vulnerabilities in languages such as Python, Java, and JavaScript remain comparatively unexplored, a gap that shapes how far current findings can reasonably be generalized. **(Papers often test more than one model, so counts do not sum to 30).**

4 - Analysis

Key Observations
- Evaluation methodology has the greatest impact on reported performance. Models fine-tuned on benchmark datasets consistently outperform zero-shot or few-shot prompting approaches.
- Benchmark dependence limits generalizability. Most studies rely on the BigVul and Devign datasets, which primarily contain C/C++ memory-related vulnerabilities. As a result, findings may not extend to other programming languages or vulnerability categories.
- Conflicting findings are often caused by differences in experimental design. Studies reporting high accuracy frequently use familiar training datasets, while stricter evaluations that reduce data leakage often report substantially lower performance.
- Current LLMs recognize textual patterns better than program semantics. Although LLMs can identify many vulnerabilities, they still struggle to fully understand code execution, control flow, and complex program logic.
- Hybrid approaches show promising improvements. Recent studies suggest that combining LLMs with static analysis tools, retrieval-augmented generation (RAG), or symbolic reasoning reduces false positives and improves detection accuracy.

Overall Interpretation
Current evidence suggests that LLMs are effective as decision-support tools that assist security analysts by prioritizing and explaining potential vulnerabilities. However, they are not yet reliable enough for fully automated vulnerability detection, particularly in real-world software systems where robustness and consistency are essential.

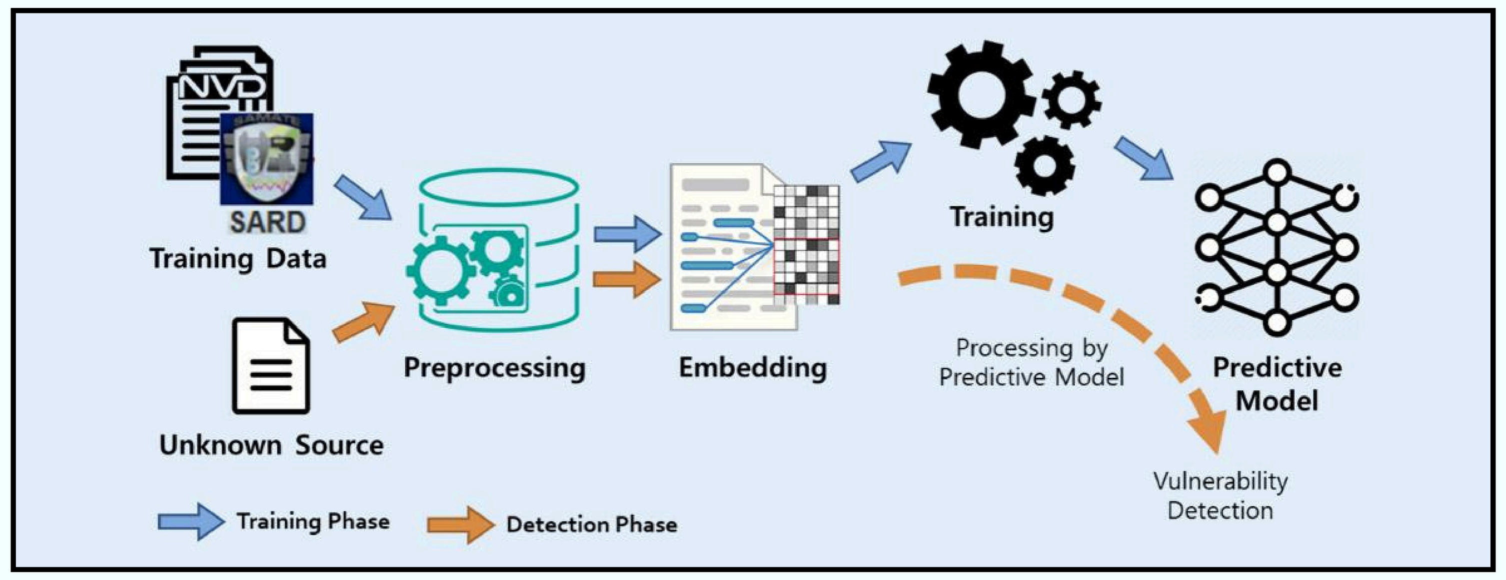
5 - Conclusion

LLMs demonstrate strong potential for assisting in software vulnerability detection.
Current evidence is limited by:
Heavy reliance on BigVul and Devign
Focus on C/C++ memory vulnerabilities.
Inconsistent evaluation methodologies.

Strong benchmark performance does not necessarily translate to real-world effectiveness.

LLMs should currently be viewed as decision-support tools rather than replacements for security analysts.

Future work should prioritize:
- More diverse programming languages
- Standardized evaluation protocols
- Real-world security benchmarks
- Hybrid and retrieval-augmented approaches



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The Impact of Campus Climate on LGBTQIA+ Students Success and Well-being

Anieya Plaines, Basma Alhusaini, Daianara Ferreras, Saba Alkobadi, Caroline Darin

City Tech 21st Annual Poster Session

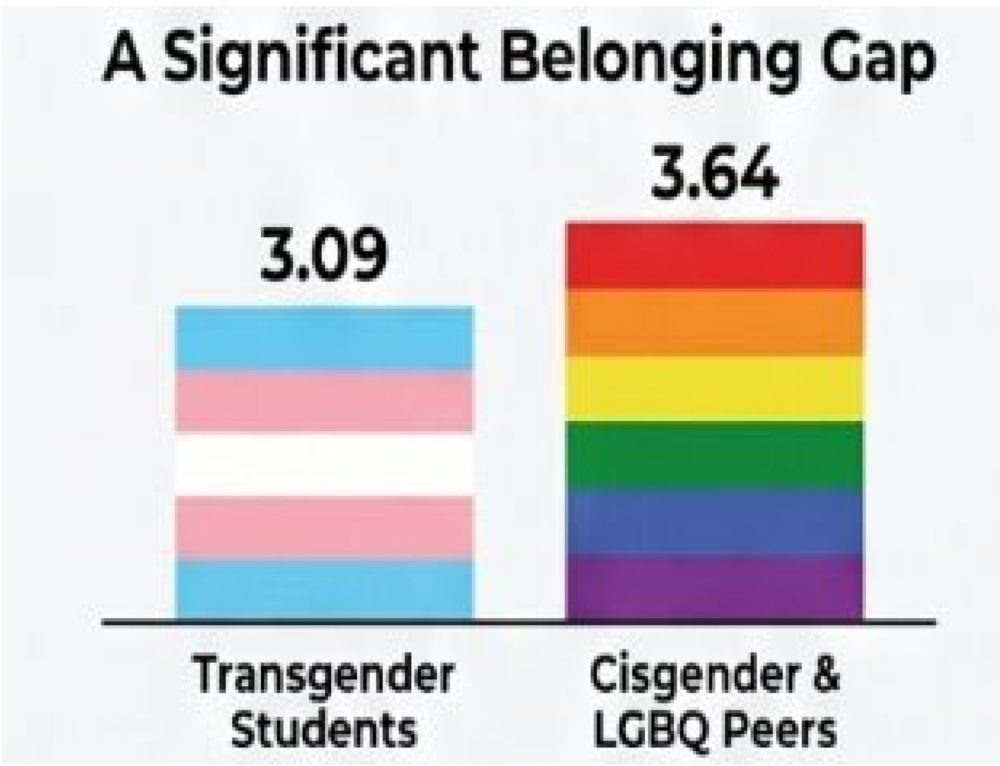
Abstract

This literature review examines the relationship between campus climate and the academic experiences of LGBTQIA+ students in higher education. The findings indicate that campus climate plays a significant role in shaping students sense of belonging, academic persistence, mental health, and overall well-being. While students who feel supported and included are more likely to succeed academically, many campuses continue to only account for heteronormative students. This contributes to discrimination, exclusion, and stress students who are different. The literature also highlights disparities in safety, institutional support, and access to LGBTQIA+ resources, particularly for transgender students and LGBTQIA+ students of color.

To address these gaps, this project proposes a mixed-methods study at New York City College of Technology (City Tech) using student surveys and interviews to better understand campus-specific experiences and institutional needs. The findings will provide evidence-based recommendations for improving campus climate and fostering a more inclusive, supportive, and equitable learning environment where all students can thrive and successfully complete their education.

Why the School Vibe Matters For Student Success

Every college has its own unique "vibe" or personality. In research, we call this the campus climate. This climate is made up of a school's policies, its culture, and the daily interactions between college students and their teachers. For students in the LGBTQIA+ community, an umbrella term for sexual and gender minorities, this environment is more than just a social issue, it is a primary factor in whether they succeed in their classes or drop out of school. While higher education has changed a lot over the last thirty years, many campuses still operate under the assumption that everyone is straight (heteronormativity) or that everyone's gender matches the sex they were assigned at birth (cisnormativity). When a campus environment doesn't affirm a student's identity, it creates a hostile "status quo" that can lower GPAs and stop intellectual growth. To address this, our research uses inclusive terms like "queer-spectrum" and "trans-spectrum" to respect the fluid ways students identify themselves.
This research is the first step toward our upcoming study at City Tech, where we will use student interviews and surveys in the fall to identify exactly what our campus needs to ensure every student feels safe, valued, and ready to graduate.



Discussion

This literature shows that LGBTQIA+ students experiences are influenced beyond identity, including campus climate, supportive resources on campus, the sense of belonging, community connections, and intersectionality. Together, these studies show that discrimination, exclusion, and limited campus support negatively affect students academic success. Many of them struggle with mental health, stress, anxiety, depression, and isolation. At the same time, affirming campus environments, having inclusive policies, peer support, and accessible mental health services can help promote the well-being. These findings highlight the importance of New York City College Of Technology strengths needed for campus climate. A suggestion box that stays anonymous to strengthen inclusion, reduce barriers, and create a more equitable campus where LGBTQIA+ students can thrive academically, socially, and emotionally.

Methodology

To find our research and to come up with our themes and what we will discuss we did through search for credible articles. Such as using the City Tech Library Ursula, Research Rabbit and breaking down key points within the research papers we have found. These are the four themes we found in our research:

1. Campus Climate-impacts and status quo (Basma)
2. Campus climate - positive resources and supports (Daianara)
3. Intersectional identities (Saba)
4. Systemic issues (Anieya)

This allowed us to look at each theme closely and analyze the research we all found. In order for all of us to see each other's work and what we found we wrote a literary review of the sources we found and how they relate to our themes. We shared this with one another to come up with our introduction and abstract.

Results

Campus Climate-Impacts and Status Quo

Campus climate refers to the perceptions and interactions shaped by a school's culture and policies, serving as a primary factor in the academic success and persistence of college students. This research identifies a "status quo" where systemic barriers like heteronormativity and severe safety gaps, particularly for transgender students, hinder a student's sense of belonging and overall intellectual growth. By naming these foundational problems, this section establishes the urgent need for institutional change and improved support resources right here at City Tech.

Campus Climate: Positive Resources and Supports

Research consistently found that LGBTQIA+ students benefit from accessible campus resources, supportive faculty, and opportunities to build community. These supports improve students' sense of belonging, resilience, academic persistence, and overall well-being, demonstrating that an inclusive campus climate is created through both institutional policies and everyday interactions.

Intersectional Identities

This theme examines how multiple identities—including race, gender identity, sexual orientation, religion, and socioeconomic status—intersect to shape LGBTQIA+ students' experiences in higher education. Understanding these overlapping identities provides a more complete picture of students' academic success, mental health, and sense of belonging while highlighting the need for inclusive institutional policies and support systems.

Systemic Issues

This theme focuses on the lack of resources, support and effort into making sure that the LGBTQIA+ students feel supported by the colleges they are attending. Systemic issues is when the system does not fully or effectively support the students that are looking for higher education. Support centers are there to help and guide the students through a new and challenging place that they will have to attend for years. Highlighting the importance of this for students that already do not feel fully supported and must seek help at the place they feel most safe at, which should be the support centers.

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Conclusion

LGBTQIA+ students academic success, mental health, and sense of belonging. At City Tech, expanding visible LGBTQIA+ resources, as well as affirming faculty members and other staff, and inclusive programs can help reduce minority stress while creating a campus climate where students feel supported. These findings connect with the other themes because campus support will strengthen the sense of belonging, feeling included improves campus climate, and helps create a more welcoming and supportive environment at City Tech.