

# Theater Actor Tracking Automation System

Authors: Rachel Yan, Anne Liu

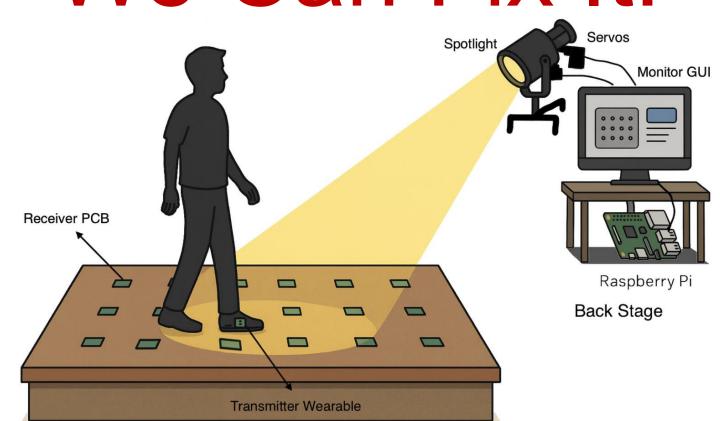
Advisor: Van Hunter Adams



### Actor Illumination is Challenging

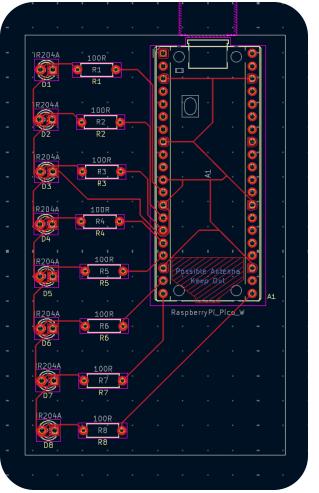
- Physically Demanding
  - Large spotlight sizes can be >100lbs!
- Prone to Human Errors
  - Operator Errors
  - Actor Errors
  - Requires lots of practice
- Existing Solutions Limited
  - Very expensive
  - Little to no automation

#### We Can Fix It!



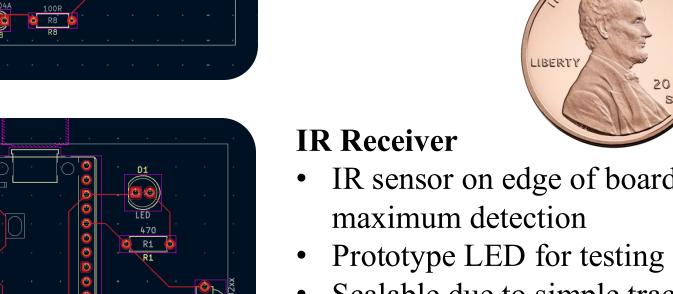
Our goal is to build a low-cost, wireless, real-time actortracking system that can automatically identify an actor's position during a performance and provide it to a controller to help guide the follow spotlight system. This system aims to be accessible to small theaters, accurate in real time, and portable.

#### Tracker PCBs



#### IR Transmitter

- Multiple IR LEDs in one location → better localization
- Only uses two layers → cheap!
- Traces layed-out to maximize board area → more LEDs per board
- Runs on 5V battery
- Easily portable

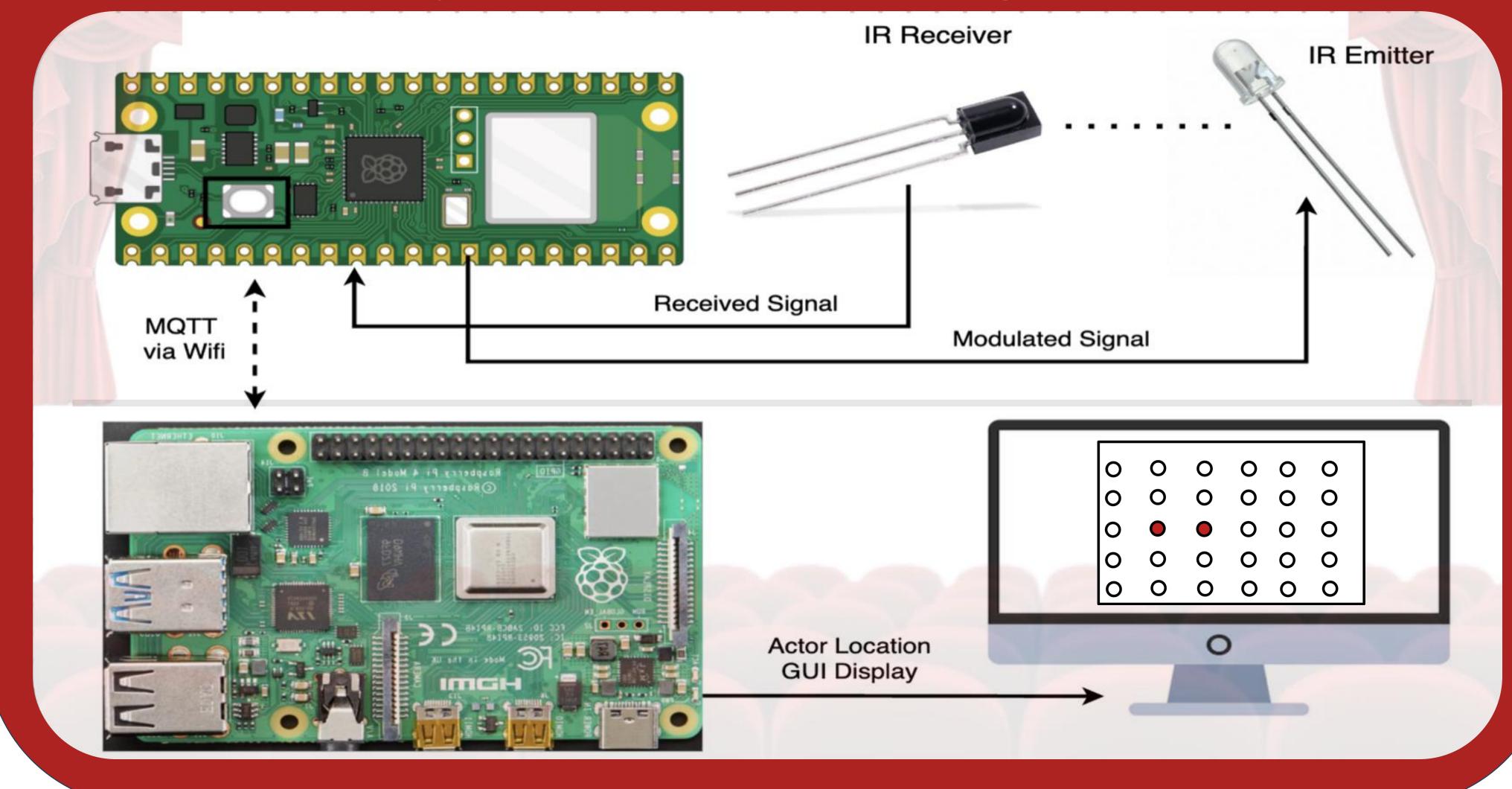


- IR sensor on edge of board for
- Scalable due to simple traces → multiple sensors can be
- connected to single microcontroller

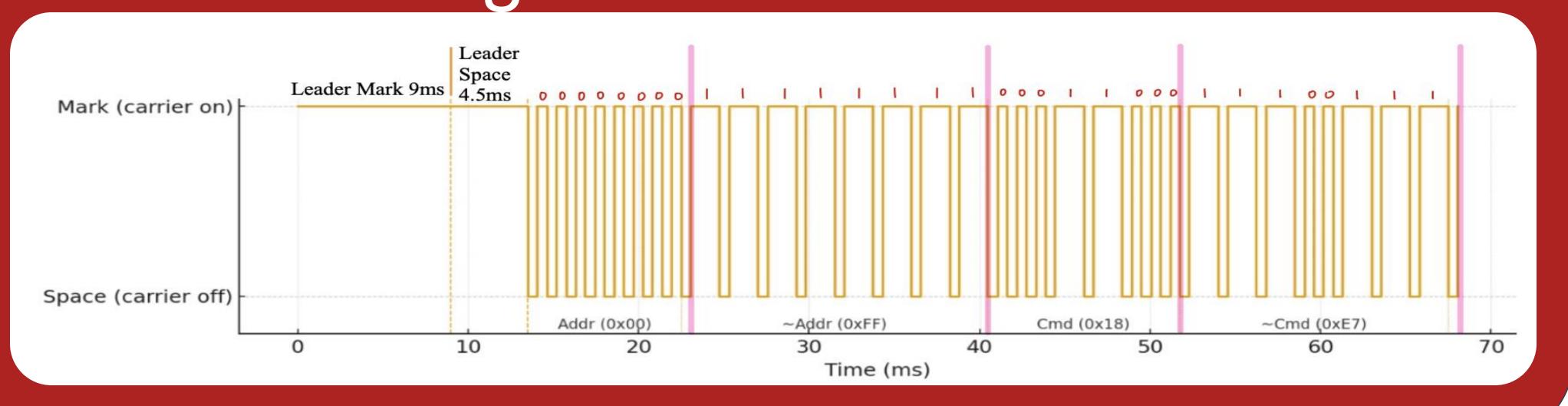
Runs on 5V battery

Easily portable

# System Block Diagram

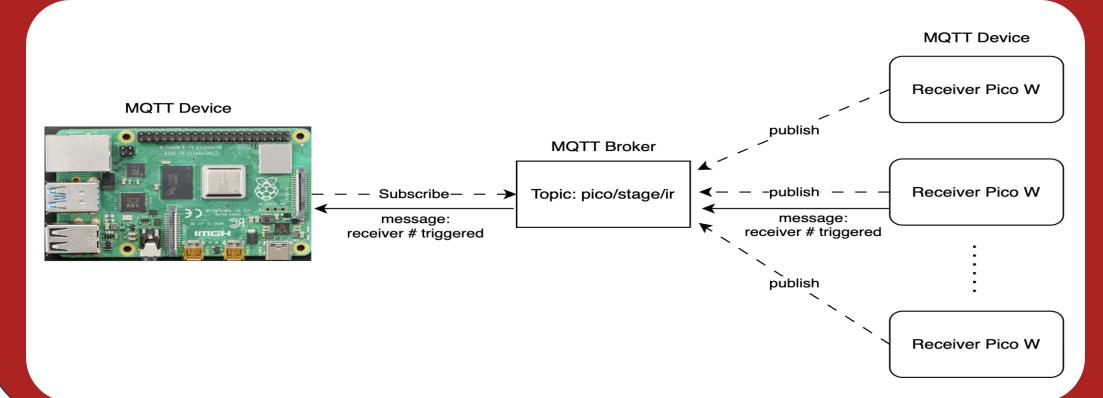


#### Messages: Sent and Received



NEC IR Frame Timing Diagram (Addr = 0x00, Cmd = 0x18, LSB-first)

### Messages: MQTT



diy.com/infrared-detector-circuit-using-phototransistor/ (accessed Dec. 3, 2025)

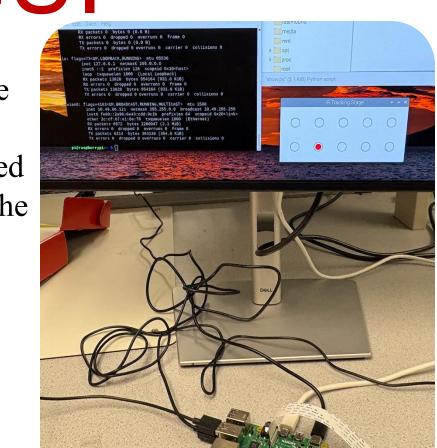
WIFI based distant communication between devices, allow far distance communication between the front stage and back stage production!

#### Advantages:

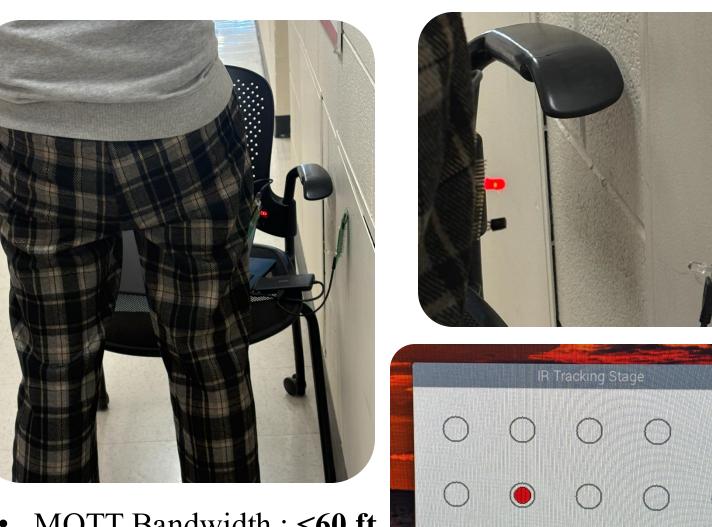
- Lightweight publish—subscribe protocol → fast, low-latency updates
- Long-range WiFi support (>100 m)
- Decouples sender and receiver leading to a simpler, modular system
- Very low bandwidth usage, stable even with frequent position updates
- Supports multiple clients, ideal for our multiple receiver location case

# Tracking Setup:

- Displays a configurable  $m \times n$  IR sensor grid on the Raspberry Pi.
- Maps each LED ID received from RP2040 message to the correct sensor position on
- Moves a red marker to indicate the actor's current location.
- Easily extendable: just change ROWS and COLS to match any stage layout.



#### Performance: Result



- MQTT Bandwidth : <60 ft</li>
- Works with University Wifi
- Attachable to clothing/fabric, variable heights

## Conclusion: Next Steps

Total Price = Tracker + GUI = \$11.74 + \$38.50 = \$50.24!

- Expanding accuracy, robustness, usability
- Add Motor + spotlight!
- Add Camera!
- Improve wireless synchronization

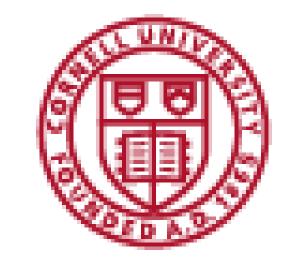
In conclusion, we have designed a cheap solution for automating theatrical performances. The next major step is integrating motorized follow-spot control, allowing the Raspberry Pi to directly drive a pan-tilt mechanism and physically aim the spotlight based on the tracked position.

### CornellEngineering

[6] "Lite-on DCC Release Lite-On Technology Corp. / Optoelectronics," IR Emitter and Detector Product Data Sheet, https://optoelectronics.liteon.com/upload/download/DS-50-92-0005/E2871.pdf (accessed Dec. 3, 2025). [7] F. Zahid, "Infrared Detector Circuit using phototransistor," Circuits DIY, https://www.circuits

#### Acknowledgements and References

[1] "Implementing MQTT in python with code examples," HiveMQ, https://www.hivemq.com/blog/implementing-mqtt-in-python/ (accessed Dec. 3, 2025). [2] "Project 31: IR Control Sound and LED - Raspberry Pi Pico Learning Kit documentation (accessed Dec. 3, 2025). [3] H. World, "Remote Control IR with RPI," YouTube, https://www.youtube.com/watch?v=-LxaNQjBn s (accessed Dec. 3, 2025). [4] V. H. Adams, "Wireless Uart via infrared, https://vanhunteradams.com/Pico/Bootloader/Infrared.html (accessed Dec. 3, 2025). [5] YoungWonks, "One can use an infrared sensor with a Raspberry Pi Pico. here's how...," YoungWonks, https://www.youngwonks.com/blog/How-to-use-an-infrared-sensor-with-the-Raspberry-Pi-Pico (accessed Dec. 3, 2025).



Electrical and Computer Engineering