



# Theater Actor Tracking Automation System

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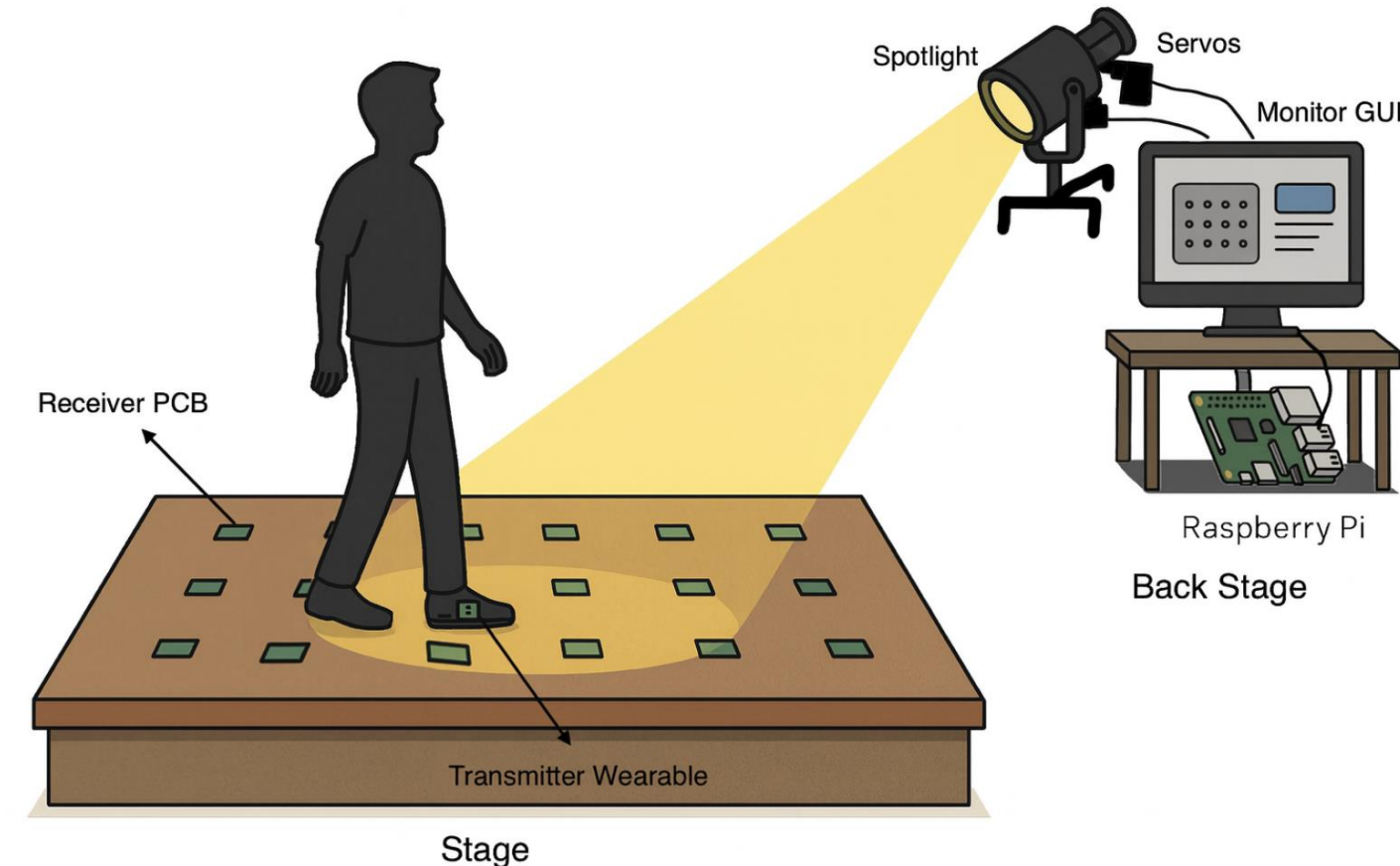
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## Actor Illumination is Challenging

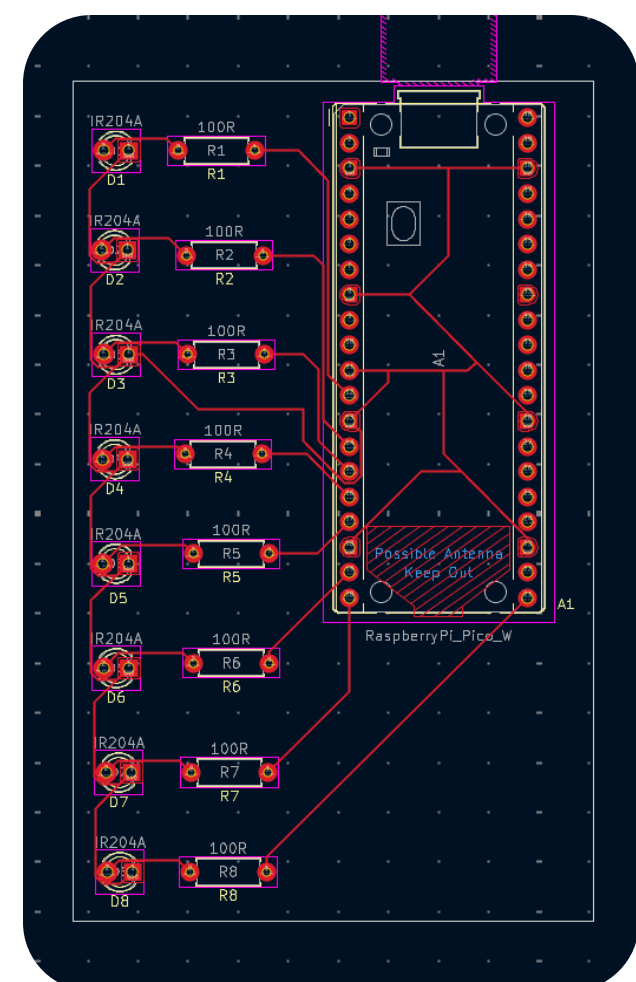
- Physically Demanding
  - Large spotlight sizes can be >100lbs!
- Prone to Human Errors
  - Operator Errors
  - Actor Errors
  - Requires lots of practice
- Existing Solutions Limited
  - Very expensive
  - Little to no automation

## We Can Fix It!



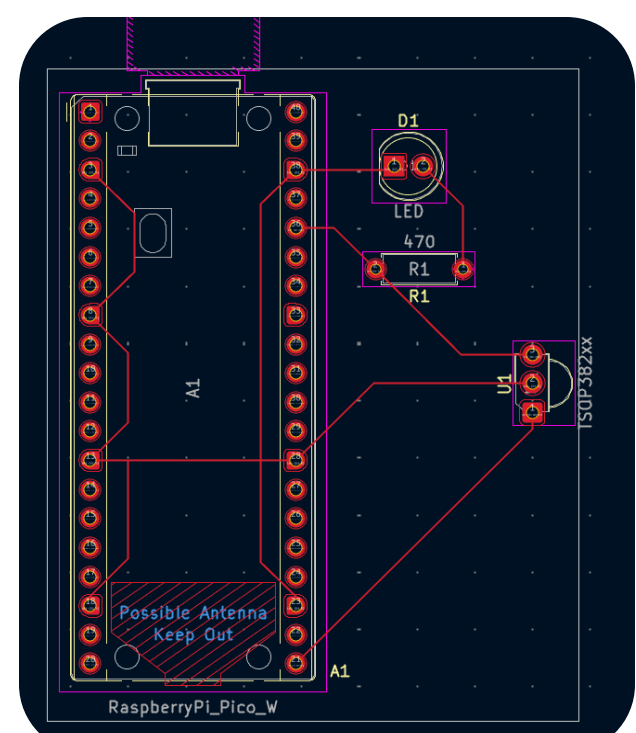
Our goal is to build a **low-cost, wireless, real-time actor-tracking system that can automatically identify an actor's position** during a performance and provide it to a controller to help guide the follow spotlight system. This system aims to be accessible to small theaters, accurate in real time,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

## Tracker PCBs



### IR Transmitter

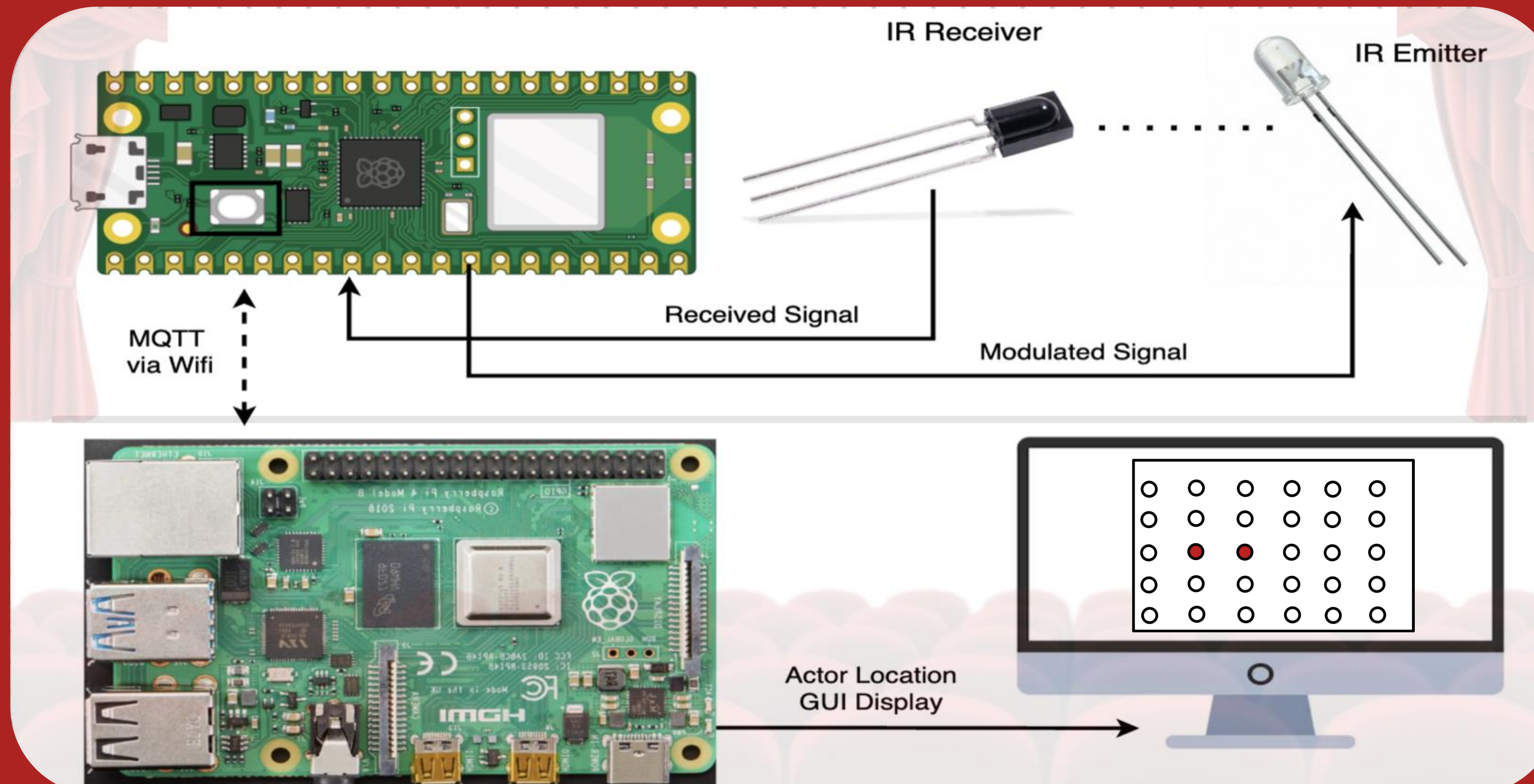
- Multiple IR LEDs in one location → better localization
- Only uses two layers → cheap!
- Traces layed-out to maximize board area → more LEDs per board
- Runs on 5V battery
- Easily portable



### IR Receiver

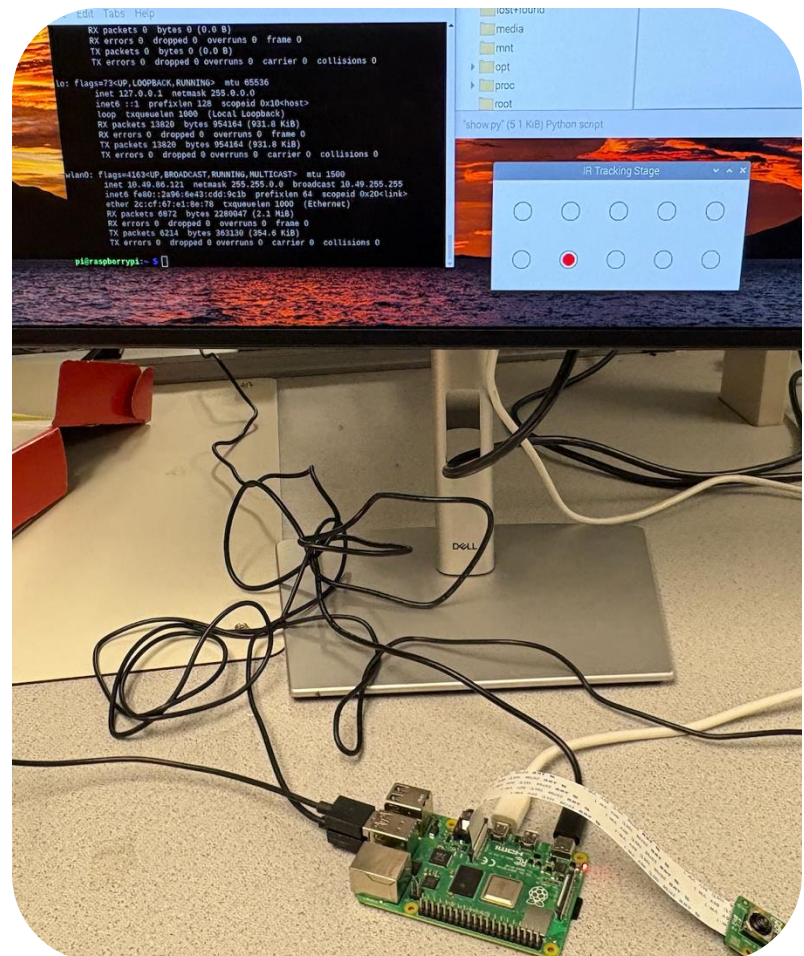
- IR sensor on edge of board for maximum detection
- Prototype LED for testing
- Scalable due to simple traces → multiple sensors can be connected to single microcontroller
- Runs on 5V battery
- Easily portable

## System Block Diagram



## Tracking Setup: GUI

- 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 screen.
- Moves a red marker to indicate the actor's current location.
- Easily extendable: just change ROWS and COLS to match any stage layout.

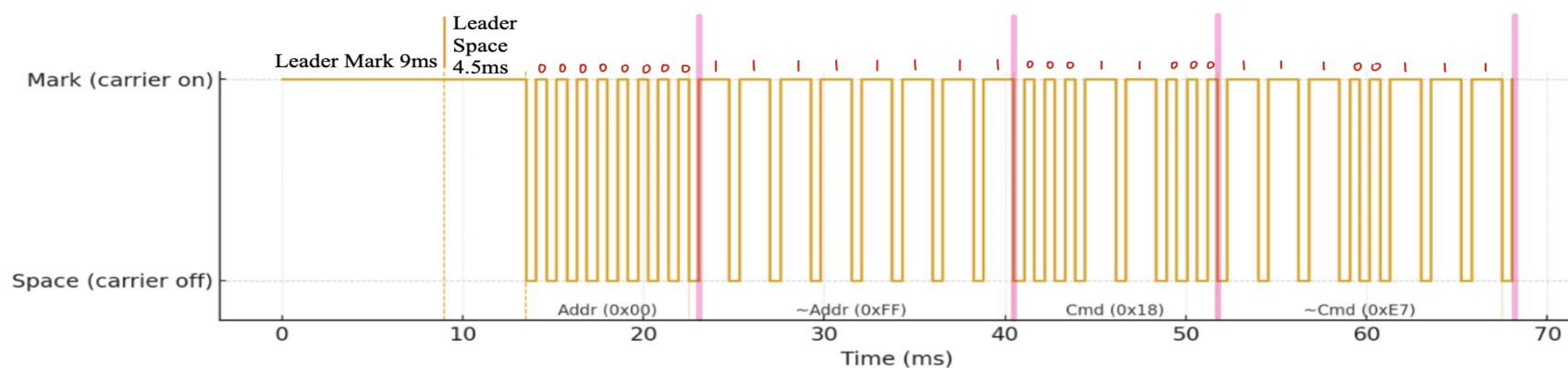


## Performance: Result



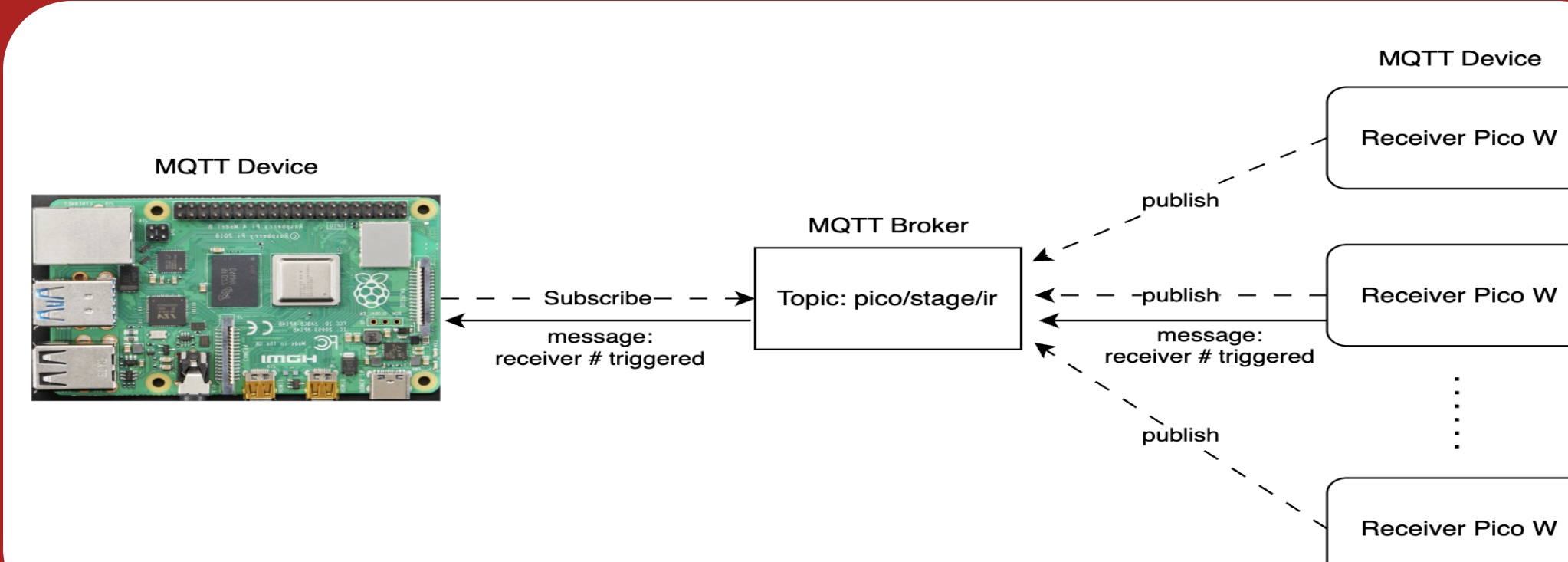
- MQTT Bandwidth : <60 ft
- Works with University Wifi
- Attachable to clothing/fabric, variable heights

## Messages: Sent and Received



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

## Messages: MQTT



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

## 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.

