# NeuroBot: EEG Controlled Turtlebot


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# Main Idea

- A few people in the public wear the headbands.
- EEG analysis → Determines the mental state of each individual wearing the band (pretrained)
- State transcribed to the robot with LED lights, Music/Sounds & different movement types

# System Architecture

Goal:

Have a robot's behavior (movement, lights, music) be a reflection of the psychological state of an audience member wearing a Muse headband, with all the controls and processing managed from a master device (laptop).

Parts:

- TurtleBot3 Burger
- Muse S Headband
- LED Strip
- JBL Speaker
- Lidar Scanner
- Raspberry Pi (Node-Red + MQTT/HTTP)
- Laptop (Python processing)
- 3D Printed Speaker Holder

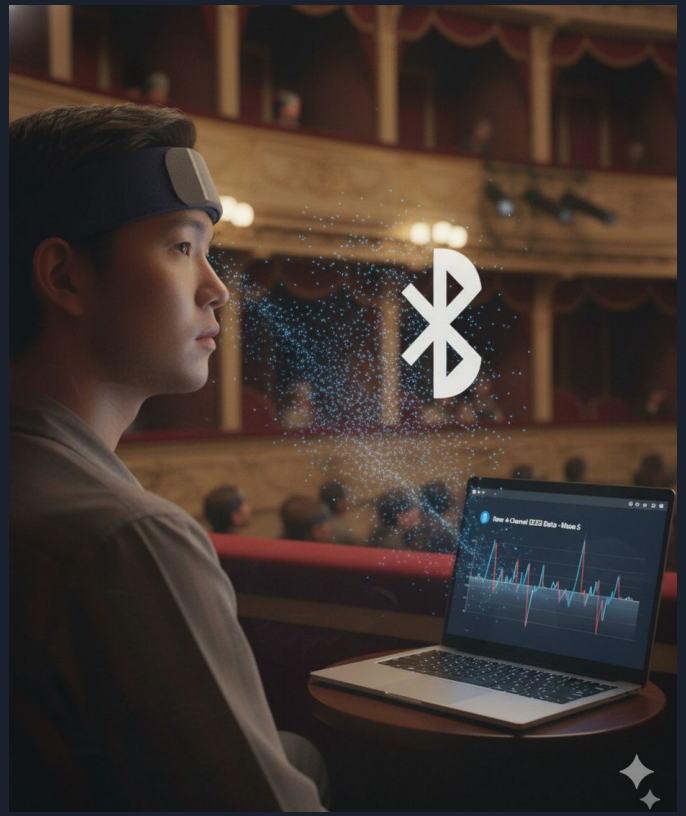
# Component 1: The sensor (Audience member)

Hardware: Muse S Headset

- The user wears the headset and watches the performance

- The headset is paired via Bluetooth to the Ubuntu Laptop

- The Bluetooth transmits wirelessly the raw 4-channel EEG data.



# Component 2: The Core Processor (Ubuntu Laptop)

- Data Processing: The laptop receives the EEG data, takes the 2-second window and applies filters to clean it

- Prediction: Our model (pretrained EEGNet) classifies the data and predicts the user's psychological state

- Stabilization: To stabilize predictions, we implement a hysteresis mechanism. The robot changes its behavior only when a new emotional state constitutes 70% of the last 10 predictions

# Component 3: Node-Red Flow (Raspberry Pi on TurtleBot)

- Input: The predicted state is sent from the laptop to Node-Red on the robot via HTTP/MQTT.
- Logic: a central switch node routes the command to a state specific behavior flow
- For all flows:
  - Lights: An HTTP/MQTT request is sent to a python script on the Raspberry Pi which controls the LEDs
  - Movement: A ROS Message is published to the /cmd_vel topic
  - Sound: A request is sent to a Flask or MQTT based music player on the Raspberry Pi to play a sound on the speaker
- States:
  - Neutral: the robot moves normally and linearly along some virtual axes created in a virtual env room.
  - Happy: the robot moves faster, does spins around itself, the lights turn to a cheerful yellow and an upbeat music/sound is played
  - Calm: the robot slows down, the lights pulse gently in violet and a calm ambient sound is played; the robot moves as if it were dancing a slow balad.
  - Focused: the robot stops, the sound is stopped and the lights shift to an intense green to symbolize concentration.
  - Stressed: the robot moves around frantically and is not concerned with collision detection. The light pulses rapidly in red and some noises play.

# Additional components for Light & Music show

Light: LED strips

- put a band of LEDs around each layer of the turtlebot
- change color and blinking pattern/speed

Music: JBL GO

- play a different melodies for every psychological state, fit for accentuating the theater ambiance

# 3D printed support for the JBL speaker

- simple design for sticking the JBL speaker at the back of the turtlebot
- model designed using Autodesk Fusion and Prusa Slicer
- 3D printed with PLA using 0.2 mm layer height and 30 % infill for more solidity, fill pattern is cubic. We use organic support.
- connected with screws