Texas A&M University at Qatar

Electrical and Computer Engineering Program
ECEN 403

Benchmarking Assignment

Project Title: AI-Social Robot for university assistant

Semester: Summer 2025
Mentor: Dr. Jim ji

Team members:

Noor AlMohammadi
Amna Al-Zeyara
Maryam Al-Obaidan

Submit date: 21/06/2025

Table of Contents

Table of Tables

1. Introduction

1-1 Problem Statement:

Many universities face challenges in providing accessible, real-time information to new or visiting students. Navigating campuses, finding rooms, labs, or halls, and connecting with the right resources can be confusing for first-time students. Current support systems often lack interactivity or require human personnel, which limits scalability.

1-2 Proposed Engineering Design Solution:

The proposed project is a cost-effective, interactive educational robot powered by an Arduino-based control system, facial recognition using OpenCV, and Python-based voice interaction. The robot will detect a student's face, ask for their name, grade, and college type, and provide spoken directions to halls, rooms, and laboratories. It will also introduce itself and offer basic assistance, serving as an automated support system for university environments.

2. Existing Solutions

2-1 Market Research:

1. **Pepper Robot by SoftBank Robotics**
    a) **Features:** Advanced AI, facial recognition, emotion detection, touchscreen, and mobile base.
    b) **Price:** Approx. $20,000+
    c) **Limitations:** High cost, complex programming environment, limited customization.
2. **Jibo**
    a) **Features:** Voice interaction, facial recognition, home assistant functionalities.
    b) **Price:** Around $900 (discontinued)
    c) **Limitations:** Not open source, limited upgrade capabilities, cloud dependency.
3. **Temi Robot**
    a) **Features:** Autonomous navigation, voice interaction, video calling.
    b) **Price:** Approx. $3,500

c) **Limitations:** Not designed for DIY or educational environments.

4. InMoov Robot

a) **Features:** 3D printable, open-source, customizable with Arduino/Raspberry Pi

b) **Price:** $700 (depends on build)

c) **Limitations:** High technical skills required, lacks polished UI/UX.

3. Benchmarking Criteria

The criteria used to compare the proposed robot with existing solutions include:

Metric	Description
Cost-efficiency	Overall affordability for development and deployment.
Facial Recognition Accuracy	Ability to detect and identify faces reliably under various lighting conditions.
Voice Interaction Quality	Clarity and accuracy of conversation responses.
Customizability	Ability to modify code, hardware, and functionalities.
Ease of Development	Required technical knowledge and ease of setup for developers.
Safety & Data Privacy	Safety in handling, ethical data storage and processing.
Cultural & Social Accessibility	Ability to adapt to different languages, regions, and user types.
Environmental Impact	Energy consumption, use of recyclable materials.
Public Health & Welfare Impact	Usefulness in therapeutic, educational, or assistive contexts.

Table 1: Benchmarking Criteria

4. Benchmarking Table

Criteria	Pepper	Jibo	Temi	InMoov	Proposed Robot
Cost	$$$$$ ($20,000+)	$$$ ($900)	$$$$ ($3,500)	$$ (~$700+)	$ (~$500)
Facial Recognition Accuracy	High	Medium	High	Depends on config	High OpenCV)
Voice Interaction	High (cloud)	Medium	Medium	Low	High (GPT API)
Customizability	Low	Low	Medium	High	High
Ease of Development	Low	Medium	Medium	Low	Medium
Data Privacy	Medium	Low	Low	High	High
Accessibility (Cultural)	Medium	Low	High	Medium	High (Multilingual)
Environmental Impact	Low	Low	Medium	Medium	Medium
Public Health Applications	High	Low	Medium	Low	High

Table 2: Benchmarking Table

5. Benchmarking Analysis

From the benchmarking table above, we observe:

a) Pepper offers premium features but is prohibitively expensive and closed-source.
b) Jibo and Temi are limited by cost, proprietary design, or discontinued support.
c) InMoov, while customizable, demands significant expertise.

The proposed robot strikes a balance between cost-efficiency and educational functionality. It offers a high level of customization, uses Python-based voice interaction instead of cloud-dependent, and integrates facial recognition with open-source libraries.

Planned improvements:

a) Implement offline fallback speech synthesis in case of API unavailability.

b) Develop a mobile app interface for remote monitoring and configuration.

6. Conclusion

The benchmarking analysis has provided valuable insight into robotic systems applicable in university education settings. Compared to expensive or proprietary commercial robots, our system offers a more inclusive, cost-effective solution. It bridges the gap by combining facial recognition, user interaction, and physical guidance in a friendly robot design. Voice interaction will be handled locally with Python libraries, ensuring both performance and student data privacy. This benchmarking evaluation has guided the refinement of our design and will support a successful implementation tailored to educational campuses.

These refinements ensure that our robot meets real student needs while aligning with best practices in safe and inclusive robotic design.

7. References

[1] SoftBank Robotics, "Pepper," [Online]. Available:

https://www.softbankrobotics.com/emea/en/pepper

[2] Temi Robot, "Temi Official Website," [Online]. Available:

https://www.robotemi.com

[3] Jibo Inc., "Jibo Robot," [Archived]

[4] InMoov Open Source Project. [Online]. Available: https://www.inmoov.fr

[5] IEEE 7001-2021, "Transparency of Autonomous Systems"

[6] Dlib: C++ Library for Machine Learning, [Online]. Available: http://dlib.net

[7] OpenAI, GPT API documentation, [Online]. Available: https://platform.openai.com/docs