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Feasibility repport

JARVIS-Inspired Smart Home for disabled people

Submitted by:

HAMRI Amina
REZIG Ahmed Khodhir
KHELIL Faiza
GHAZI Nesrine
RAZALI Abderahman
LAKHAL Sid Ahmed

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Contents

1 Executive summary

The construction and conversion of ordinary homes into “smart homes” has seen a tremendous rise in recent years. This can be ascribed to technologies such as the Internet of Things, sensors, smart phones, smart appliances, cloud computing, and digital assistants .At the outset, smart homes were built to enhance the quality of life for ordinary persons. So, most smart home devices are not designed with people with disabilities and limited range of movement in mind. Of course, being able to control home devices using smart technology could be a tremendous benefit to people with physical disabilities and the older persons.

In the development of a smart home for people with disabilities, clients, customers, and users play distinct but complementary roles. *Clients* are often the entities or individuals who finance and commission the project, such as families of people with disabilities, government agencies, or non-profit organizations. These clients are responsible for initiating and managing the project, which aims to improve the quality of life of people with disabilities through adapted technological solutions. *Users* are the disabled people who will directly benefit from the technologies, with specific needs depending on their type of disability. *The clientele* includes both users and their caregivers and carers, who can also interact with the system.

2 Benefits

- A flexible use which goes with the situation of the disability, which does not require great physical effort.
- User safety by ensuring a safe environment from any physical damage such as falling from the stairs or hit a wall.
- extend the safety of the patient even outside the house.
- Make a better environment for blind people to move around easily.

3 Preliminary requirements analysis

3.1 Objectives :

- Develop a smart home to handle various areas in the house and the disabled person's wheelchair.
- Integrate a voice assistant with functionalities such as voice-to-text, text-to-speech,and advanced AI features.

3.2 Functional Requirements :

- **Hardware Control:** A PCB that combines ESP32 and relay modules can be used to control a home prototype.

- **Wheelchair control:** Use JARVIS to intelligently control the wheelchair, such as recognizing the house's pathways and understanding the various areas and avoiding obstacles (e.g., kitchen, bedroom, etc.).
- **Remote Monitoring:** Provide real-time updates and control via a web application.
- **Voice Interaction:** Enable voice command execution and feedback through a JARVIS- inspired assistant which gives an advanced technology vibe yet an easier access and use.
- **API Integration:** Incorporate external APIs (e.g., weather, calendar) for advanced features to add the concept of a personal assistant.

3.3 Non-Functional Requirements :

- **Performance:**
  - Real-Time control and web updates.
  - Ensure that the wheelchair's battery lasts for at least 8 hours.
  - The environment needs to be analyzed in real-time for obstacle detection.
- **Reliability:** It is crucial that the system operates without any failures as much as possible.
- **Security:**
  - Encryption(TLS/SSL), secure boot for firmware.
  - In the case of a problem, an emergency stop button should be accessible.
- **Scalability:**
  - Modular design that allows future expansion (including the PCB and the AI assistant).
  - Software updates that are compatible can enhance functionality without the need to change hardware.

3.4 Scope :

Included functions

- AI assistant that controls doors, lights,the curtains and the wheelchair,etc.
- AI voice assistant(e.g., "remind him of the medication times", "remind me of this at such and such time", "go to the kitchen","bring me my wheelchair").
- Voice-interaction via an AI-powered personal assistant.
- Controls the wheelchair with joystick
- Avoid obstacles automatically by changing the path
- Stop if there are stairs or fire for example

- Memorize the paths in the house by recognizing objects (e.g., a refrigerator and an oven indicate a kitchen).
- Equipped with a GPS module to track the user's position when he goes outside.

Excluded functions

- The fact that JARVIS is not a robot means it cannot carry things or perform any physical tasks yet it can control devices remotely.
- It cannot make calls.
- This wheelchair cannot climb the stairs.
- The wheelchair does not provide assistance for transferring the user from another location to the wheelchair.
- May have difficulty on certain terrains (sand, gravel, deep snow, steep slopes).
- Cannot cross obstacles that are too high (sidewalks without ramps, high door thresholds)

4 Technical feasibility of the project

4.1 Requirements

- The wheelchair's camera captures the environment in real time.
- The image is treated locally with OpenCV+ CUDA/VPI (NVIDIA)/TensorRT on the Nvidia Jtson using C/C++.
- AI model returns a response and controls the wheelchair's motors,relays and other areas in the home (e.g., "Obstacle detected, turn left",etc).
- The command is sent to the wheelchair, relays,... via webRTC/MQTT.

User voice command:

- The user speaks through the wheelchair microphone.
- The sound is processed locally with C/C++ libraries(python is a strong alternative):
  - **PocketSphinx:** simple and fast voice command.
  - **DeepSpeech avec TensorRT:** more advanced voice recognition.
  - **Riva:** powerful voice system optimized for NVIDIA Jetson.

  Or using AI agents with deepseek/openAI.
- The AI interprets the commands and executes the requested action (e.g.: "Go to the kitchen")

Remote monitoring:

- The wheelchair sends its GPS position to an MQTT/cloud server.
- If a problem, an alert is sent to a close person.

4.2 Technical Choices (Software Hardware)

Hardware

- Nvidia Jtson.
- ESP32 (It is used with sensors because of the analog inputs, which are not available in Nvidia, managing wireless communication to decrease the load on NVIDIA.)
- eCAM86_CUONX_CHLC_1H01R1(Camera for Nvidia)
- Battery 12v. /7Ah
- joystick
- Microphone: voice recognition module V3.1
- GPS6MV2
- Motor 5840- 31ZY WORLD GEAR SINGLE AXIS 12V 260 RPM
- Motor driver
- Motor braking circuit.
- RFID-RC522.
- SD carte
- Connection queues

Software

- Google colab.
- Google Drive.
- WebRTC.
- Deepseek/openAI.
- OpenCV+ CUDA/VPI (NVIDIA)/TensorRT.
- PocketSphinx/Riva/DeepSpeech avec TensorRT.
- Flutter
- C/C++
- Figma

4.3 Estimation of necessary resources

This section presents a detailed cost analysis for the project, including:

- Personnel.
- Hardware.
- Software.
- Development.
- Marketing.
- Operational expenses.

The goal is to ensure financial feasibility and efficient budget allocation. The total available budget for this project is **10,000,000 DZD**.

4.4 Personnel Costs

Personnel expenses include salaries and benefits for team members.

Role	**Nbr of People**	**Monthly Salary (DZD)**	**Total Cost (12 months) (DZD)**
Engineers	6	45 000,00	4 860 000,00
Accountant	1	30 000,00	540 000,00
Marketing Specialist	2	40 000,00	1 440 000,00
Total Personnel Cost	9		6 840 000,00

Table 1: Personnel Costs

4.5 Hardware & Software Costs

Breakdown of required components and software licenses.

4.6 Hardware Costs

Item	**Quantity**	**Unit Price (DZD)**	**Total Cost (DZD)**
Nvidia	1	65 000,00	65 000,00
Camera for Nvidia	1	36 000,00	36 000,00
ESP32 Microcontroller	6	1 700,00	10 200,00
Sensors (Various)	3 Kits	3 600,00	10 800,00
Power Supply Units	6	3 750,00	22 500,00
Total Hardware Cost	15		144 500,00

Table 2: Hardware Costs

4.7 Software Costs

Software Licence Type	**Cost (DZD)**
Cloud Services (Firebase, AWS) (Monthly)	7500 x 12 = 90 000,00
Development Tools & IDEs (One-Time)	30 000,00
API Integrations (One-Time)	20 000,00
Total Software Cost	140 000,00

Table 3: Software Costs

4.8 Marketing & Advertising Costs

Category	**Cost (DZD)**
Website & Branding	500 000,00
Content Creation (Videos, Banners)	250 000,00
Total Marketing Cost	750 000,00

Table 4: Marketing & Advertising Costs

4.9 Operational & Miscellaneous Costs

Category	**Cost (DZD)**
Office Rent (12 months)	25000,00 x 12 = 300 000,00
Utilities (Internet, Electricity)	200 000,00
Training & Documentation	750 000,00
Unexpected Expenses	850 000,00
Total Operational Cost	2 100 000,00

Table 5: Operational & Miscellaneous Costs

4.10 Total Estimated Cost

Category	**Total Cost (DZD)**
Personnel Cost	6 840 000,00
Hardware & Software Costs	284 500,00
Marketing & Advertising Costs	750 000,00
Operational & Miscellaneous Costs	2 100 000,00
Grand Total	9 974 500,00

Table 6: Total Estimated Cost

5 Planning and ressources

5.1 Estimate the staffing and equipment needs

Role	Responsibilities	Estimated Time
Fablabe team	Create a 3D model of the home	1-3 weeks
	Create a 3D model of the wheelchair	1-3 weeks
Embedded Developer	Studying the functioning of: Nvidia Jtson, ESP32 and other sensors	1-2 weeks
	Ensure the correct connection between hardware	3-4 weeks
AI Engineer	Developing object detection models	3-6 weeks
	Build a Voice assistant using AI models APIs	4-6 weeks
Mobile Developer	Studying Flutter	1-2 weeks
	Develop the backend and link it with MQTT/WebRTC server	3-4 weeks
	Create UI/UX design with figma	2-3 weeks
	Develop the frontend	4-5 weeks
Cloud Engineer	Studying WebRTC, MQTT, and Cloud storage	1-2 weeks
	Ensure interaction between hardware and the cloud	1-2 weeks
Electronics Engineer	Place the motors, relays, the battery and ensure proper operation	2-3 weeks
	Create the braking circuit and place it	3-4 weeks
The whole team	Inject the different algorithms with the engines	2-5 weeks
	Test the model and correct errors	3-4 weeks
	Move to real model production	5-6 weeks

Table 7: Estimation of staffing and required time

5.2 Milestones and decision points

From the initial assessment of the individual's needs to the selection of appropriate technologies and the installation of the system, there are milestones and decision points which mark the objectives to be achieved throughout the implementation process.

Milestone 1: Deal with the customer on specific needs, preferences and limitations. Consult with the different users where they will provide information on the daily challenges encountered and participate in the evaluation of suitable technologies.
Decision point: Customizing the smart home system to fit the exact requirements of

the user.

Milestone 2: Choose appropriate smart devices and technologies.
Decision point: The decision of which technology to use will depend on the user's abilities and the level of automation they desire.

Milestone 3: Ensure that hardware equipments(chosen devices) and the firmware are correctly interract.

Milestone 4: Study which security measures should be integrated.

Milestone 5: Develop a simple, intuitive interface for controlling the smart home.
Decision point: Consider using voice-activated controls which can adapt with all disabeled cases.

Milestone 6: Establish a budget and prioritize the technologies to include.
Decision point: The budget should account for both initial installation and long-term costs.
Milestone 7: Install the selected devices into the home environment.
Decision point: Carry out various tests (functional, reliability, security, performance) to arrive at a final product.

Milestone 8: Provide training to the user and their caregivers.

Milestone 9: Set up a plan for ongoing maintenance and software updates.

Milestone 10: Make adjustments based on user feedback. Therefore, add new devices or modify existing systems to improve usability.

6 alternatives and risks:

6.1 What could go wrong?

- **Reliability:** Potential failures in relays or wiring.
- **Technical malfunctions:** system failures or internet connectivity issues.
- **Latency:** Possible communication delays between components.
- **AI Accuracy:**Challenges with voice recognition and natural language processing.
- **User adaptation difficulty:** The user may face a problem using the system due to its complexity or lack of experience.

- **Power outage:** The system relies on a continuous supply of electricity, so any interruption at this level will cause the system to stop.
- **Security risks:** hacking or unauthorized access to data.

6.2 How will progress be monitored and problems identified?

- **Regular system testing:**Routine checks for the performance of software and hard-Ware.
- **User feedback:** Collecting feedback from users for improvements and updates.
- **Performance metrics:** Tracking system uptime, response time, and error rates.
- **Emergency alerts:** Automatic notifications for malfunctions.

6.3 Evaluation of alternatives:

- **Improving device quality:** Using high-quality wires and performing regular main Tenons.
- **Backup systems for technical failures :** Using offline software to reduce reliance On it.
- **Real-time optimization:** Implementing real-time processing techniques.
- **Improving the AI model:** Training the models with diverse datasets and providing manual control alternatives to enhance AI accuracy.
- **User training and support:** Providing an easy-to-use interface, customizing educational programs for users.
- **Backup power solutions:** using alternatives to electrical energy or renewable energy.
- **Security measures:** Data encryption and regular security updates to prevent breaches.

7 Future Enhancements

Potential improvements for the system include:

- **Device Expansion:** Adding support for additional devices (Air conditioning, security cameras).
- **Facial Recognition:** Implementing biometric authentication for personalized interactions.
- **Mobile Application:** Developing a dedicated mobile app to further enhance accessibility and control.
- **Advanced AI Features:** Integrating more sophisticated AI capabilities for proactive assistance, predictive maintenance, and energy optimization.

8 Conclusion

The feasibility analysis indicates that the JARVIS-Inspired Smart Home for disabled people is feasible from both technical, logistical and economical perspectives. Leveraging affordable and proven hardware (Nvidia, ESP32) alongside robust software tools, the project demonstrates a clear path toward creating an integrated smart home solution. While challenges exist in hardware reliability, AI integration, and overall system security, these risks can be avoided or at least mitigated through a structured, iterative development process, periodic testing, and continuous stakeholder communication.