UEMF
الجامعة الأورومتوسطية بفاس
EUROMED UNIVERSITY OF FES

UM6P

# Specifications Document

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# Contents

# 1 Introduction

The Intelligent Receptionist Robot is designed to autonomously navigate and interact with humans using multimodal communication. The goal of this project is to develop a functional prototype capable of performing tasks such as autonomous navigation, face recognition, speech interaction, and providing guidance within the DICE (Digital Innovation Center of Excellence) at UM6P. The robot will be equipped with various sensors, a touchscreen interface, and AI-based interaction capabilities to ensure a smooth and effective user experience.

# 2 Functional Requirements

The project consists of two main components: autonomous navigation and multimodal interaction.

## 2.1 Autonomous Navigation

The robot must be able to explore and map an unknown environment using Simultaneous Localization and Mapping (SLAM). It will navigate autonomously, avoiding obstacles and determining optimal paths. The RPLidar A1 sensor will be used for real-time mapping, while the Robot Operating System (ROS) will manage the SLAM algorithm (GMapping or RTAB-Map) to allow the robot to localize itself and build a dynamic map of its surroundings.

## 2.2 Multimodal Interaction

The robot will engage with users through four key functions. First, it will include a face identification system that recognizes known users and customizes interactions accordingly. If a user is not recognized, the robot will proceed with the new user registration step, where it asks for the user's name and role within DICE and stores this information for up to 50 people. The third function involves speech interaction, where the robot will use a chatbot to maintain conversations and respond naturally to questions. Lastly, the direction guidance feature will allow the robot to provide location-based assistance, guiding users to different areas within the DICE laboratory. Additionally, the robot will feature an interactive touchscreen that displays user information, maps, and other relevant data.

# 3 Hardware Components

| Component | Specification | Purpose / Justification |
|---|---|---|
| Jetson Nano | 32GB SD Card | Handles AI processing, face recognition, and speech interaction. |
| Motor | 12V 37GB-520 | Provides torque for robot movement. |
| Wheels | 10-12cm rubber | Ensures stability and traction. |
| Motor Driver | BTS7960 | Controls motors efficiently. |
| RPLidar A1 | 360° scanning, 12m range | Enables SLAM-based mapping. |
| Camera | 1080p USB | Captures images for face recognition. |
| Microphone | wireless USB | Captures voice commands. |
| Touchscreen | Interactive display | Provides visual interaction. |
| Speakers | Integrated with Jetson Nano | Outputs voice responses. |
| DC-DC Converter | 12V to 5V, 5A | Converts battery power for Jetson Nano and sensors. |
| Battery | 55.5Wh, 12V, 10Ah LiPo | Supports the power requirements. |

# 4 Power Consumption and Battery Justification

Power Consumption Breakdown:

- Jetson Nano: 10W - 15W
- Motors (2x 12V 37GB-520 High Torque): 15W - 20W
- RPLidar A1: 5W
- Camera, Microphone, Speakers, Display: 10W
- **Total Estimated Power Consumption:** 45W - 50W

To support the system, a 12V, 10Ah (55.5Wh) LiPo battery was selected.
The estimated runtime of the battery is calculated as:

$$\text{Battery Runtime} = \frac{\text{Battery Capacity (Wh)}}{\text{Total Power Consumption (W)}}$$

$$\text{Battery Runtime} = \frac{55.5Wh}{50W} \approx 1.1 \text{ hours}$$

$$\text{Battery Runtime} = \frac{55.5Wh}{45W} \approx 1.2 \text{ hours}$$

# 5 Software and AI Components

## 5.1 Navigation System (Autonomous Navigation)

**Goal:** Enable autonomous movement and mapping.
**Software Used:**

- ROS (Robot Operating System) for integrating hardware and software.
- SLAM (Simultaneous Localization and Mapping) Algorithm for localization.

## 5.2 Multimodal Interaction System

**Face Recognition System:**

- Face Detection → Find human faces in an image.
- Face Normalization → Align and resize the face for better recognition.
- Feature Extraction → Convert faces into numerical data.
- Face Matching → Compare extracted features with stored faces.
- Database Management → Store known users and update records.

**Speech Recognition and Chatbot:**

- Speech-to-Text (STT) → Convert spoken words into text.
- Natural Language Understanding (NLU) → Understand the intent of the user.
- Chatbot Response → Generate a meaningful answer.
- Text-to-Speech (TTS) → Convert text back to voice.

**Touchscreen Interaction**

- Display user details (face recognition results).
- Show chatbot responses as text.
- Allow users to select options for directions or information.

# 6 Robot Conception

For the development of the intelligent receptionist robot, we will use 3D modeling tools such as **SolidWorks** or**CATIA**. These software tools allow for precise modeling of the robot's various parts, ensuring an optimal design for integrating all the necessary components (sensors, motors, etc.).