Assignment 01	SECORO	should be submitted by 22:00 HRS on the 29th of April, 2025
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multi-robot delivery solution for an indoor office environment

Requirement Analysis and Project Planning

Declaration of AI Assistance

In the creation of this requirement specification, we independently defined and developed the requirements and their acceptance criteria based on the project scenario provided.

To refine the expression, improve clarity, and ensure correct formatting of the requirements and their acceptance criteria, we used ChatGPT as a language support tool.

The content, structure, and original ideas presented in this document are entirely our own.

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List of Abbreviations

Abbreviation	Meaning
F	Functional Requirement
NF	Non-Functional Requirement
PD	Pre-Delivery Phase
WD	While-Delivery Phase
RT	Run-Time Requirement
DT	Deployment-Time Requirement (static requirement)
GT	General Requirement

Set of requirements Requirement and Acceptance Criteria

Req. nr.	Requirement (R) definition[1] and acceptance criteria (AC)	
Req-PD-DT-NF-01	R	The system shall require user authentication before allowing delivery requests.
	AC	• Users must log in with a valid account (e.g., via username/password) before submitting a delivery request. • Unauthenticated users will not be granted access to the delivery request form.
Req-PD-DT-F-02	R	When requesting a delivery, the user shall be able to specify the target room inside the office environment or staff members through a web interface.
	AC	• Interface accuracy of user requests is 95%. • Users can specify destinations through a web interface within 1 minute.
Req-PD-DT-F-03	R	When the web interface is launched and before confirming a delivery, the system shall display a safety briefing on how to interact safely with the robots
	AC	• The safety briefing appears immediately upon launch, before confirming delivery, in 100% of interface launches. • Users must confirm reading the briefing before proceeding.
Req-PD-DT-F-04	R	When initiating a delivery request, the web interface shall display a list of allowed and forbidden package contents.
	AC	• The interface displays allowed and forbidden package contents clearly. • Users must acknowledge reviewing contents guidelines before proceeding.
Req-PD-DT-F-05	R	When initiating a delivery request, the web interface shall display the maximum allowed package size and weight that the robot can safely carry.
	AC	• The interface consistently displays maximum allowed package size and weight, verified in 100% of tests. • Users must confirm understanding these limits before submitting the request.
Req-PD-RT-F-06	R	When a delivery request is initiated, the robot nearest to the sender shall accept the request and inform all other robots that the request is taken.
	AC	• Nearest robot correctly accepts the request 90% of the time. • All robots are reliably informed within 5 seconds that the request has been taken
Req-WD-RT-NF-01	R	The Lidar and optical system of the robot should detect static and dynamic obstacles that are at least 10 cm high and 5 cm wide[2]
	AC	During obstacle detection tests, the robot successfully detects 90% of obstacles larger than or equal to 10 cm in height and 5 cm in width in 10 out of 10 trials.
Req-WD-RT-F-02	R	The robots shall autonomously navigate the indoor office environment and

[1] Format: EARS – Easy Approach to Requirements Syntax

[2] We chose a minimum detectable obstacle size of 10 cm in height and 5 cm in width based on the TurtleBot 4's physical dimensions but this should be tested experimentally and, if necessary, redefined.

	AC	• During autonomy navigation test, the robot successfully navigates to destinations without human intervention in 90% of trials • Robots navigate successfully to the target destination autonomously with a 95% success rate in tests. • No manual intervention is required during navigation.
Req-WD-RT-F-03	R	The robots shall autonomously avoid static and dynamic obstacles that are at least 10 cm high and 5 cm wide and keep 50 cm from the obstacles in its environment.
	AC	• During obstacle avoidance tests, the robot successfully detects and avoids 90% of obstacles larger than or equal to 10 cm in height and 5 cm in width in 10 out of 10 trials. • Obstacles smaller than 10 cm in height are ignored, unless the robot cannot safely pass, in which case it generates a warning or rerouting attempt. • Robots avoid obstacle or halt movement within 0.5 s upon obstacle detection during obstacle avoidance tests in 90% of cases.
Req-WD-RT-F-04	R	When a robot detects inconsistency between its IMU data and odometry data indicating potential slipping, sticking, or kidnapping, and recovery is not successful within 1 minute, the robot shall stop recovery attempts and report the incident to the system monitor.
	AC	• The robot shall attempt automatic recovery actions (e.g., re-localization, small movement attempts) for up to 1 minute after detection. • If IMU and odometry data diverge for more than 60 seconds and recovery actions failed, the system generates an alert and sends it to the system monitor in 90% of tested incidents.
Req-WD-RT-F-05	R	When the delivery destination becomes inaccessible, the robot shall inform the sender of the blockage and request an alternative destination before returning the package.
	AC	• When a destination is blocked, the robot sends a notification to the sender within 5 seconds. • The robot waits up to 2 minutes for the sender to provide an alternative destination. • If no alternative is given, the robot proceeds to return the package to the sender.
Req-WD-DT-F-06	R	When returning the package and the sender's location is also inaccessible, the robot shall generate an incident report and notify both the sender and the assigned supervisor responsible for system monitoring.
	AC	In 10 simulated scenarios, the robot successfully moves to the side within 10 seconds after stopping.
Req-WD-RT-F-07	R	When waiting for a response from the sender or the system monitor, the robot shall move to the nearest safe location off the main corridor or shared pathway to avoid blocking movement
	AC	• Robot moves to a safe location within 30 seconds of awaiting response. • Robot maintains safe clearance and does not obstruct pathways verified through trials.
Req-WD-RT-NF-08	R	Robots shall continuously share their current positions with each other during operation to enable cooperative behavior. (optional)
	AC	• Robots' position data updates every 3 seconds. • Cooperative behaviours demonstrate consistent accuracy and efficiency improvements.

Req-WD-RT-F-09	R	Robots shall share their local maps with each other to maintain a shared global map of the environment. (optional)
	AC	• Local map sharing occurs continuously at intervals not exceeding 5 seconds. • Shared global map maintains 95% accuracy throughout robot operation.
Req-WD-RT-F-10	R	When a robot detects a closed door or an inaccessible destination, it shall notify all other robots immediately to avoid redundant navigation attempts.
	AC	• Notification about closed doors or inaccessible destinations is broadcast to all robots within 3 seconds of detection. • Robots receiving notifications adjust routes immediately, avoiding redundant attempts.
Req-WD-RT-F-11	R	When the robot is en route to the receiver, the receiver shall be notified via web or app notification, and a safety briefing on how to interact with the robot shall be displayed to them.
	AC	• Receivers receive notifications via web or app reliably, with 100% notification accuracy. • Safety briefing is automatically displayed and requires user acknowledgment before delivery.
Req-WD-RT-F-12	R	When reaching the destination, the robot shall inform the sender that it has arrived and wait for the receiver to take the package.
	AC	• Sender is notified immediately (within 5 seconds) upon robot reaching the destination. • Robot consistently waits safely until the receiver picks up the package.
Req-WD-RT-F-13	R	After taking the package, the receiver shall be notified by the robot to confirm receipt via the web interface
	AC	• Receiver must confirm receipt via web interface, with confirmations reliably recorded. • System captures confirmation events with 100% accuracy.
Req-WD-RT-F-14	R	Upon receiving the confirmation, both the robot and the sender shall be notified, and the robot shall become available to accept a new delivery request.
	AC	• Receiver must confirm receipt via web interface, with confirmations reliably recorded. • System captures confirmation events with 100% accuracy.
Req-WD-RT-F-15	R	When battery level drops below a defined threshold (e.g., 20%), the robot shall switch to energy-saving mode and notify the monitoring supervisor
	AC	• Robot switches automatically to energy-saving mode precisely at the defined battery threshold. • Supervisor receives immediate notification of low battery status within 5 seconds.
Req-GT-NF-1	R	The robotic system shall maintain operational reliability continuously.
	AC	Robots maintain operational status without software failure for at least 99% of uptime during testing phases.

Req-GT-NF-2	R	The system architecture shall allow future scalability to accommodate additional robots without significant modifications
	AC	Addition of extra robots requires less than 2 hours of system downtime for integration and testing.
Req-GT-NF-3	R	The system shall ensure data security and privacy concerning delivery instructions and operational data.
	AC	○ Passes all security audits without any critical vulnerabilities. ○ Data is transmitted and stored using encrypted communication protocols. ○ Only authenticated users can initiate delivery requests

Development Milestones

Milestone 1: Requirement Analysis and Project Planning (Week 2)

- Team collaboration and client validation of final requirements document.
- Milestones Determination

Milestone 2: System Architecture and Design (Week 4)

- Design approval including software architecture, navigation methods, and interface layouts.

Milestone 3: Prototype Development (Week 6)

- Initial software prototype demonstrating basic navigation and delivery capabilities.

Milestone 4: System Integration and Initial Testing (Week 8)

- Integration of navigation, interface, and obstacle detection subsystems for initial testing phase.

Milestone 5: Full System Testing and Refinements (Week 10)

- Comprehensive testing under various scenarios including edge cases.
- Necessary refinements based on test outcomes.

Milestone 6: Final Deployment and Review (Week 12)

- System deployment in the client's environment.
- Final project review and handover.

Timeline Overview

Project phase	Task	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12
Phase 1	Requirement collection and documentation												
Phase 2	Design and architecture validation												
Phase 3	Software development and prototyping												
Phase 4	Subsystem integration and initial testing												
Phase 5	Full system testing and refinement												
Phase 6	Deployment, final validation, and handover												

Phase	**Week**	**Activities**
requirement analysis	1-2	Requirement collection and documentation
system design	3-4	Design and architecture validation
implementation	5-6	Software development and prototyping
integration	7-8	Subsystem integration and initial testing
testing	9-10	Full system testing and refinement
deployment	11-12	Deployment, final validation, and handover