Indoor Mapping System

System Requirements Specification (SRS)

Group 3

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Revision Table

Revision	Date	Authors	Description of Revision
0.0	10/18/13	Abdel-Latif, Sari Batth , Chanderdeep Bishara, Marc Elsaftawy , Mahmoud Mansour, Ahmed Wahid , Fahim	First iteration of the requirements document
0.1	10/21/13	Elsaftawy , Mahmoud	Revised copy, organization of requirements and finalizing the black box diagram.
0.2	10/23/13	Abdel-Latif, Sari Batth , Chanderdeep Bishara, Marc Elsaftawy , Mahmoud Mansour, Ahmed Wahid , Fahim	Review past document in light of Prof's feedback. • Updated Black Box diagram to reflect the updated monitored variables and controlled variables. • Identified constants • Added a Definitions table. • Added a
0.21	10/23/13	Abdel-Latif, Sari	• Final Formatting and organization of document. • General Formatting andEditing.
0.22	10/23/13	Abdel-Latif, Sari Bishara, Marc	• Added Descriptions to monitored variables.
0.23	10/23/13	Abdel-Latif, Sari Bishara, Marc	• Added overall Assumptions • Added more functions to the function table. • Last Minute Editing
0.24	01/12/13	Bishara, Marc	• Changed version number to be less than 1 as this is only the draft
1.0	05/03/14	Bishara, Marc	• Modifications to requirements to meet new goals
1.1	06/03/14	Abdel-Latif, Sari	• Review and Formatting
1.2	06/03/14	Elsaftawy , Mahmoud	• Fixed Typo
1.3	06/03/14	M. Bishara	• Final fixes to some assumptions

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1. Introduction

1.1. Purpose

This document identifies the system requirements of the Indoor Mapping System

1.2. Scope

This document does not describe the design or implementation of the system, this document identifies the system requirements and all information needed to clarify them, such as controlled and monitored variables, assumptions, and rationale

1.3. Reference

Project goals definition Version 1.0: IndoorMapping_SystemGoals_V1.1.pdf

2. Overall System Description

2.1. Environmental Assumptions:

2.1.1. The hallway being mapped are at no point larger than the range specified for m_dist_(Left, Right and Front). As such the mapping system shall not find itself in a position with no walls visible.

2.1.2. It is assumed that the mapped floor does not have any stairs.

2.1.3. It is assumed that the floor being mapped does not contain any rooms with no doors. All the rooms have to be closed prior to the mapping.

2.1.4. It is assumed that the robot is initially place parallel to one of the walls

2.1.5. It is assumed that the hallways are empty when the system is mapping

2.2. Definitions

Point of Interest	A point of interest is a Door or a Name tag
2D_map	A 2D map is an array of locations correlated with their surrounding distances
Visual_2D_map	A visual 2D map is an image with a complete plot of all the points in the 2D_map. It also shows all the points of interest in their correct position
Area of Interest (AOI)	Is the area surrounding the mapping system with a radius of k_AOI_radius
Sensor Orientation	The current angle of the mapping sensor
Time Zero	It is the initial moment when the system starts mapping. At this moment the position and orientation are recorded to be used for reference for the rest of the mapping procedure.

Hallview	It is a view that is very similar in appearance to Google Streetview

2.3. System Context Diagram

The system as a whole will contain the following monitored and controlled variables.

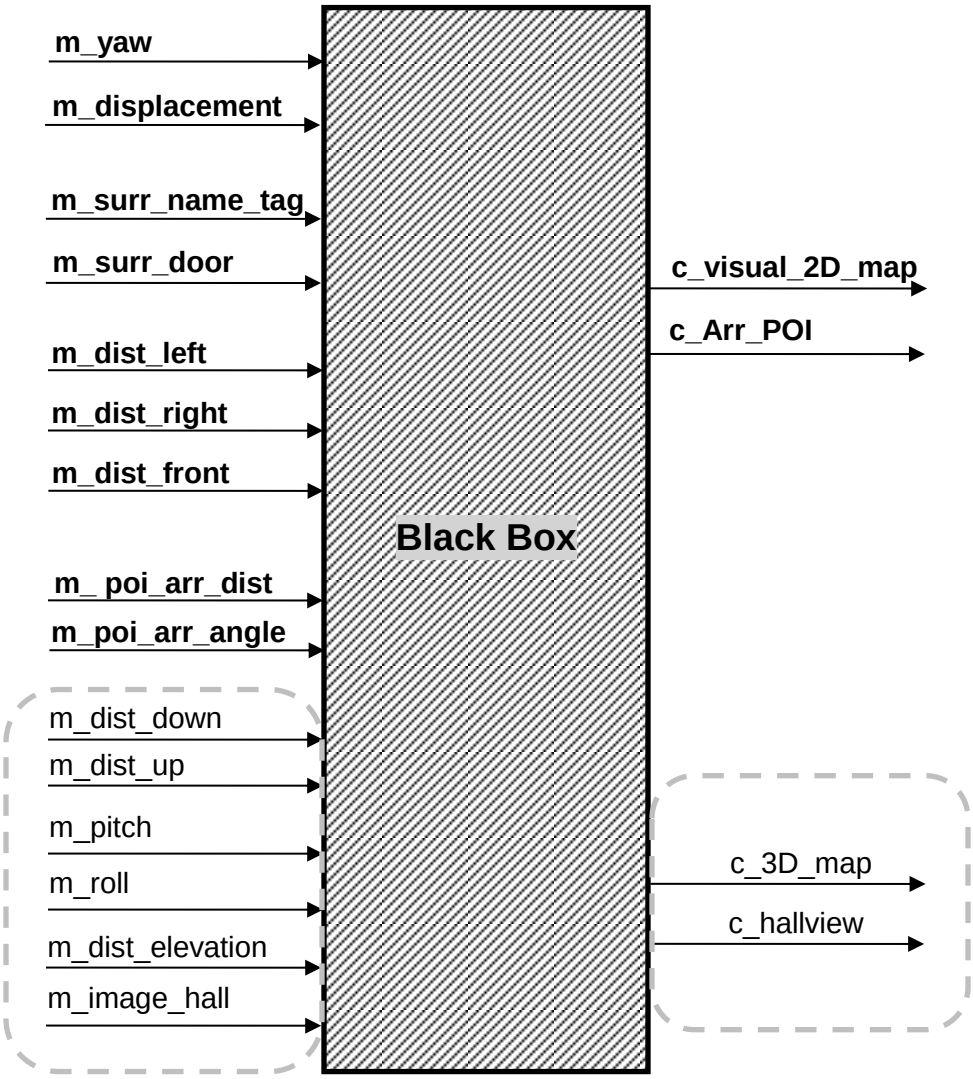

Figure 1 -
Black Box Diagram

[1] Dashed Area are the Monitored and Controlled Variables for the Secondary Goals and Requirements

2.4. System Diagram with Monitored Variables

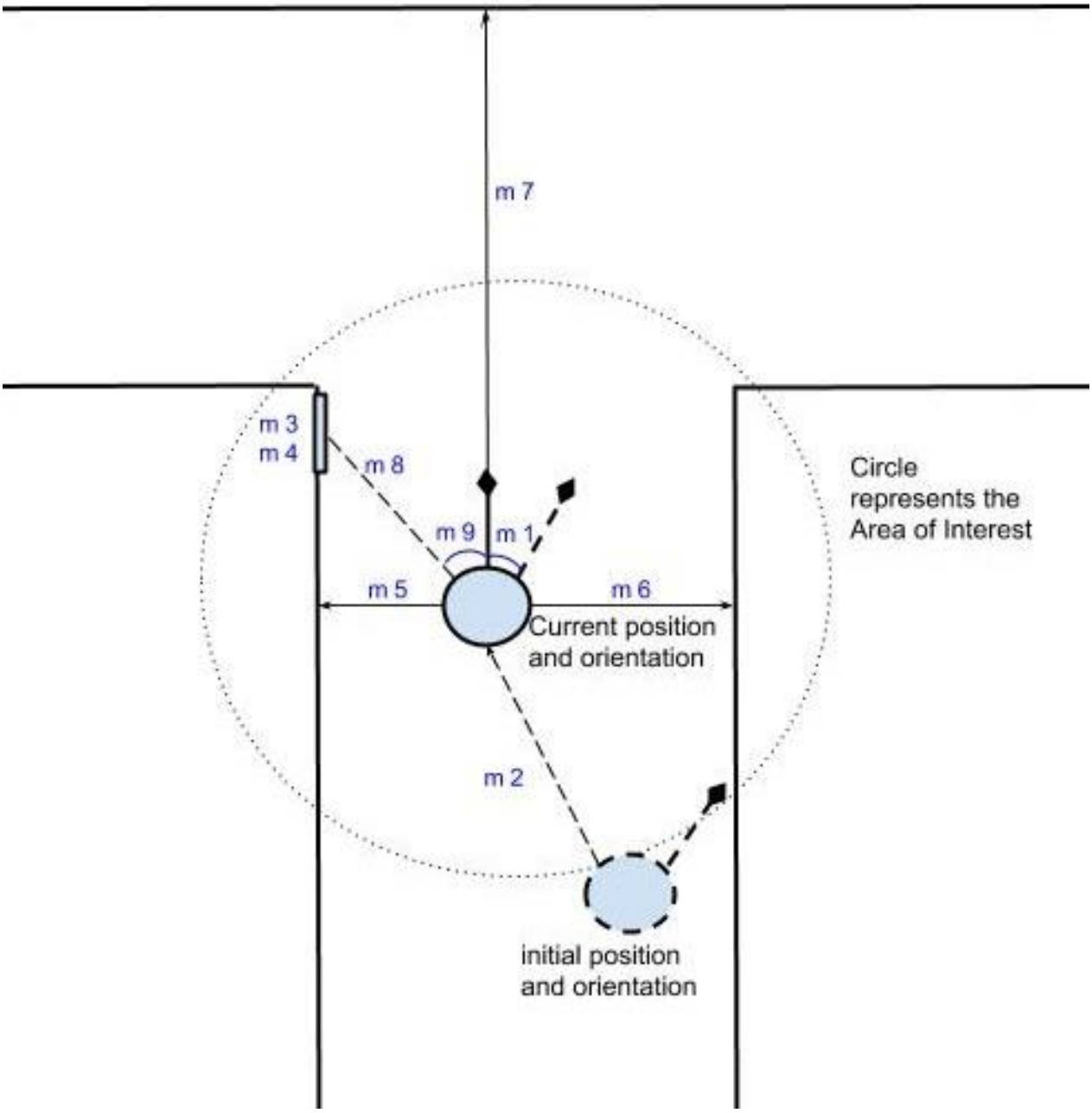

Figure 2 - System Diagram with Monitored Variables

2.5. Variables

2.5.1. Monitored Variables

Variable #	Variable Name	Type	Units	Description	Range
M1	**m_yaw**	$+\mathbb{R}^2$	degrees	The difference in angle between the system's current orientation and its orientation at time zero.	0 to 360
M2	**m_displacement**	$+\mathbb{R}$	cm	Holds the position of the mapping unit relative to the starting point. Is a vector that hold the distance and direction.	-
M3	**m_surr_name_tag**	JPEG	N/A	Represents all the surrounding name tags that can are found in the system's area of interest	N/A
M4	**m_surr_door**	N/A	N/A	Represents all the doors that can be found in the system's area of interest	N/A
M5	**m_dist_left**	$+\mathbb{R}$	cm	The physical distance between the mapping unit and the wall to the left of it.	0 to 2000
M6	**m_dist_right**	$+\mathbb{R}$	cm	The physical distance between the mapping unit and the wall to the right of it.	0 to 2000
M7	**m_dist_front**	$+\mathbb{R}$	cm	The physical distance between the mapping unit and the wall to the front of it.	0 to 2000

[2] $+\mathbb{R}$: positive Real Numbers

M8	**m_poi_arr_dist**	$+\mathbb{R}$	cm	Holds the distance between the mapping system and the point of interest	0 to 2000
M9	**m_poi_arr_angle**	$+\mathbb{R}$	degrees	Holds the angle at which the point of interest exist with reference to the front of the system	0 to 360
M10	**m_sensor_orientation**	$+\mathbb{R}$	Degrees	Orientation of the sensor measuring the distance to the walls	0-180
The following requirements have been identified as the monitored variables that would have to be added to the system in case the project's scope expand to include the secondary requirements:					
	m_dist_down				
	m_dist_up				
	m_pitch				
	m_roll				
	m_hall_image	JPEG	-	Image of the surrounding that is captured by the unit	

2.5.2. Controlled Variables

Variable Name	Description	Dependencies
c_visual_2D_map	A blueprint like map of the target floor, with all points of interests marked on their locations.	M5,M6,m7,M1,M2
c_array_poi	A collection of all points of interest detected, with information about their type, content, and location.	M3,M4,M2,M8,M9

2.5.3. System Variables

v_poi_location	f(m_displacement, m_poi_arr_dist, m_poi_arr_angle)

2.5.4. Constant Variables

Variable Name	Type	Units	Description	Range
k_mapping_speed	$+\mathbb{R}$	m/s	The speed at which the mapping system will move	0.2 +- 0.10
k_mapping_accuracy	$+\mathbb{R}$			
k_AOI_radius	$+\mathbb{R}$	m	The radius in which points of interest shall be detected	20 +- 5
k_POI_discovery_percentile	$+\mathbb{R}$	%	The percentage of points of interest that need to be correctly identified for the system to succeed	80

2.6. Functions

Function Name	Description	Monitored Variables Used
F_map_generation	$For\ every\ itteration,$ $Plot\ i * (X,Y)\ positions\ where:$ $X = m\_Displacemet.X + (m\_Dist[i] * \cos(m\_Yaw + m\_SensorOrientation))$ $y = m\_Displacemet.y + (m\_Dist[i] * \sin(m\_Yaw + m\_SensorOrientation))$	m_yaw, m_displacement, m_dist_sensor
F_POI_generation	Table(POI type, POI location)	m_yaw, m_surr_name_tag, m_surr_door, m_poi_arr_dist, m_poi_arr_angle
Visual_2D_map	**m_dist(left,right)** input variables are used to calculate the width of the hallway being mapped. In order to detect any walls and determine when to turn the system. **m_dist_front**variable is used keep track of the distance between the system and any wall that may be in path of the system. **m_displacement**input variable is used for keeping track of location and to determine if the system has completely mapped a floor of the building. **m_yaw** input is required in order to generate a properly oriented visual 2-D map.	m_yaw, m_displacement, m_dist_left, m_dist_right, m_dist_fron
Array_POI	**m_surr_name_tag** and **m_surr_door** input variables feed information about the type of point of interest and its contents such as room number or door . In order to determine the location of the point of interest in the map. **m_displacement** variable inputs the displacement of the system. In order to determine the location of points of interest within the area of interest. **m_poi_arr_dist** and **m_poi_arr_angle** variables are used to determine the distance and angle of the point of interest relative to the mapping system.	m_displacement, m_surr_name_tag, m_surr_door, m_poi_arr_dist, m_poi_arr_angle

3. Non-Functional Requirements

3.1. SR_NFR_3-1:

The Mapping System shall be fully autonomous.

- **3.1.1. Rationale**: As required by G - 1.
- **3.1.2. Likely to Change**: No.

3.2. SR_NFR_3-2:

The Mapping System shall not harm any person as it maps a hallway.

- **3.2.1. Rationale:** It is not acceptable for people to be harmed by the system.
- **3.2.2. Assumptions:**The mapping system isn't being used in any way that isn't described or intended.
- **3.2.3. Likely to Change:** No.

3.3. SR_NFR_3-3:

The Mapping System shall not crash into walls or objects in the hallway.

- **3.3.1. Rationale:** So that it does not cause damage to the hardware
- **3.3.2. Assumptions:** All objects must be removed from the hallways and the floor must be dry. The width of the hallway must be larger than twice the width of the Mapping System.
- **3.3.3. Likely to Change:** No.

3.4. SR_NFR_3-4:

Software should follow information hiding Standards.

- **3.4.1. Rationale:** Future hardware should cause minimal implications on software changes.
- **3.4.2. Assumptions:** None.
- **3.4.3. Likely to Change:** No.

4. Functional Requirements

4.1. SR_FR_4-1:

C_visual_2D_map shall be produced according to the function F_map_generation.

- **4.1.1. Rationale:**
- **4.1.2. Assumptions:**
  - 4.1.2.1.1. Hallways must be empty. All rooms have a door that must be locked during the mapping process
  - 4.1.2.1.2. While mapping, there must not be anyone around the unit who may interfere.
- **4.1.3. Likely to Change:** No.

4.2. SR_FR_4-2:

C_visual_2D_map shall be fully mapped in a period no more than k_mapping_speed.

- **4.2.1. Rationale:** Adding a time restriction prevents busy hallways from being locked.
- **4.2.2. Likely to Change:** Yes**.** K_mapping_speed is subject to change based on the limitations of the hardware used.

4.3. SR_FR_4-3:

C_array_points_of_interest shall be a compilation of 80% of m_surr_doors at their respective v_point_of_interest_location as indicated by function F_POI_generation.

- **4.3.1. Rationale:** As specified by goal G_3. Therefore needed for the system to succeed.
- **4.3.2. Assumptions:**
  All rooms must have doors that closed so that the robot can capture the tags. Lights must be turned on
- **4.3.3. Likely to Change:** No.

4.4. SR_FR_4-4:

The mapping system shall provide live feedback and map compilation to users

- **4.4.1. Rationale:**This will allow the user to monitor the progress of the mapping system
- **4.4.2. Assumptions:** This assumes that wireless communication infrastructure is established and correctly functioning
- **4.4.3. Likely to Change:** No

4.5. SR_FR_4-5:

C_visual_2D_map shall be accurate to the real world within k_mapping_accuracy

- **4.5.1. Rationale:** Map should be accurate enough to allow users to use it in indoor settings.
- **4.5.2. Likely to Change**: No

4.6. SR_FR_4-4:

The mapping system shall be able to identify any module that is no longer responding by implementing watchdog timers

- **4.6.1. Rationale:** This will allow the system to limit hazards by shutting off if any critical module is suddenly not responding
- **4.6.2. Assumptions:** This assumes that hardware that shuts off the system does not fail. No redundancy in design.
- **4.6.3. Likely to Change:** No

5. Secondary Requirements

Given the above requirements are met well before the deadline; the following requirements will be fulfilled:

5.1. The Mapping System shall generate a "hallview" of the hallway/floor.

5.1.1. Rationale: Hallview is defined as a set of stitched pictures of the hallway that the user can navigate through to see what the hallways look like. This functionality is much like Google's street view

5.1.2. Assumptions: Lights must be turned on.

5.2. The Mapping System shall generate a 3D map of the hallway/floor.

5.2.1. Rationale: This enhances user experience and allows for more use possibilities.

5.2.2. Assumptions: There must not be any object or person in the hallway or around the unit that could interfere with the mapping process**.**