

Software (SW) Requirements Specification (SRS) - Homework 2

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1. Introduction

This document describes in detail the functions, characteristics, constraints, and requirements for the production and use of a fully autonomous robotic vacuum cleaner.

1.1 Purpose

The purpose of this document is to ensure that all software requirements are to the specifications of the clients needs to fill customer expectations and functionality. This will inform the software developers what is to be expected of the final product.

1.2 Scope

The product, to be produced, is a robotic vacuum cleaner that will pick up dirt and debris from carpet and hard floors. The benefits of the device must include: programmable scheduling; balanced battery and cleaning efficiency; obstacle avoidance; be able to return to its charger home base; and ease of maintenance. Objectives include: user friendly cleaning cycle programming interface; a dustbin large enough for two cleaning cycles (length of which is based on battery performance) in an active household; ability to free itself from minor snags; and motion planning software for the most efficient cleaning cycles. Restrictions include: Unable to guarantee the device will avoid all obstacles; user will not be able to program any aspect of the device outside of scheduling run times; restricted to indoor use only; user will have to perform basic maintenance; and no there is no display screen interface on the device.

1.3 Definitions, acronyms, and abbreviations

- *The device:* the cleaning unit
- *Cleaning cycle:* one attempt (scheduled or unscheduled) to pick up dirt and debris in a household(closed area).
- *Home station* - The device's charging base station (home base)

- *Basic maintenance* - User interactions that include emptying dust bin, cleaning rotating brush, unclogging vacuums utilities from any obstructions, and replacing filters.

1.4 Organization

The following sections will describe the overall product description, the functions of the product, user characteristics, the physical and user constraints of the device, and assumptions and dependencies from/of the user. The following sections will also detail modeling requirements for the prototype and the generalized physical model for the physical layout of the unit nearing completion.

2. Overall Description

This section will describe the product perspective, the functions of the product, user characteristics, the constraints of the device, and assumptions and dependencies.

2.1 Product Perspective

This device is designed to pick up dirt and debris from a user's carpet or hardwood floor. It will be able to perform a cleaning cycle fully autonomously with minimum to no amount of user interaction.

Interface Constraints:

- User interface will not be directly on the device.
- All interface between user and unit is done through colored lights and simple voice output from the device.
- User must perform basic maintenance between alternating cleaning cycles.
- Walls and other obstructions may interfere with device communicating with its home station.

Other types of constraints:

- Physical size of device.
- Location of field sensors must be located around the units normal direction of travel
- Battery size limited by device size and possible weight load.
- Dust bin size limited by device size.
- Motor power output limited by device and battery size.

2.2 Product Function

Functions that the software will include are:

- *Programmable scheduler* - ability for user to schedule when the device will begin a cleaning cycle
- *User interface for programmable scheduler* - A simplistic interface that allows the user to access the program scheduler and set the current time and date
- *Internal clock* - Tracks the current time and date set in the user interface and to be used by the program scheduler.
- *Obstacle avoidance* - Ability to avoid major obstacles such as walls, large furniture, large clutter (such as shoes), and other sudden drop offs (i.e. stairs).
- *Self freeing* - When caught/stuck due to unknown reason, device should turn off vacuum and rotating brush (in case of a cable or shoelace, etc) and attempt to dislodge. The dislodge attempt should be on a relatively short timer that will cause an error code, and force the device to shut down if unable to become free.
- *Motion planning software* - Software that will optimize the robot's movement that will provide full cleaning performance while reducing current battery usage by 15%.
- *Return to charger* - The device must be able to return to its charger(home base) once the battery hits a certain level without user intervention.
- *Colored error lights* - Informs user of basic issues with the device that include: low battery, full dustbin, needing maintenance, and stopped because it could not free itself.

2.3 User Characteristics

User is expected to have basic knowledge of computers since they are comfortable purchasing this device. The users are expected to have little to no knowledge about how the device is used at purchasing time since it is still relatively new technology. Their general expertise will be their, assumed, basic knowledge about how a vacuum works and what it is supposed to accomplish.

2.4 Constraints

- *User interface* - Will only allow user to set the time, date and when the device should operate on its own.
- *Dustbin size* - Dust bin size is limited due to size of the device. User must be expected to empty it at least once every two cleaning cycles based on the conditions of the floor (caused by dirt, pet hair, etc). Or a full dustbin will restrict the effectiveness of the vacuum and lead to increased battery drain.

- *Error notifications* - Notifications are limited to different colored lights or voice output to save on physical space and extra battery that a display would take. Must include user friendly documentation to explain codes.
- *Basic maintenance* - User will have to perform basic maintenance such as emptying dustbin, cleaning the rotating brush and changing filters.
- *Device becoming stuck*- While there is a focus on obstacle avoidance and self freeing software, it is impossible to fully predict how an area will be laid out and what obstacles will be involved. The device may get stuck and the user will have to free it.
- *Finding charger* - If the device travels to another room, or has obstacles in the way that it can't navigate around before its battery dies, it might not make it back to its home station to charge, causing the user to have to place it on its charger.
- *Indoor use only* - This device will only be able to handle conditions of an indoor environment and not the possible obstacles or debris that occurs outdoors.

2.5 Assumptions and Dependencies

- The user must schedule a date and time before the device will begin on its own.
- Likewise, the user must set the internal date and time before attempting to input a scheduled cleaning.
- The device must be at least half charged before starting a cleaning cycle (scheduled or not)
- The length of each cleaning cycle is dependent on the battery's efficiency, capacity, and current battery level (a higher charge will allow a longer cleaning cycle)
- There must be space in the dust bin in order for the device to complete a cleaning cycle. A cleaning cycle may terminate early if the dust bin becomes full. If the dust bin is full at the start of a scheduled cleaning cycle, the cycle will be skipped and an error light will be shown.
- The user should clear large obstacles from the area to be cleaned. The efficiency of the device is dependent on the amount of obstacles in a given cleaning area.
- The user should move delicate objects away from the path of the device. Anything left in the cleaning area should be able to withstand an accidental push from the device.
- The user should also pick up any low lying cables or string, as to not get wrapped up in the vacuum's rotating brush.

3. Specific Requirements

1. The device must be able to start a cleaning cycle (scheduled or unscheduled)
 - a. The device must be able to retain the current date and time

- b. The device must be able to retain a cleaning schedule
 - c. The device must be able to leave and return to its home station with minimal exceptions
- 2. The device must manage its battery life efficiently
 - a. The device must monitor its battery life while cleaning as well as at the start of a cleaning cycle
 - b. The device must be able to stop a cleaning cycle early in order to save battery life
 - i. In the case of an obstruction or other conditions where the device is unable to free itself, the device may shut down away from its home station
 - ii. In all other cases, the device should return to its home station before running out of power
 - c. The software must maintain battery efficiency (software will be acceptable if it will reduce power consumption by 15%).

4. Modeling Requirements

- The unit should be appropriately proportioned to maximize the battery size, motor size, and dustbin size to be mobile enough to have a longer cleaning cycle while not having a charge take extensive amounts of time.
- All of the masses of the components of the unit should be appropriately positioned around the wheel base to keep the unit sturdy and balanced.
- Two main drive wheels must be used to power the motion of the unit and be able to apply power differentially as to control the steering of the unit

5. Prototype

- Prototype of unit should be mostly complete functionally, and have all sensors efficiently communicating with the unit to be able to navigate a maze and avoid major and minor collisions. The software/hardware integration should be seamless, and the unit should function as a whole.
- All components needed for prototype are; lightweight structural casing, lightweight CPU with integrated feedback sensors mounted on body of unit, battery pack mounted on frame, dustbin, vacuum motor with rolling brush and rotating dislodger attached.