Heart Monitor Software Requirements Specification

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1. Objective

A program that simulates the controller of a heart monitor to continuously monitor heart functions of a patient, based on simulated data. The heart monitor receives simulated data as input consisting of heart rate (pulse), oxygen level and systolic and diastolic blood pressure.
The program must provide a warning level based on the severity of a particular input value or combination of values. The warnings purpose is for a trained medical professional to be alerted and not to provide any diagnosis.

The functional requirements are specified in the table below, and detailed further within the software requirements specifications. Requirement type 1 details the context of the data simulation and the input format and warning and error requirements, while requirement type 2 determines the boundaries for warnings, errors and normal ranges.

Requirement Type	**ID**	**Requirement**
1	FR01	Input Data Format
1	FR02	Warnings and errors
2	FR03	Error specification
2	FR04	Grade 3 problem warning specification
2	FR05	Grade 2 problem warning specification
2	FR06	Grade 1 problem warning specification
2	FR07	Normal range values specification

Further, we identify different priorities per requirement. We prioritize at three different levels and categorize the requirements in them. The priority levels are given in the following table.

Priorities	**Identifier**
Low Priority	Low
Medium Priority	Medium
High Priority	High

2. Requirements

Functional Requirement #1

Requirement Identifier: FR01
Requirements Type: 1
Priority: Medium
Introduction: This requirement defines the format of the input data.
Rationale: The input data must be correctly formatted for the program to work as expected.
Author/Source: Oliver
Inputs: -
Requirement Description:

- The heart monitor needs to read the following values: pulse, systolic and diastolic blood pressure, oxygen level
- The heart monitor is required to read these values from a file in a csv format
- All input values must be floating point numbers without their unit of measurement included in the CSV.
- One line in the input data must correlate to, in this order; pulse, the systolic blood pressure, the diastolic blood pressure, and oxygen level with a positive numerical value for each, separated by commas
- Pulse has to be measured in beats per minute
- Oxygen level has to be measured in a percentage representing the fraction of oxygen-saturated hemoglobin relative to total hemoglobin.
- Diastolic and systolic blood pressure must be used, measured in millimeter of mercury (mmHg)

Outputs: -
Persistent Changes: no persistent changes
Related Requirements: Project description, FR 01. FR02.R03. FR04. FR05. FR06. FR07
Conflicts: no conflicts
Test Cases: -

Functional Requirement #2

Requirement Identifier: FR02
Requirements Type: 1
Priority: High
Introduction: This requirement describes what kind of warnings and errors the program gives in different situations
Rationale: Different warnings and errors are the key functionality of the program. Warnings and errors are provided without any specific diagnosis. The purpose of the heart monitor is not to

diagnose a patient, but rather to alert medical personnel of any monitored values that are outside normal boundaries.
Author/Source: Oliver
Inputs: Simulated data
Requirement Description:

- The monitor reads pulse, oxygen level and the systolic and diastolic blood pressure.
- Firstly, the monitor must check for errors in the input as defined in requirement 3. If it raises an error, it must not check for other conditions and continues with the next input.
- Next, the monitor must check for, in this order: grade 3, grade 2 and then grade 1 problems. It raises corresponding warnings, depending on the individual or combinations of values. Grade 1 is less critical than grade 2 and grade 2 is less critical than grade 3. If the monitor recognized several warnings, it must output the highest grade problem. For example: If one individual value is a grade 1 warning, and the combination of three values is a grade 3 warning, the monitor must output the higher grade 3 warning.
- The monitor must raise no error or warning if the values for pulse, oxygen level and systolic and diastolic blood pressure values are within their normal range/domain as defined in requirement 7.

Outputs: Errors or warnings along with printed individual monitored values for the doctor to assess.
Persistent Changes: no persistent changes
Related Requirements: FR 01. FR02.R03. FR04. FR05. FR06. FR07
Conflicts: no conflicts
Test Cases: -

Functional Requirement #3

Requirement Identifier: FR03
Requirements Type: 2
Priority: Medium
Introduction: This requirement is meant to define when the program has to give an error when a singular value is in a specified range
Rationale: If the sensors deliver impossible or zero values, the program has to raise errors so that medical personnel can be alerted to check the sensors.
Author/Source: Oliver
Inputs: Simulated data
Requirement Description:

- This requirement focuses on the individual values and resulting errors.
- If an error occurs, the program has to print a message to the screen, stating an error, specifying the values and recommending to check the sensors.
- If the pulse (P) is less than or equal to 0 or greater than 240, the program must raise an error and print all the values.
- If the oxygen level (O) is smaller than or equal to 0% or bigger than 100%, the program must raise an error.

- If the systolic blood pressure is lower than or equal to 0 or greater than 400, the program must raise an error
- If the diastolic pressure is lower than or equal to 0 or greater than 300, the program must raise an error
- This is presented in Table 1 below:

Pulse (P)	P <= 0 || P > 240
Oxygen level (O)	O <= 0 || O > 100
Sys. Blood Pressure (sysBP)	sysBP <= 0 || sysBP > 400
Dia. Blood Pressure (diaBP)	diaBP <= 0 || diaBP > 300

Table 1. Individual error value boundaries.

Outputs: Errors printed to screen along with medical values.
Persistent Changes: no persistent changes
User Satisfaction: The user is warned about an error in the setup of the machine.
User Dissatisfaction:
Related Requirements: FR 01. FR02.R03. FR04. FR05. FR06. FR07
Conflicts: no conflicts-
Test Cases: -

Functional Requirement #4

Requirement Identifier: FR04
Requirements Type: 2
Priority: High
Introduction: This requirement informs when the program has to raise a grade 3 problem warning.
Rationale: A grade 3 problem relates to a life threatening situation where a medical value is far outside of its normal domain. A warning alerts medical personnel to check on the patient.
Author/Source: Oliver
Inputs: Simulated data
Requirement Description:

- This requirement focuses on the individual values and grade 3 problems.
- If a grade 3 problem occurs, the program has to print a message to the screen, stating a grade 3 problem and specifying the values.
- If the pulse is lower than 45 and the oxygen is lower than 96 and the systolic blood pressure is lower than 90 and the diastolic blood pressure lower than or equal to 55 then the program must return a grade 3 problem warning.

- If the pulse is either lower than 45 or higher than 150 and the oxygen is lower than 95 and the systolic blood pressure is higher than 140 then the program must return a grade 3 problem warning.
- If the the pulse is lower than 59 and the systolic blood pressure is larger than 160 and the diastolic blood pressure is larger than 120 then the program must return a grade 3 warning.
- If the pulse is greater than 0 and smaller than 40, the program must return a grade 3 problem warning.
- If the Oxygen level is greater than 0 and smaller than 90, the program must return a grade 3 problem.
- If the systolic blood pressure is greater than 0 and smaller than or equal to 80 or greater than 180 and smaller than or equal to 400, the program must return a grade 3 problem.
- If the diastolic blood pressure is greater than 0 and smaller than or equal to 40 or greater than 110 and smaller than or equal to 300, the program must return a grade 3 problem.
- This is given in table 2 below.

Interaction	P < 45 && O < 96% && && sysBP < 90 diaBP <= 55
Interaction	(P < 45 || P > 150) && O < 95 && sysBP > 140
Interaction	P < 59 && sysBP > 160 && diaBP > 120
Pulse (P)	0 < P < 40
Oxygen level (O)	0 < O < 90
Sys. Blood Pressure (sysBP)	0 < sysBP <= 80 || 180 < sysBP <= 400
Dia. Blood Pressure (diaBP)	0 < diaBP < 40 || 110 <= diaBP <= 300

Table 2. Grade 3 warning boundaries.

Outputs: grade 3 warning printed to screen along with individual values for doctor/nurse to assess.
Persistent Changes: no persistent changes
User Satisfaction: The user is alerted about very critical values
User Dissatisfaction:
Related Requirements: FR 01. FR02.R03. FR04. FR05. FR06. FR07
Conflicts: no conflicts-
Test Cases: -

Functional Requirement #5

Requirement Identifier: FR05
Requirements Type: 2

Priority: High
Introduction: This requirement is meant to inform when the program has to raise a grade 2 problem.
Rationale: A grade 2 problem relates to a dangerous situation where a medical value is far outside of its normal domain.
Author/Source: Oliver
Inputs: Simulated data
Requirement Description:

- This requirement focuses on the individual values and grade 2 problem warnings.
- If an grade 2 problem occurs, the program has to print a message to the screen, stating a grade 2 problem and specifying the values.
- If the pulse is lower than 60 or higher than 100 and the systolic blood pressure is less than 90 or higher than 120 then the program must return a grade 3 problem warning.
- If the pulse is greater than 120 and smaller than or equal to 240, then the program must return a grade 2 problem warning.
- If the oxygen level is higher or equal to 90% and smaller or equal than 92%, the program records a grade 2 problem warning.
- If the systolic blood pressure is greater than 140 or smaller than or equal to 180, the program must return a grade 2 problem warning.
- If the diastolic blood pressure is smaller than 90 or larger than or equal to 110, the program must return a grade 2 problem warning.
- This is represented in table 3 below.

Interaction	P < 60 || P > 100 && sysBP < 90 || sysBP > 120
Interaction	P < 45 && O < 95 % && sysBP > 130
Pulse (P)	120 < P <= 240
Oxygen level (O)	90 <= O <= 92%
Sys. Blood Pressure (sysBP)	140 < sysBP <= 180 OK
Dia. Blood Pressure (diaBP)	90 < diaBP <= 110

Table 3. Grade 2 warning boundaries

Outputs: grade 2 warning printed to screen along with individual values for doctor/nurse to assess.
Persistent Changes: no persistent changes
User Satisfaction: The user is alerted about critical values
User Dissatisfaction:
Related Requirements: FR 01. FR02.R03. FR04. FR05. FR06. FR07
Conflicts: no conflicts

Test Cases: -

Functional Requirement #6

Requirement Identifier: FR06
Requirements Type: 2
Priority: Medium
Introduction: This requirement is meant to define when the program has to raise a grade 1 problem.
Rationale: A grade 1 problem relates to a non-life-threatening situation where the medical values are outside of their normal domain.
Author/Source: Oliver
Inputs: Simulated data
Requirement Description:

- This requirement focuses on the individual values and defines when the program must return a grade 1 problem warning.
- If an grade 3 problem occurs, the program has to print a message to the screen, stating a grade 3 problem and specifying the values.
- If the pulse is greater than or equal to 40 and smaller than or equal to 60 or greater than 100 and smaller than or equal to 120, the program must return a grade 1 problem warning.
- If the oxygen level is higher than 92% but smaller than 96%, the program must return a grade 1 problem warning.
- If the systolic blood pressure is greater than 80 and smaller than 90 or greater or equal to 120 and smaller than or equal to 140, the program must return a blood pressure grade 1 problem warning.
- If the diastolic blood pressure is greater than or equal to 40 and smaller than 60 or greater or equal to 80 and smaller than 90, the program must return a blood pressure grade 1 problem warning.
- This is represented in table 4.

Pulse (P)	40 <= P <= 60 || 100 < P <= 120
Oxygen level (O)	92% < O < 96%
Sys. Blood Pressure (sysBP)	80 < sysBP < 90 || 120 <= sysBP <= 140
Dia. Blood Pressure (diaBP)	40 <= diaBP < 60 || 80 <= diaBP < 90

Table 4. Grade 1 warning boundaries

Outputs: grade 1 warning printed to screen along with individual values for doctor/nurse to assess.
Persistent Changes: no persistent changes

User Satisfaction: The user is alerted about lowest priority problems
User Dissatisfaction:
Related Requirements: FR 01. FR02.R03. FR04. FR05. FR06. FR07
Conflicts: no conflicts
Test Cases: -

Functional Requirement #7

Requirement Identifier: FR07
Requirements Type: 2
Priority: Low
Introduction: This requirement is meant to inform when the program must not provide any warning as the values are within normal range.
Rationale: The heart rate monitor has defined domains for normal medical values that do not produce a warning.
Author/Source: Oliver
Inputs: Simulated data
Requirement Description:

- The monitor raises no warning if the values for pulse, oxygen level and blood pressure are inside their normal domains.
- If the values are in their normal boundaries, the program has to print a message to the screen, stating the normal state and specifying the values.
- The normal domain for pulse is higher than 60 and lower than or equal to 100.
- The normal domain for oxygen level is higher than or equal to 96 and lower than or equal to 100.
- The normal domain for systolic blood pressure is greater than or equal to 90 and lower than 120.
- The normal domain for diastolic blood pressure is greater than or equal to 60 and lower than 80.
- These boundaries are represented in table 5 below.

Pulse (P)	60 < P <= 100
Oxygen level (O)	96 <= O <= 100
Sys. Blood pressure (sysBP)	90 <= sysBP < 120
Dia. Blood Pressure (diaBP)	60 <= diaBP < 80

Table 5. Normal boundaries

Outputs: Normal is printed to screen along with individual values for doctor/nurse to assess.
Persistent Changes: no persistent changes
User Satisfaction: The user is not alerted about normal values

User Dissatisfaction: The user does not have explicit information about normal values
Related Requirements: FR 01. FR02.R03. FR04. FR05. FR06. FR07
Conflicts: no conflicts
Test Cases: -

Note: For the purpose of the Software Testing Assignment, test cases have been removed from the Software Requirements Specifications.