Analysis Document

# Version Control

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| --- | --- | --- | --- |
| Version (v) | Date | Sprint | Changes |
| 0.1 | 02-2023 | 0 | Initial Analysis Doc |
| 0.2 | 27-02-2023 | 0 | Proposed System, initial completion of doc |
| 0.3 | 09-03-2023 | 1 | Updated non-functional requirements post-research. Some grammar improvements (doc cleanup) |
| 1.0 | 16-03-2023 | 1 | Process stakeholder feedback into overview changes, FR-08 and -09 and their User Stories/Use Cases, NFR-06 and UI update |
| 1.1 | 12-06-2023 | 5 | Updated links, added most recent mock-ups |

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# Introduction

## Purpose of The System

The goal of the system, once implemented, is primarily aimed at providing a tool for healthcare professionals to train their CTG interpretation skills with.

## Scope of The System

The system will cover the following aspects:

* An intuitive web-application as an interface for the end user, displaying the MATLAB calculations as graphical interpretations and allowing the manipulation of values.
* A backend service to connect with MATLAB for receiving graph calculations to display on the web user-interface.
* Import/export data functionality to allow external data to be read and exported from the UI (User Interface).
* Template selection for default values; starting points for the end-user.

## Objectives and Success Criteria of The Project

* A successful translation of MATLAB data through the backend and displayed in the frontend.
* An intuitive user interface that can be used and picked up by any clinician, regardless of their knowledge of computers.

## Definitions, Acronyms and Abbreviations

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| Term | Abbreviation | Definition |
| Cardiotocography | CTG | Cardiotocography is a technique used to monitor the fetal heartbeat and the uterine contractions during pregnancy and labor. The machine used to perform the monitoring is called a cardiotocograph. |
| MATLAB | - | MATLAB is a programming platform designed specifically for engineers and scientists to analyze and design systems and products that transform our world. |
|  |  |  |

## References

Access to the Teams group is required to open the following files:

* Problem Statement: [Fontys CTG simulatorprojectomschrijving.docx](https://stichtingfontys.sharepoint.com/:w:/r/sites/ClinicalDecisionSupport/Gedeelde%20documenten/Baby%20Monitor%20Simulator/External%20Documents/Baby_Monitor_Simulator%20-%20Fontys%20CTG%20simulatorprojectomschrijving.docx?d=w32af6fd005334166874a48cece2441a8&csf=1&web=1&e=3sJjDu)
* Existing Systems: [MATLAB Files.zip](https://stichtingfontys.sharepoint.com/:u:/r/sites/ClinicalDecisionSupport/Gedeelde%20documenten/Baby%20Monitor%20Simulator/Archive/Matlab%20Files.zip)
* Study: [Research Output Website](https://research.tue.nl/en/publications/a-mathematical-model-for-simulation-of-fetal-heart-rate-decelerat)
* Thesis: [PhD Thesis - Hout 2013.pdf](https://stichtingfontys.sharepoint.com/:b:/r/sites/ClinicalDecisionSupport/Gedeelde%20documenten/Baby%20Monitor%20Simulator/Archive/External%20Documents/PhD%20Thesis%20-%20Hout%202013.pdf)

# Initial System

A mathematical model has been developed in MATLAB that can be used to describe the physiology of a CTG scan, allowing clinicians to understand how these uterine contractions affect the heartbeat during labor. This system is purely run through MATLAB and the user interface is therefore very developer oriented and not intuitive for a general user. This is a problem for training clinicians since many are not familiar with a technology tool such as MATLAB. The application we will develop should allow clinicians to manipulate values through a simple user-interface, requiring no dependencies and build-tools, thus providing a far more streamlined process than what is currently in place.

# Proposed System

## Overview

**The project is primarily aimed at providing a tool for healthcare professionals to train their CTG interpretation skills on. This includes not only being able to read these graphs, but also to figure out which ‘input values’ affect which parts of the results. This way they can also practice with finding a judgement on what to do in situations that are bad for the fetus.**

**Key Points:**

* The mathematical model has already been fully developed in MATLAB.
  + Fully functional for research users
  + NOT functional for clinical users
* This means that our project is **targeted specifically for clinical end users, as a training tool**, and therefore needs:
  + An **intuitive interface**, easy for clinical users to pick up and use (frontend):
    - Multiple interfaces are also permitted.
    - It is expected that this **user interface will provide graphical representations of the data** from the underlying MATLAB algorithms.
* This new tool needs to **utilize the existing MATLAB mathematical model** (including MATLAB within the project).
  + See: <https://nl.mathworks.com/products/matlab/matlab-and-other-programming-languages.html>
  + This program is intended to be used as an educational tool rather than in practice.
* The main data graphs we need to display are:
  + **pO2** – *Fetal Blood* (ONLY SIMULATOR)
  + **MAP** – *Umbilical Artery Blood Flow* (ONLY SIMULATOR)
  + **FHR** – *Fetal Heart Rate* (ALWAYS AVAILABLE)
  + **UP** – *Uterine Contractions* (ALWAYS AVAILABLE)

Since some variables are only available in simulator, these should also be more prominent in our UI. These variables can affect each other. **FHR** & **UP** are what usually form the **CTG**.

## Functional Requirements

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| Functional Requirement | | | |
| FR-01 | System must communicate with the given MATLAB model. | **Priority** | Must Have |
| Qualities | | | |
| Q-01.01 | MATLAB model must be independent of system | | |
| Q-01.02 |  | | |
| Constraints | | | |
| C-01.01 | MATLAB code cannot be edited | | |
| C-01.02 |  | | |

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| Functional Requirement | | | |
| FR-02 | Updates must be real-time graphical representations for multiple end-users (calculations done in background). | **Priority** | Must Have |
| Qualities | | | |
| Q-02.01 | UI data graphs should update parallel of each other | | |
| Q-02.02 | UI should only send updates to backend in certain intervals (ex. 1sec), to prevent too much data traffic. | | |
| Constraints | | | |
| C-02.01 | Graphical update delay is constrained by the calculation speed of the MATLAB model. | | |
| C-02.02 |  | | |

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| Functional Requirement | | | |
| FR-03 | The system uses a randomize function to set the values to a randomly chosen scenario | **Priority** | Could Have |
| Qualities | | | |
| Q-03.01 |  | | |
| Constraints | | | |
| C-03.01 | System randomly selects from a selection of premade scenarios. | | |
| C-03.02 | The system cannot select a scenario that has previously been selected. This includes the template scenarios. | | |
| C-03.03 |  | | |

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| Functional Requirement | | | |
| FR-04 | The system should be able to import data generated in previous simulations. | **Priority** | Should Have |
| Qualities | | | |
| Q-04.01 | Imported data should be convertible to a scenario | | |
| Q-04.02 |  | | |
| Constraints | | | |
| C-04.01 | When converted, data should be constrained to specified range (Max value/min value) | | |
| C-04.02 |  | | |

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| Functional Requirement | | | |
| FR-05 | The system should be able to export the generated data to import it in a future simulation. | **Priority** | Should Have |
| Qualities | | | |
| Q-05.01 | Exported data should be ‘human readable’ (JSON/XML) so data can be used outside of the simulation environment. | | |
| Q-05.02 |  | | |
| Constraints | | | |
| C-05.01 | The system should only export relevant data. | | |
| C-05.02 |  | | |

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| Functional Requirement | | | |
| FR-06 | The system has access to template scenarios to select for simulations. | **Priority** | Could Have |
| Qualities | | | |
| Q-06.01 |  | | |
| Constraints | | | |
| C-06.01 |  | | |

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| Functional Requirement | | | |
| FR-07 | Users must be able to enter custom simulation values. | **Priority** | Must Have |
| Qualities | | | |
| Q-07.01 | These values can also be set by the template scenarios. | | |
| Q-07.02 |  | | |
| Constraints | | | |
| C-07.01 | Users are limited to a specified range of values (Max value/min value) | | |
| C-07.02 |  | | |

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| Functional Requirement | | | |
| FR-08 | Graphs will show the lines of data from previous input values. | **Priority** | Should Have |
| Qualities | | | |
| Q-08.01 | These lines are of a different color or texture, to differentiate them from the graph lines for the current values. | | |
| Q-08.02 |  | | |
| Constraints | | | |
| C-08.01 | These lines only update once new input values are put through and calculated. | | |
| C-08.02 | Only one past line can be visible at a time. | | |
| C-08.03 |  | | |

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| Functional Requirement | | | |
| FR-09 | Users have access to a manual. | **Priority** | Must Have |
| Qualities | | | |
| Q-09.01 | The manual will be downloadable by the user as for example a docx or PDF-file. | | |
| Q-09.02 | The manual should displayed in the language that is currently selected for the app. | | |
| Q-09.03 |  | | |
| Constraints | | | |
| C-09.01 |  | | |

## User Stories

Each week has twenty effort points, two per person per day. As such, every sprint has sixty points. The second week of a sprint is planned for programming efforts, which is the focus on the estimates for the User Stories.

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| Time | Effort Points per Person | Effort Points Total |
| Workday Segment (3 hours) | 1 | 5 |
| Workday | 2 | 10 |
| Week (2 workdays) | 4 | 20 |
| Sprint (6 workdays) | 12 | 60 |
| Entire Project (Sprints 1-5) | 60 | 300 |

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| **Title:** Send values to MATLAB (FR-01) | **Priority:** Must Have | **Estimate:** 24 |
| **User Story:**  As a Developer,  I want the system to communicate with the MATLAB model and send values,  so that said values can be calculated into the wanted graphs. | | |
| **Acceptance Criteria:** (conditions that a software product must meet to be accepted by a user, a customer, or other systems)   * Valid values are sent to MATLAB to be calculated into graphs. * Invalid values or other problems return a proper error message that describes the issue and do not relay the data to MATLAB | | |

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| --- | --- | --- |
| **Title:** Receive data from MATLAB (FR-01) | **Priority:** Must Have | **Estimate:** 24 |
| **User Story:**  As a Developer,  I want the system to communicate with the MATLAB model and receive calculation results,  so that said results for graphs can be displayed. | | |
| **Acceptance Criteria:** (conditions that a software product must meet to be accepted by a user, a customer, or other systems)   * Graph data from MATLAB is received to use on the app. * If something happens to go wrong within MATLAB, a proper error message is received and relayed back to the app | | |

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| **Title:** Graphics update when changing values (FR-02 & FR-07) | **Priority:** Must Have | **Estimate:** 18 |
| **User Story:**  As a User,  I want the graphs to update after having changed values,  so that I can see and understand the relevant changes in the results for each value. | | |
| **Acceptance Criteria:** (conditions that a software product must meet to be accepted by a user, a customer, or other systems)   * If values are being changed before the timer ends, the timer resets. * When the timer ends, the values are sent to be calculated by MATLAB. | | |

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| **Title:** Randomize values (FR-03) | **Priority:** Could Have | **Estimate:** 4 |
| **User Story:**  As a User,  I want the option to have the application select a random scenario,  so that I have the option to train with assessing graphs without my own input. | | |
| **Acceptance Criteria:** (conditions that a software product must meet to be accepted by a user, a customer, or other systems)   * The random values are chosen from a set number of pre-set options to at least have realistic options. * A result should not be chosen if it is currently being displayed. * The “default templates” are also part of the random list. * The scenarios are stored locally | | |

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| **Title:** Import data (FR-04) | **Priority:** Should Have | **Estimate:** 8 |
| **User Story:**  As a User,  I want to import previously generated values/graphs,  so that I reassess past results or use scenarios to train others with. | | |
| **Acceptance Criteria:** (conditions that a software product must meet to be accepted by a user, a customer, or other systems)   * If an invalid file or a file without the required data is selected, nothing will happen. * If the file contains data for the graphs, the system does not need to communicate with MATLAB. Otherwise, it will. | | |

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| **Title:** Export data (FR-05) | **Priority:** Should Have | **Estimate:** 8 |
| **User Story:**  As a User,  I want to export generated values/graphs,  so that I can assess the results later or create scenarios to train others with. | | |
| **Acceptance Criteria:** (conditions that a software product must meet to be accepted by a user, a customer, or other systems)   * The file is humanly readable. * The user can name the exported file, so they can recognize it. * The exported file contains both the enterable values and the graph values. * Once the file is created, it is automatically downloaded to the device. | | |

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| **Title:** Access template scenarios (FR-06) | **Priority:** Could Have | **Estimate:** 6 |
| **User Story:**  As a User,  I want access to example scenarios for common situations,  So, there is a basis from where learning can start and as a reference to use when looking at other graphs. | | |
| **Acceptance Criteria:** (conditions that a software product must meet to be accepted by a user, a customer, or other systems)   * The options contain both enterable values and graph data.  This way there is no need to have the graphs calculated by MATLAB. | | |

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| **Title:** Display ghost line (FR-08) | **Priority:** Should Have | **Estimate:** 6 |
| **User Story:**  As a User,  I want to see the lines of previous graphs after having changed values,  So I can see/learn what effect the input changes I gave have on the output. | | |
| **Acceptance Criteria:** (conditions that a software product must meet to be accepted by a user, a customer, or other systems)   * The ‘ghost line’ is clearly distinct from the main line that displays current value output. * The ‘ghost line’ will only display/update once new values are being put through. | | |

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| **Title:** Access toUser Manual (FR-09) | **Priority:** Must Have | **Estimate:** 12 |
| **User Story:**  As a User,  I want to have access to a user manual,  So I can see how the application works and what I can do with it. | | |
| **Acceptance Criteria:** (conditions that a software product must meet to be accepted by a user, a customer, or other systems)   * The manual should be downloadable as for example a Word or PDF-file. * The manual will display in the currently selected language of the application. * The manual itself describes everything step-by-step in detail, with images where possible. | | |

## Use Cases

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| Naam | UC-01: Enter Custom Initial Values | Requirement: | | FR-07 |
| Summary | User enters custom simulation values | | | |
| Actors | User | | | |
| Assumptions | - | | | |
| Scenario | 1. Actor selects” pO2” input. 2. Actor enters” pO2” value. 3. Actor selects” MAP” input. 4. Actor enters” MAP” value. 5. Actor selects” FHR” input. 6. Actor enters” FHR” value. 7. Actor selects” Contractions per Minute” input. 8. Actor enters” Contraction per Minute” value. 9. Simulation is started **[1]** | | **pO2** = Fetal Oxygen level  **MAP** = Fetal blood pressure  **FHR (Fetal Heart Rate)** = Fetal Heart Rate | |
| Exceptions | **[1]** Any of the values is outside of the valid scope. The error is displayed, and the simulation is not started. | | | |
| Result | Simulation is started and the values will be calculated into graphs. | | | |

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| Naam | UC-02: Export data | Requirement: | FR-05 |
| Summary | User exports generated data to a file | | |
| Actors | User | | |
| Assumptions | User has generated graphs using valid values | | |
| Scenario | 1. Actor selects to “Export data.” 2. The actor is prompted to name the file to export. 3. Actor provides a title **[1] [2]** 4. The data is converted to a file **[3]** | | |
| Exceptions | **[1]** Actor refutes the prompt, Use Case aborted.  **{2]** File name is not valid, return to step 2.  **[3]** Something goes wrong while converting. The error is displayed, and the Use Case is aborted. | | |
| Result | Graph data is converted to a file and  will be downloaded on the device for later use | | |

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| Naam | UC-03: Import data | Requirement: | FR-04 |
| Summary | User imports previously generated data | | |
| Actors | User | | |
| Assumptions | User has access to previously generated file | | |
| Scenario | 1. Actor selects to “import data.” 2. Actor is prompted to provide a file. 3. Actor provides a valid file **[1] [2]** 4. The file data is converted **[3]** | | |
| Exceptions | **[1]** Actor cancels the prompt. Use Case aborted.  **[2]** The file is not of the valid filetype. Unable to proceed until a valid one is provided.  **[3]** Data from the file cannot be read or is missing. The error is displayed, and the Use case is aborted. | | |
| Result | Data from the files is put into the value fields  and the graph data from the file is immediately converted to graphs, without help from MATLAB. | | |

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| Naam | UC-04: Use template scenario | Requirement: | FR-06 |
| Summary | Actor selects to use a template scenario | | |
| Actors | User | | |
| Assumptions | - | | |
| Scenario | 1. The actor selects one of the template scenarios. 2. The actor is prompted on whether they want to change their current values. 3. Actor confirms prompt **[1]** 4. Data from the template is used. | | |
| Exceptions | **[1]** Actor refutes the prompt. Use Case aborted. | | |
| Result | Values for the template are filled in  and the graphs are shown without needing to connect with MATLAB. | | |

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| Naam | UC-05: Realtime UI update | Requirement: | FR-02 |
| Summary | When changing values, the graphs will update in real-time | | |
| Actors | User | | |
| Assumptions | - | | |
| Scenario | 1. Actor selects desired value slider to change. 2. Actor changes value slider to a different value. 3. System starts internal timer. 4. If the user changes to another slider within the timer, the timer resets (return to 1). 5. If the timer runs out, the system sends these new values to the MATLAB model. | | |
| Exceptions | - | | |
| Result | Users have changed simulation values and changes have been sent to MATLAB model, so graphs can be created. | | |

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| Naam | UC-06: Randomize scenario | Requirement: | FR-03 |
| Summary | The system randomly selects one of the premade scenarios to simulate. | | |
| Actors | User | | |
| Assumptions | There are at least two scenarios to choose from. | | |
| Scenario | 1. User indicates wanting a random scenario. 2. System checks for more than two scenarios **[1].** 3. System randomly selects one of the predefined scenarios. 4. System prompts user with selected scenario **[2]**. 5. System applies selected scenario values to input fields. | | |
| Exceptions | **[1]** There are not enough predefined scenarios to choose from. Use Case aborted.  **[2]** User denies selected scenario. Use Case aborted. | | |
| Result | System randomly selected a predefined scenario for the user to simulate. | | |

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| Naam | UC-07: Display ghost line | Requirement: | FR-08 |
| Summary | The system displays the line of previous results once the input is changed and put through. | | |
| Actors | User | | |
| Assumptions | A past results is already being displayed on the graphs. | | |
| Scenario | 1. Actor changes input values. 2. System puts through new values and displays new graphs 3. Ghost lines that were already present are removed **[1]**. | | |
| Exceptions | **[1]** No past ghost line is present, so it does not get removed. | | |
| Result | The ghost graphs for the results before the input was changed is visible over the new graphs. | | |

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| Naam | UC-08: Access to User Manual | Requirement: | FR-09 |
| Summary | The user can select to view the User Manual of the application | | |
| Actors | User | | |
| Assumptions | - | | |
| Scenario | 1. Actor selects the ‘User Manual‘. | | |
| Exceptions | - | | |
| Result | The Manual is opened/downloaded in the currently selected language of the application.. | | |

## Non-functional Requirements

### Performance

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| Non-Functional Requirement | | | |
| NFR-01 | From the moment values are sent, the results should be shown within 5 seconds. |  |  |

### Supportability

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| Non-Functional Requirement | | | |
| NFR-02 | Code coverage needs to be at least 60%. |  |  |

### Implementation

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| Non-Functional Requirement | | | |
| NFR-03 | The end-product must be a scalable software solution without altering the existing MATLAB code. |  |  |

### Legal & Privacy

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| Non-Functional Requirement | | | |
| NFR-04 | The system must respect local privacy laws regarding any data captures and-or distributed over the network (GDPR for EU (European Union)). |  |  |

### Security

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| Non-Functional Requirement | | | |
| NFR-05 | The system must be secure from hacking and all data related to clinicians using the system must be stored securely and available for deletion if requested. |  |  |

### Accessibility

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| Non-Functional Requirement | | | |
| NFR-06 | The system should be available in multiple languages. This so it can support education for foreign clinicians. |  |  |

## Definition of Done

A technical task must adhere to the following before being merged into master/release branches:

1. Passing Pipelines:
   1. Build Succeeded (no errors)
   2. Local Code Tests Passed (no errors, warnings allowed)
   3. Code Analysis Criteria Passed:
      1. 60% code coverage
2. The developer has assessed the code responsible for the merge request.
3. The merge request has been reviewed and approved by at least one other developer who was not involved in the original development of the ticket.
4. The branch has been merged with the parent branch.

Note that anything implemented or edited that previously had no documentation should be added to the wiki documentation.

### User Interface

A picture containing text, screenshot, font, number

Description automatically generated

The UI here displays the options for data on the left. System options are in a drop-down menu at the top left, so that they can be folded in to focus on the main application. Below are the main input values. These values are used to calculate the graphs that are displayed on most of the screen. Below the input values are the template options, where the user can select a template to use or to use a random template.  
Lastly, the Manual can be accessed from the top right.

## Glossary

Template: <https://www.cs.fsu.edu/~lacher/courses/COP3331/rad.html>