Software Requirements Specification

For

**An Automatic Home Health Monitor System For Expectant Mothers**

Version 1.0 approved

Prepared by

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FitMama

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Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Date** | **Reason For Changes** | **Version** |
| Bakulumpagi Joseph | Dec 2017 | Original Version | 1.0 |
| Mulengera Charles | Dec 2017 | Original Version | 1.0 |
| Wasswa Michael | Dec 2017 | Original Version | 1.0 |
| Kisubi Joshua | Dec 2017 | Original Version | 1.0 |

# Introduction

The health of a mother impacts the family and even the entire community. Her ability and access to receive necessary healthcare largely determines health outcomes for herself and her baby. Like many developing countries Uganda has high maternal mortality rates, which is often reflective of access to health care services [[1]](https://en.wikipedia.org/wiki/Maternal_health_in_Uganda#cite_note-3). According to estimates from [**UNICEF**](https://en.wikipedia.org/wiki/UNICEF), Uganda’s maternal mortality ratio, the annual number of deaths of women from pregnancy-related causes per 100,000 live births, stands at 435 after allowing for adjustments [[2]](https://en.wikipedia.org/wiki/Maternal_health_in_Uganda#cite_note-4) . Women die as a result of complications during pregnancy and childbirth. The major complications include severe bleeding, infections, unsafe abortion and obstructed labor [[3]](https://en.wikipedia.org/wiki/Maternal_health_in_Uganda#cite_note-5). **Fitmama** (Automatic home health monitoring System for expectant mothers) has the potential to reduce these health issues by providing full automatic home health monitoring of expectant mothers.

## Purpose

This document is written to specify precisely what the system being built would do and the necessary external components or systems it would connect to.

The document does not specify how the system and its components are built, interact or connect with its external dependencies.

The document is used as a system design blueprint, from which all assumptions and design criteria are derived through the development process.

## Intended Audience and Reading Suggestions

This document is aimed at different types of readers that are involved directly and indirectly in the development of the project. These include graphic designers, end-users, project managers and supervisors, programmers, system analysts.

The table below lists the different readers and on the left the most important sections to them as per relevance.

**Table 1**: Shows the different readers and the most important sections to them as per relevance.

**READER SECTION**

|  |  |
| --- | --- |
| **Programmers** | 2, 3, 4 |
| **System analysts** | 2, 3 |
| **Graphic designers** | 2, 3, 4 |
| **Project managers** | All sections |
| **Client managers** | All sections |
| **End users/clients** | 2 |

## Product Scope

### Functional Scope

An Automatic home health monitoring system for expectant mothers is a custom application which will specifically benefit pregnant women and health personnel to monitor the four vital measurements (ECG, FHR, Fetus Mobility and Uterine Contractions), blood pressure, and body temperature of the pregnant woman in a more efficient and effective way, in order to minimize on pregnancy complications and deaths. The users of the application will be the pregnant women and health personnel.

The wearable soft state-of-the-art fabric belt will incorporate sensors to measure all these parameters like blood pressure body temperature and Heart Beat rate and transfer it to an Android SMARTPHONE.

An Android SMARTPHONE will be used to take readings from the wireless sensor using GSM technology and send them to a physician and also to send feedback to the pregnant woman from the physician through SMS.

### Context of Use

The system will be used as a prototype of a bigger Fitmama system. It will be designed to allow vendors to build a full-sized Fitmama system on top or integrate completely in already completed systems with maximum compatibility.

### Benefits, Goals and Objectives

#### Main Objective

The objective of this project is to design an automatic home health monitor system for expectant mothers that would fully monitor the condition of the pregnant woman and her fetus in a more efficient way, in order to minimize on pregnancy complications and deaths.

#### Other Objective

* To make a feasibility study for Fitmama software application.
* To carry out requirements engineering.
* To create a design document for Fitmama application.
* To implement Fitmama application.
* To test Fitmama application.

## References

## [1] Media Aminian and Hamid Reza Naji “A Hospital Healthcare Monitoring System Using Wireless Sensor Networks,”, Department of Computer,Science and Research branch, Islamic Azad University, Kerman, Iran and College of Electrical and Computer Engineering, Kerman Graduate University of Technology, Iran, vol 4, 2013.

[2] Darwish A, Hassanien AE (2012) Wearable and Implantable Wireless Sensor Network Solutions for Healthcare Monitoring. Sensors 12: 12375-12376.

[3] Marc Spaanderman1, Marina Velikova2 and Peter Lucas (2011).e-Mom Care: Remote Monitoring in Pregnancy Care.Department of Obstetrics and Gynecology,Radboud University Nijmegen Medical Centre.Email: [M.Spaanderman@obgyn.umcn.nl](mailto:M.Spaanderman@obgyn.umcn.nl)

[4] Microcontroller Muhammad Ali Mazadi book

[5] www.microdiditaled.com

[6] www.8052.com

[7] www.keil.com

[8] www.fsinc.com

[9] [http://developer.intel.com/design/mcs51/doc\_mcs 51.htm](http://developer.intel.com/design/mcs51/doc_mcs%2051.htm).

# Overall Description

## Product Perspective

Health monitor systems are designed to automatically read the pregnant woman’s vital signs.

Wireless sensors are embedded in an independent standalone device and are their primary role is to read and report the vital signs of the pregnant woman.

This wireless sensor device is at one end connected to the pregnant woman’s mobile device using GSM .

## Product Functions

Hospital ICT

Router + Server + Modem

**INTERNET- WWW**

Database

Expert/Doctor Mobile device for sending SMS feedback to the patient.

MIS Expert

System

Wireless Sensor device for reading vital signs like ECG, High-blood pressure, pulse, body temperature, etc

## User Classes and Characteristics

This software applies to mainly the pregnant women and medical personnel.

The System administrators are the other users who will work from the administration end which will allow them to monitor and make necessary changes to the system accordingly.

The other users include the Testers, developers and maintainers who are responsible for locating and fixing existing bugs and maintaining the system respectively.

## Operating Environment

The software will be installed on the ArduinoUno circuit board or its equivalent which is connected to a homemade vital signs sensor, the Arduino Uno is a microcontroller board based on the ATmega328. It has a 16 MHz ceramic resonator, 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a USB connection, a power jack, an ICSP header, and a reset button.

A GSM modem will be connected to the ArduinoUno circuit board. The HC-05/06 is a user friendly need only basic knowledge and it is programmable using the AT commands. It comes only in one fixed mode either master or slave. In this project the slave module will be used.

GSM module will be used to send SMS from the physician mobile device to the patient’s mobile device

## Design and Implementation Constraints

This system places limitations on programming languages and technologies as per compatibilities and specifications provided by the Arduino Uno circuit board [4].

The GSM [13] communication is limited to the specifications of the TTL SIM800 GSM module and its dependencies [2].

Java and Embedded-C programming languages will be used.

Android Smart phones will be used.

## User Documentation

This specification document plus the design document, implementation report, user manuals and video tutorials will be provided in both hard prints where possible and digital formats. Also, online help will be provided through the application’s own dedicated blog/website.

## Assumptions and Dependencies

### Assumption

It’s expected that the operation environment defined in section 2.4 can created as failure will create major changes to the expected performance and design of the application.

### Dependencies

The complete system development is primarily dependent on the availability of the following components or their equivalent;

* Arduino Uno [4]
* GSM Module [2]
* GSM Module [2]
* 4G or 3G internet
* Transistor BC547 (2) [5]
* Connecting wires [6]
* Power supply 12v 1Ab [7]
* Vital sign Sensor [8]
* Resistors (1k, 10k) [9]
* Variable Resister (10k, 100k) [10]
* Terminal connector [11]
* Voltage Regulator IC LM317 [12]

# External Interface Requirements

## User Interfaces

The system provides only one GUI e.g. LCD screen and typing user interface provided by the user’s SMS sending and receiving device e.g. mobile phones. This primarily allows the user to read system messages send and receive response commands if necessary. No special GUI qualities are required for both the visual screen and the typing keyboard.

### Use Case Diagram

A use case diagram captures the actors and the role they perform in a system. It depicts the roles performed by each actor. The three actors for this project include the medical Experts, the remote user (The pregnant woman) and a database administrator.

Pregnant woman Medical Expert

System Administrator

**Use Case UC1: View Vital Signs**

**Primary Actor:** User (Pregnant woman)

**Preconditions:** The pregnant woman views vital signs from the vital signs sensor.

**Post conditions:** The vital signs are sent to the pregnant woman’s mobile phone using GSM .

**Main Success Scenario**

1. GSM connection is successful.
2. The pregnant woman’s vital signs are read and sent to the pregnant her mobile device.

**Use Case UC2:** **View list of pregnant women**

**Primary Actor:** User (Medical Expert)

**Preconditions:** View a list of pregnant women attached to the hospital.

**Post conditions:** proceed to work on the pregnant woman.

**Main Success Scenario**

1. Information displayed on the Doctor’s phone is valid.
2. Canceled processing by pressing exit button because information did not match.

**Use Case UC3: View Message from Pregnant Woman**

**Primary Actor:** User (Medical Expert)

**Preconditions:** The internet is available to receive the message.

**Post conditions:** MIS expert systems are able to send a readable message to Medical expert’s mobile device.

**Main Success Scenario**

1. The Medical expert receives the message.
2. The Medical expert suggests and sends solution to the pregnant woman.

**Use Case UC4: View SMS from Medical Expert**

**Primary Actor:** User (Pregnant woman)

**Preconditions:** The pregnant woman’s mobile device is available to receive the SMS.

**Post conditions:** The pregnant woman is available to receive the SMS.

**Main Success Scenario**

1. The pregnant woman receives solution from Medical expert.
2. The pregnant woman reacts to the solution received.

**Use Case UC4: View alert from MIS expert systems**

**Primary Actor:** User (Systems’ administrator)

**Preconditions:** Internet is available all the time.

**Post conditions:** The system’s administrator is available to view the alert.

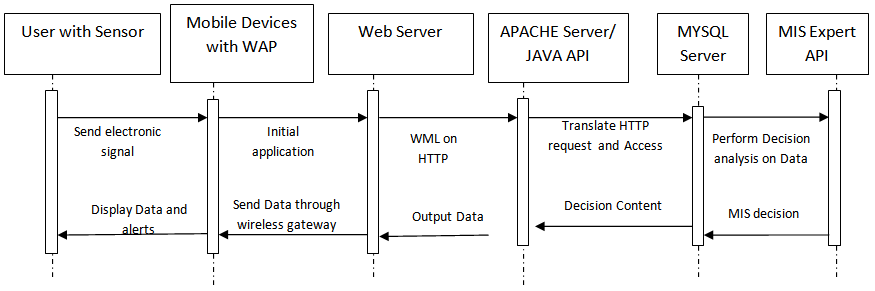
**Main Success Scenario**

1. The alert is received by the system’s administrator.
2. The message is sent to the Medical expert’s mobile device.

The MIS expert system collects the data and generates useful decision information for medical expert to use in the decision making processes. Special alerts are also generated to be sent to users regarding their health status and other general health tips.

#### Sequence diagram

The sequence diagram is a derivative of the use case analysis and shows the interactions, relationships and methods of the objects in the systems. The remote user initiates the application via their mobile devices (Phones, PDAs, Smart Phone, IPad, and Tablets) which are connected to the remote sensor via wireless GSM connection. The requests in the form of electronic pulses are sent from the wireless sensor to the mobile device which is equipped with Wireless Application Protocol (WAP) application that runs on these devices and convert it to readable format that can be transmitted via WAP gateways. The application establishes an internet connection to heath care provider web server. The web server then connects the database server through J2ME platform where the collected vital signs data are stored.



## Hardware Interfaces

All hardware interfaces and communication are defined in the specifications of the individual external components defined in section 2.7.2 above.

## Software Interfaces

The software will communicate with the patient’s mobile device to display the vital signs readings through GSM .

The software will communicate with GSM module to send and receive messages to and from the user GSM receiver respectively.

The software will act as part of the Arduino circuit board operating system to control and coordinate all connected components e.g. mobile device, GSM module and GSM module.

The medical expert will use a mobile device to send an SMS to the pregnant woman’s mobile device.

## Communications Interfaces

Arduino-Uno board doesn’t support GSM connection on its own, which makes the idea of connecting it wirelessly to an Android device impossible. So a medium between the ArduinoUno board and android device is needed and in this project it is a GSM module specifically the HC-06 GSM module.

Communication interfaces and protocols defined by the GSM standards including the GSM security i.e. pre-shared key and challenge response and over-the-air encryption, are to be used for communication between system and user exchange of commands and messages.

# System Features

## Automatic vital signs detection

### Description

The ECG monitor displays the heart beat price (per min) via heartbeat sensor, temperature through Temperature sensor and other vital signs through the respective sensors. It gives signal to the system when values are going below or above threshold. The signal goes through the ADC channel which is attached to the Microcontroller Board.

### Stimulus/Response Sequences

No user actions are required here but the feature is triggered by changes in vital signs

### Functional Requirements

**Requirement #1:**

**ID: REQ1**

**Title:** Detect Vital signs readings

**Description:** The sensors should be able to detect and relay changing vital signs readings data to the ArduinoUno circuit board.

**Rationale:** Failure to detect changes in vital signs renders the entire system as absolute or irrelevant.

**Fit Criterion:** Very accurate sensors should be used since they will be able to display the data in an easy to read format.

**Dependencies:** None

**Scenario:** A homemade vital signs sensor gives signal to the system when values are going below or above threshold. The signal goes through the ADC channel which is attached to the Microcontroller Board.

**Requirement #2:**

**ID: REQ2**

**Title:** Digest vital signs data from sensors

**Description:** The software embedded with the Arduino circuit is should be able to analyze data received from sensors and identify differences in the readings.

**Rationale:** Failure to detect differences in the different data provided results in the system being useless as this is core and critical to the overall functions of this subsystem.

**Fit Criterion:** The continuously provided data should actually be different from the previous otherwise it would seem like this function is not available.

**Dependencies:** REQ1

**Scenario:** Sequences of different data is received from vital signs sensors, analyzed, difference in percentage is computed and made available for relay to the GSM receiver (mobile device).

## GSM Message Relays

### Description

This features provides conversion of analyzed vital signs percentages into GSM messages and send them as readable text to the user (Pregnant woman) using a GSM receiver e.g. a mobile phone.

### Stimulus/Response Sequences

Feature is triggered every time there as difference in sequential vital signs level percentages.

### Functional Requirements

**Requirement #3:**

**ID: REQ3**

**Title:** Send GSM messages to users.

**Description:** The software embedded with the Arduino circuit should be able to convert vital signs level differential data in human readable messages, relay them to the GSM module which sends messages to user GSM receiver (mobile phone) and await response.

**Rationale:** Failure to send human understandable messages cause the use to never know if the vital signs levels have changed or not.

**Fit Criterion:** The GSM receiver should be capable of receiving and displaying the messages.

**Dependencies:** REQ1, REQ2

**Scenario:** Sequences of different vital signs percentages are detected and a message is sent to target mobile device for each unique new percentage.

**Requirement #4:**

**ID: REQ4**

**Title:** Receive SMS messages from users (physician).

**Description:** The physician’s GSM mobile device receives a message sent from the user (pregnant woman) through IOT (Internet of things) and then sends feedback in form of an SMS message.

**Rationale:** Failure to receive or interpret user messages cause the user requested actions to never get executed.

**Fit Criterion:** The GSM receiver should be capable of sending SMS messages which can be received and interpreted by the system GSM module (should also be capable of receiving and interpreting SMS messages).

**Dependencies:** REQ1, REQ2

**Scenario:** A user (pregnant woman) sends a message received through GSM from the vital signs sensor device to the physician through IOT (Internet of things) and the physician sends feedback in form of an SMS message.

**Requirement #5:**

**ID: REQ5**

**Title:** Storing vital signs at the hospital.

**Description:** The MYSQL Database will receive and execute the message from the pregnant woman and then generate a notification to be sent to the Medical Expert.

# Other Nonfunctional Requirements

## Performance Requirements

High speed measuring and analyzing of vital signs valves is required.

No other specific performance requirements are available for this subsystem.

## Safety Requirements

The use or integration of this system in bigger systems presents no possible loss, damage, or harm even in misuse.

## Security Requirements

The following are the precautions that will be taken to prevent and protect the software from accidental or malicious access, use, modification, destruction, or disclosure.

1. GSM communication should be relatively encrypted controlled to allow specific and known users to send, start and stop messages or receive information regarding the patient’s health status and other general health tips.

## Software Quality Attributes

### Reliability

|  |  |  |  |
| --- | --- | --- | --- |
| ***#*** | ***Metric*** | ***Value*** | ***Interpretation*** |
| ***1*** | POFOD | 0.02 | This implies that 2 of every 100 service requests may result in failure.  This is referenced as the number of failures per every 100 inputs. |
| ***2*** | ROCOF | 0.3 | This implies that 3 failures are likely to occur every 10 operational hours.  This references the number of transactions between failures. |
| ***3*** | AVAIL | 0.95 | This implies the system is available every 9.5 hours every 10 hours.  This describes the amount of time required to recover from failure. |

### Availability

The system shall be run on-demand, automatically restarts in less than 5 seconds in case of failure and restores all input values entered at least 1 second before failure.

### Portability

All components of this subsystem will be relatively small in size, light weight and easy to disconnect and reconnect to allow better support for integration in other bigger systems.

### Summary of Quality Characteristics

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ID** | **Characteristic** | **H/M/L** | **1** | | **2** | | **3 4** | | | **5** | | **6** | | | **7** | | | **8** | | **9** | **10** | | | **11** | **12** |
| 1 | Correctness |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |
| 2 | Efficiency |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |
| 3 | Flexibility |  |  |  |  |  |  | | |  | |  | | |  | | |  | |  |  | | |  |  |
| 4 | Integrity/Security |  |  |  |  |  |  |  |  |  |  |  |  | |  | | |  | |  |  | | |  |  |
| 5 | Interoperability |  |  |  |  |  |  |  |  |  |  |  |  | |  | | |  | |  |  | | |  |  |
| 6 | Maintainability |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |
| 7 | Portability |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |
| 8 | Reliability |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |
| 9 | Reusability |  |  |  |  |  |  |  |  |  |  |  | | |  | | |  | |  |  | | |  |  |
| 10 | Testability |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  | | |  |  |
| 11 | Usability |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  | | |  |  |
| 12 | Availability |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  | | |  |  |

Appendix A: Glossary

**SRS –** Software Requirements Specification.

**GSM –** Global Systems for Mobile Communications.

**Arduino Uno –** A microcontroller board based on the ATmega328P (datasheet) distributed by Arduino.

**POFOD –** Probability of Failure on Demand.

**ROCOF –** Rate of Occurrence of Failure.

**AVAIL –**Availability.

**AC –** Alternating Current.

**SMS –** Short Message Service.

**LCD –** Liquid Crystal Display.

**GUI –** Graphical User Interface.

**SIM –** Subscriber Identity Module.

**TTL –** Transistor to Transfer Logic

**IOT –** Internet of things.