FUNCTIONAL SPECIFICATION
HEXIMED

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Revision History			
Version	**Date**	**Description**	**Author**
1.1	4-March-2018	1 Introduction, 1.3 Existing Systems, 2 Functional Description, 2.1 User Attributes and Cases, 2.6 Interfaces, 2.8 Performance, 4 References	Vanessa Yanez
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1.2	22-March-18	1 Introduction (diagram), 2 Functional Description (diagrams), 2.1 User Attributes and Cases, 2.6 Interfaces, 2.8 Performance	Vanessa Yanez
1.2	22-March-18	2.7 Boundary Conditions and Constraints	Franco Justo
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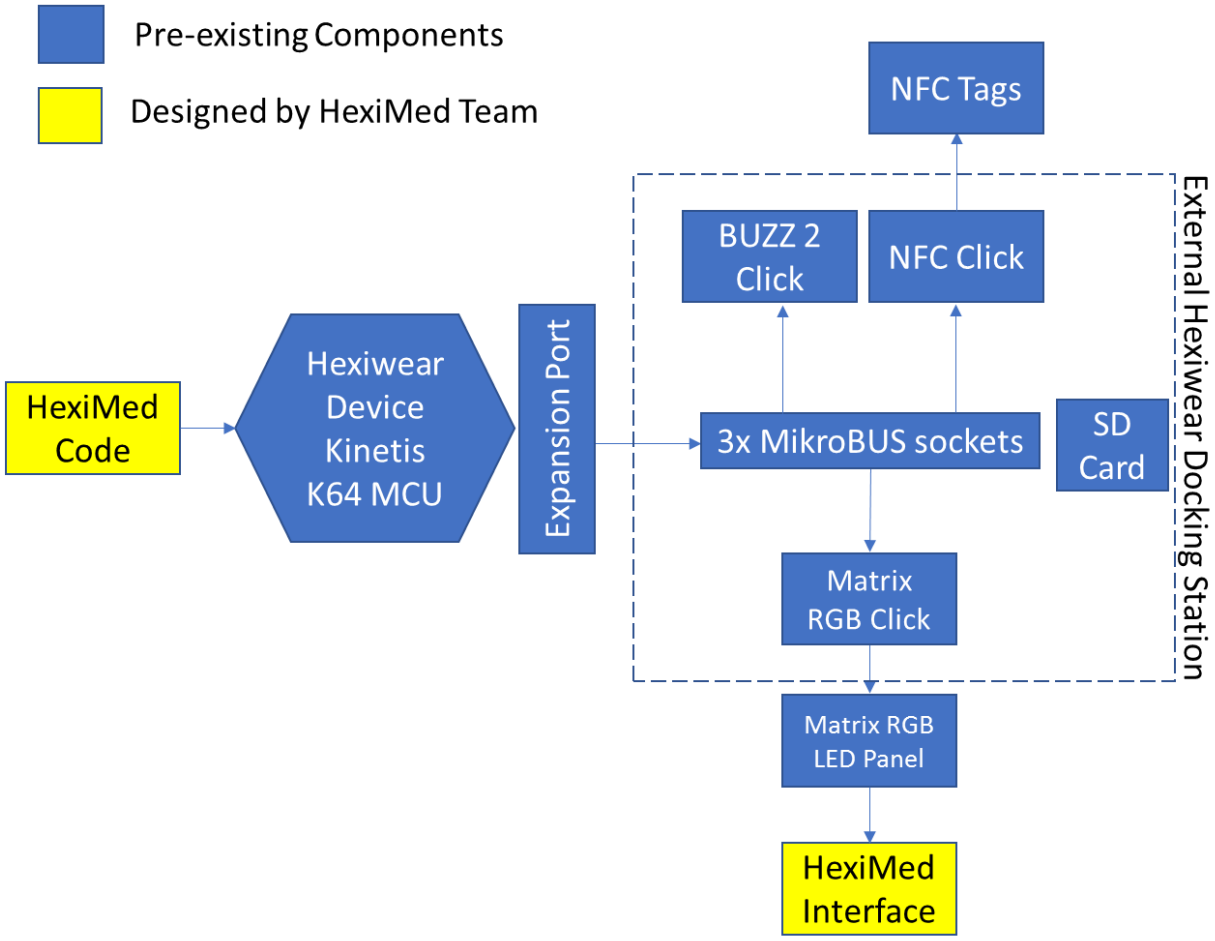
1 Introduction

(Vanessa Yanez)
The HexiMed system is an IoT connected medication reminder that notifies a patient when to take medications by integrating a set of sensors using various communication systems. The system seeks to improve medication adherence by establishing an organized medication schedule, along with a medication log stored onto an SD card which can be accessed by a physician, caregiver, or patient.

Figure 1: HexiMed Block Diagram



1.1 Summary

(Kelly Carranza)
HexiMed is a simple way to manage even the most complex medication regimens. It helps remind user to take medication on schedule from convenient pre-filled cups, reducing the risk of unplanned hospital or doctor visits. It also records when each medication is taken to show physician's how consistent the patient is. HexiMed will be available to share medication information with other loved ones through a removable SD card. HexiMed is a demo project to show off the expandability and capabilities of NXP's Hexiwear as a do-anything IoT device.

1.2 Customer (or Sponsor) Requirements

(Franco Justo)

- User will create medication schedule for any pills by navigating an RGB display.
- Using an RGB LED display, it will show the current time (hours: mins), time till next medication (mins) and will flash when medication time is equal to the current time. The display will flash red, while highlighting what bay the medication is store in for 10 minutes or until the user has triggered the correct response from the NFC reader.
- BUZZ2 click and display will trigger audio and visual cues when alarm is active.
- Once the user needs to take a pill, an alarm will be triggered, and the user will scan a 13.57 MHz passive RFID tag with the NFC reader.
- when the correct tag is read then the alarm will stop and log data in SD card, if an incorrect tag is read it will alert the user to stop and scan the correct tag. If tag is not read in first 10 minutes audio alarm stops and display changes to next following alarm, and logs missed medication

1.3 Existing System

(Vanessa Yanez)

The Livi automatic pill dispenser system is currently being used for medication adherence, specifically among elderly people. Its main features implement the stretch goal of the HexiMed demo project which is device communication between system and smartphone. The Livi system can send text or email alerts to users or caregivers when medications are dispensed, when doses are late or missed, when lockable device cover is opened, and when refills are necessary. It also implements another stretch goal, which is access to a data cloud of stored medication history for easy sharing among physicians and caregivers. ref[1]

The HexiMed system is limited to basic Hexiwear functionalities:

- User Input through Hexiwear Device
- Visual and Audio Medication Alerts through Buzz2 Click and LED Panel
- Display of Medication Information through LED Panel
- Medication Reading/Logging through NFC Click
- Data (Medication History) stored through an SD Card

Constraints within the HexiMed system in contrast to the Livi system are as follows:

- 15 additional reminders for items not stored in the Livi (ointments, eye drops, etc.)
- Audit history of device interaction
- Send text or email alerts to users or caregivers
- Nationwide cellular connection included in monthly subscription
- Livi web portal, allowing easy scheduling and real-time monitoring of medications
- Livi cloud stores medication history and adherence data for easy sharing with physicians and caregivers

1.4 Terminology

Term	Description
HexiMed	An IoT connected medication reminder that sends alerts to a patient by integrating a set of sensors using various communication systems
Hexiwear	A wearable open-source platform for IoT consumer device development designed by MikroElektronika in collaboration with NXP intended to reduce the time and cost of IoT project development.
Hexiwear Docking Station	Expands Hexiwear to allow users to have complete control over Hexiwear's hardware and also includes 3 clock boards to turn the system into something completely different. ref[4]
BUZZ 2 Click	A click that carries the CMT-8540S-SMT magnetic buzzer transducer that runs on 3.3V or 5V power. ref[5,11]
Matrix RGB Click	An add-on board powered by a 32-bit FT900 MCU. The board has a 16 wire IDC connector for connection to a single 16x32 LED Panel. Multiple panels are able to be connected together into a daisy-chain configuration. ref[8]
Matrix RGB Panel	A panel with 1024 RGB LEDs arranged in a 32x32 grid on the front on a 6mm grid. on the back there is a PCB with a set of dual IDC connectors and 12 16-bit latches that allow to drive the displace with a 1:16 scan rate. ref[9]
NFC Tag	A small sticker which contains an unpowered NFC chip. Depending on how the tagged is programmed, it can change various settings, launch apps, or perform certain actions just by holding the tag near the Hexiwear click.
NFC Click	A mikroBUS add-on board with a versatile near field communications controller from NXP - the PN7120 IC. ref[10]
Mbed	Programming platform for IoT connected devices and embedded devices based on 32-bit ARM Cortex-M microcontrollers.
SD Card	Secure digital memory card is a non-volatile memory card format developed by the SD Card association for use in portable devices. ref[13]

2 Functional Description

(Vanessa Yanez)

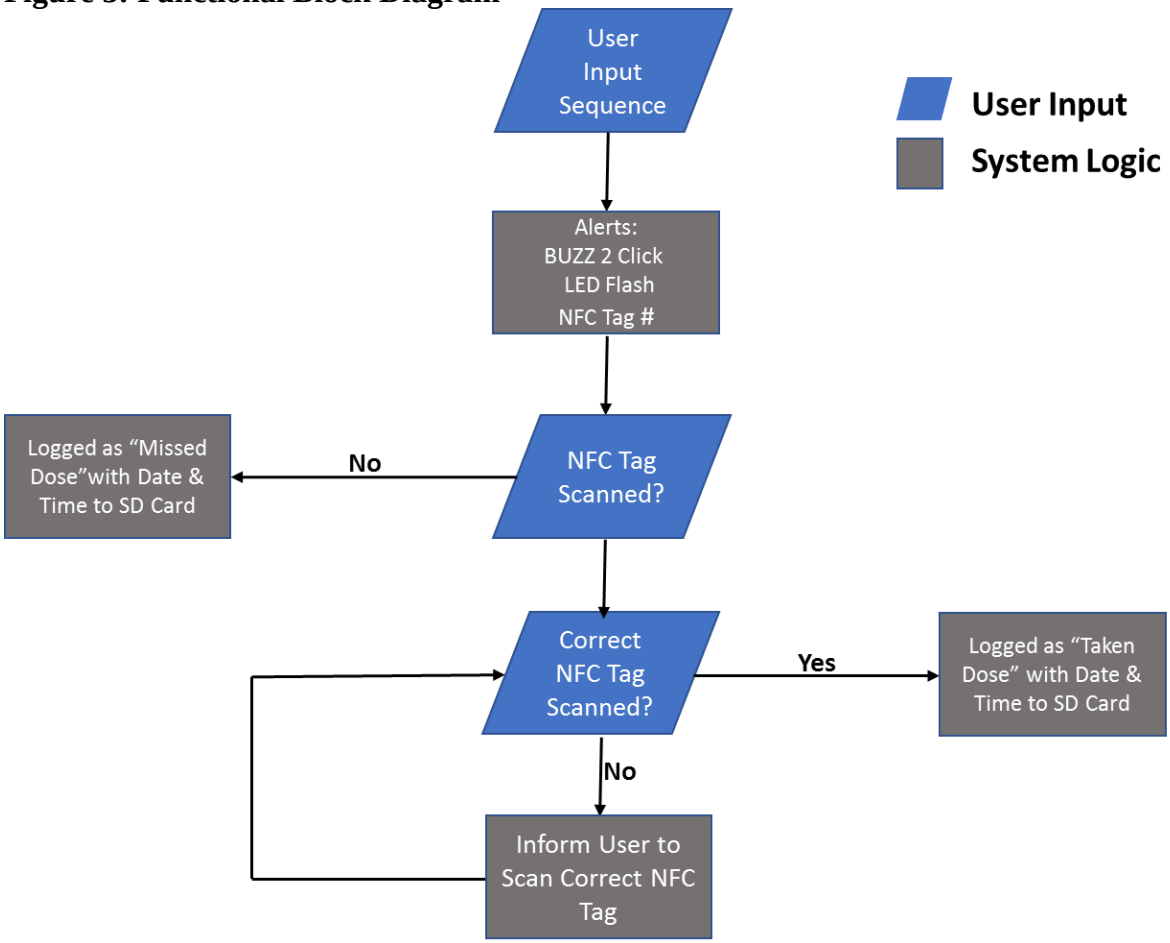
Figure 2: User Input Sequence

2.1 User Attributes and Use Cases

(Vanessa Yanez)

1. User/Caregiver: Input User Sequence Information:
    - NFC Tag Number
    - Number of Pills in Bottle
    - Time(s) of Day to take Medication (Alarm Time)
    - Days of Week
    - Number of Pills per Dose
2. HexiMed: Generates a sound alert via BUZZ 2 Click, a flashing alert via LED Panel, and prompts the user which NFC tag number to scan.
3. User/Caregiver: Scans an NFC tag on the medication bottle to verify the correct medication has been taken.
4. HexiMed: If the medication is not scanned, it will be logged as “Missed Dose.”
5. HexiMed: If the medication is scanned, then the system will identify if the correct NFC tag is scanned.
    - If yes, logged as “Taken Dose”
    - If no, the user will be informed to take scan the correct NFC tag.
6. HexiMed: Repeat step 5 until medications in time slot is take

Figure 3: Functional Block Diagram



2.2 Administration Functions

(Kelly Carranza)

Patients, caregivers, and loved ones will be able to maintain the HexiMed system. The administration function will be the Hexiwear Application. Once the application is opened the user is required to set up a username and password in order to set the date and time on the Hexiwear device.

2.3 Error Handling

(Franco Justo)

Errors are possible for any system, being able to anticipate and fix these issues will speed up testing and make any other potential problems easier to spot. The main issues with the Hexiwear will be getting all the added expansion clicks to work seamlessly together, some possible issues will be:

- NFC reader having problems reading tags
- Freezing or delayed images.
    - By limiting the number of displays, this is not an issue
- Display and sound synchronization
- SD card has a reading/writing errors, actions when full and detection.
    - Need to decide what will occur these will be handled.

2.4 Safety and Security

(Kelly Carranza)

Taking into consideration the personal medication history, available on the SD card, can possible be a security issue when moving forward with HexiMed, but the system is simply a demo project, so for this reason safety and security issues are not being considered now.

2.5 Help and User Documentation

(Kelly Carranza)

All of the help issued will be limited to the User Guide that will be provided, with the following instructions:

User Guide

- Downloading Hexiwear App
- Starting HexiMed
- User Input Sequence
- Creating alarms
- Scanning medication tags
- Accessing logged data on SD card
- Troubleshooting

Documentation with test results will be provided as well for future teams/projects.

2.6 Interfaces

(Vanessa Yanez)

2.6.1 User

The user will have five primary interfaces within the HexiMed system:

1. 1.1” OLED Hexiwear Screen necessary for the User Input Sequence.
2. 7.5x7.5” LED Panel which will display the NFC tags the user needs to scan as well as a visual flashing alarm.
3. Audio Alarm emitted through the BUZZ 2 Click to alert the user.
4. NFC Tags the user is required to scan to the NFC Click to log data to the SD card.
5. Memory Interface via SD Card, which will save NFC tag numbers that are scanned/not scanned.

2.6.2 Software

- Arm Mbed OS will be used to program HexiMed.
- HexiMed software will be implemented through a physical Micro USB connection using the Hexiwear Docking Station. ref[2]

2.6.3 Hardware

HexiMed will consist of the following hardware components:

- Hexiwear ref[3]
- Hexiwear Docking Station ref[4]
- BUZZ 2 Click ref[5]
- NFC Click ref[6]
- NFC Tags ref[7]
- Matrix RGB Click ref[8]
- Matrix RGB Panel ref[9]

2.6.4 Mechanical

There will be no mechanical interfaces used in HexiMed, however a stretch goal is to design a mount that will hold the LED Panel and Docking Station to be mounted on a wall for easy and clear access.

2.7 Boundary Conditions and Constraints

(Franco Justo)

Boundary Condition:

- 1 32X32 Matrix RGB LED panel
- 15-minute time differential between alarms

Constraint:

- $500 Budget
- Use of Hexiwear, NXP K64 MCU ref[2]
- USB powered docking station with 3 expansion slots ref[3]

2.8 Performance

(Vanessa Yanez)

Software Performance Parameters		
Function	***Description***	***How Tested***
Input Information	User inputs information (Medication Name, Number of Pills, Time of Day to be taken) on Hexiwear device.	Test by inputting information of 50 usage instances.
User Interface	Display on RGB LED Matrix Panel will load in 5 seconds or less.	Use a timer to measure load time of 50 usage instances.

Sound Alarm	The BUZZ 2 Click will create audible medication alarms, signal frequency determines the sound pitch and duty cycle determines sound volume.	Test by implementing alarm code and collecting data from 50 usage instances.
Visual Alarm	The LED display will create a visual flashing medication alarm.	Test by implementing alarm and collecting data of 50 usage instances.
Log Data ref[10]	The NFC sensor will read medication tags scanned within a 2cm-3cm and log medication name and time to SD card.	Test by scanning tags and collecting data of 50 usage instances.
Store Data	A 32GB SD card inserted into the docking station will store medication information.	Test by checking if data is stored each time after 50 usages.
Memory Usage ref[11]	Hexiwear's Kinetis K64 MCU has a limit of 1MB of flash memory.	Upload code into Hexiwear, observe functionality and performance of system after 50 usages.

2.9 Software Platforms

(Franco Justo)

- Hexiwear MK641.0.2 ref[2]
- ARM Mbed OS5 ref[4]
- Wolksense

2.10 Service, Support, & Maintenance

(Kelly Carranza)
HexiMed does require service, support, and maintenance since the project does not have any internet features and because it is considered a demo project.

2.11Expandability or Customization

(Kelly Carranza)
Expandability includes:

- Adding LED panels to increase screen size so the user can see more information clearly.
- Increasing the amount of prescriptions, the system can hold

Customization includes:

- Option to input specific times at which the alarms will be triggered

3 Project Alignment Matrix

(Vanessa Yanez)
Outside Advisors (if any) and affiliations: Dr. Semih Aslan, Faculty Advisor

TABLE 1: Knowledge Alignment Matrix

Course No.	**Core knowledge**	**Specific knowledge incorporated by team**
EE 3350 (Electronics I)	Design and analysis of active devices and equivalent circuits	The click boards will be connected with pins to the docking station sockets.
EE 3370 (Signals and Systems)	Frequency domain representation of signals and frequency response, transfer functions	The BUZZ2 Click adds audio signalization at a 4 kHz resonant frequency.
EE 3420 (Microprocessors)	Principles of operation and applications of microprocessors	The embed operating system will be used for programming click boards as well as interfaces for the design.
EE 4352 (Introduction to VLSI Design)	Analysis and design of CMOS integrated circuits	Not applicable, design does not include VLSI applications.
EE 4370 (Communications Systems)	Transmission of signals through linear systems, analog and digital modulation, and noise	Not applicable because transmission analysis will not be needed.

TABLE 2: Constraint Alignment Matrix (and applicable standards)

ABET Criterion 3 (c): "an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability."

Constraint Type	**Specific Project Constraint**
Economic	Components needed must be within a $500 budget.
Environmental	System will consume energy since it must be plugged in.
Health and safety	Electrical issues within the system.
Social/Ethical	System intends to prevent misuse of, or missed medications
Applicable Standards	IEEE Code of Ethics Section 7.8.5

4 References

(Vanessa Yanez)

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5 Approvals

The signatures of the people below indicate an understanding in the purpose and content of this document by those signing it. By signing this document, you indicate that you approve of the proposed project outlined in this Functional Specification and that the next steps may be taken to proceed with the project.

Approver Name	Title	Signature	Date
	Project Manager		
	D2 Project Manager		
	Faculty Sponsor		
	Sponsor		
	Instructor		