



DigiHealth-Asia

Deliverable D1.4: Report Describing the technical system requirement for digital health care monitoring prototype.

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Authors	Qasim Zeeshan Ahmed (UoH), Adnan Shahid (UGent), Ingrid Moerman (UGent), Rafia Mumtaz (NUST), Amir Qayyum (CUST), Pradorn Sureephong (CMU), Worasak Rueangsirarak (MFU), Ariuntuul Garidkhuu (MNUMS), Mend-Amar Majig (NUM)
Reviewers	Muhammad Tahir (CUST), Fahim Shahzad (CUST)

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Executive Summary

In this deliverable, we are going to present the technical requirements of our Asian partners, Pakistan, Thailand, and Mongolia. We are going to initially discuss the three different use cases architecture followed by their technical requirements. The technical requirements are broken down into hardware and software parts. The hardware and software requirements are tentative and may change as the project proceeds. Furthermore, both the hardware and software requirements will be more definitive in work package 2 deliverables (D2.1, D2.2, D2.3, D2.4, D2.5, and D2.6).

1. Introduction

Three different pilot use cases for remote monitoring are being proposed in this CBHE Digital Health project. All these different use cases propose a different architecture and can provide more flexibility to the project. All three project pilot use cases will help to develop a project-based course in the partner Asian countries and the collected data from the pilot cases will be used for artificial intelligence and data analytics in health care courses. National University of Science and Technology (NUST) and Capital University of Science and Technology (CUST) are proposing the remote monitoring of cardiovascular system for Pakistan. Chiang Mai University (CMU) and Mae Fah Luang University (MFU) are proposing a remote monitoring of mobility disorder for people of Thailand. Finally, Mongolian National University of Medical Sciences (MNUMS) and National University of Mongolia (NUM) are proposing a remote consultation of patients. In this report we will initially discuss the architecture of each pilot use cases and their detailed technical system (hardware and software) requirements.

2. Pilot use case I – Remote Monitoring of Cardiovascular Patients

This task is responsible for running a trial of the developed prototype system in Pakistan for cardiovascular patients. The pilot use case will be launched for a period of 4 – 6 weeks where a total number of 20 patients will be monitored. The task is equally distributed between NUST and CUST and each University will develop their own system architecture.

2.1. National University of Science and Technology (NUST)

The proposed architecture for remote monitoring cardiovascular patients is shown in Figure 2.1. In this architecture most of the processing will be carried out at the edge.

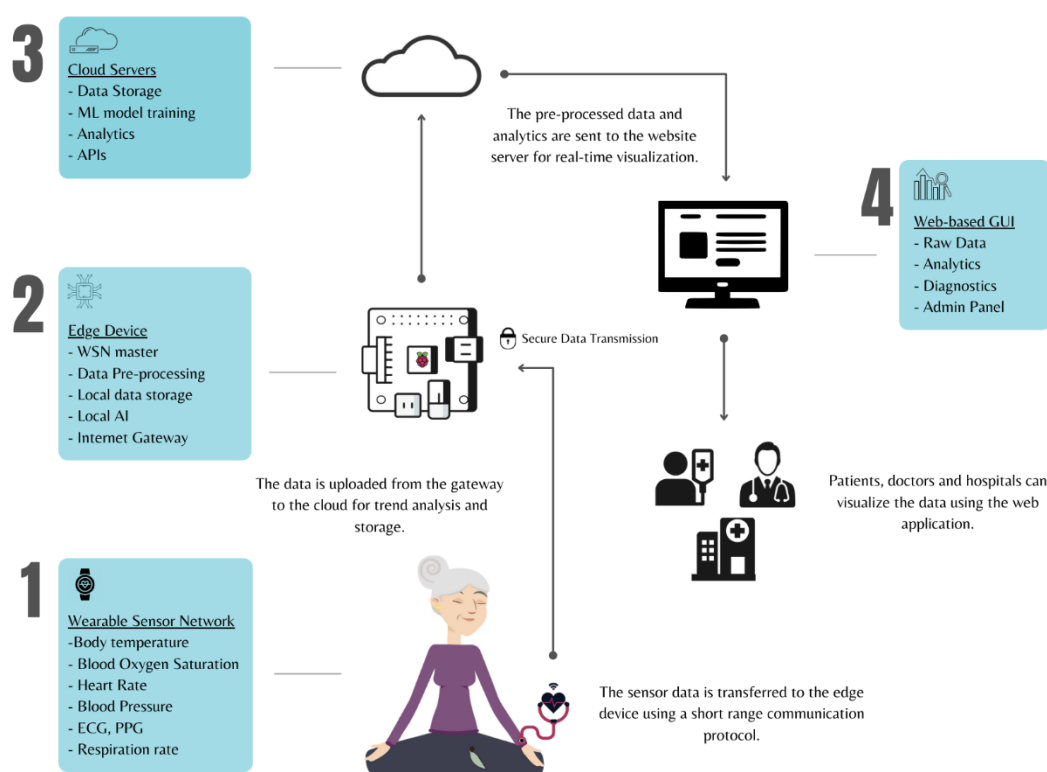


Figure 2.1: Proposed Remote Monitoring System for Cardiovascular Patients by NUST

2.1.1. Hardware Requirements

The hardware requirements consist of sensors, microcontrollers, communication modules, edge computer devices and reference devices. The details of the components are presented in Table 2.1.1.

Table 2.1.1. Hardware Requirements from NUST

Hardware Requirements		
S/No	Description	Remarks
Sensors		
1	MLX90614	Body temperature sensor
2	MAX30101	Pulse oximeter & HR sensor
3	ADS1292R	ECG sensor
4	MAX86150	BP estimation & respiration rate

Microcontrollers		
5	ESP32 dev-kit	Sensor Interface
6	Arduino	
7	STM32MCUs	
Communication Modules		
8	Wi-Fi modules	
9	BLE modules	
10	LoRa modules	
Edge Computing Devices		
11	Raspberry Pi 4	ML inference at Edge
12	Jetson Xavier	
Reference Devices		
13	Medical-grade Cardiac Monitor	
14	ECG Holter	
15	BP monitor	

2.1.2. Software Requirements

The software requirements are broken down into programming environments, machine learning libraries, required cloud management and services, web development applications and libraries and finally the programming languages. The details of the software requirements are presented in Table 2.1.2.

Table 2.1.2. Software Requirements from NUST

Software Requirements		
S/No.	Description	Remarks
Programming Environments		
1	Windows 10 OS	Desktop development environment
2	Micro-python	Programming microcontrollers
3	STM32CubeIDE	Programming STM32 microcontrollers
4	Thonny Python IDE	Programming on Raspberry Pi
5	Anaconda	ML application for model training
6	Visual Studio Code	Web development
7	Sublime	Code editing and Web development
8	MATLAB	Signal processing
Machine Learning Libraries		
9	TensorFlow	Open-source ML software library
10	Pickle	To serialize a python object (ML model) into a binary format
11	Keras	Python library
12	NumPy	Mathematical computations in Python
13	Sci-kit learn	Software library containing different ML algorithms
14	Matplotlib	Plotting and data visualization
Cloud Management and Services		
15	Athena	AWS Cloud Services
16	AWS IoT core	
17	AWS IoT Analytics	
18	AWS Greengrass	

19	AWS Sage-Maker	
20	AWS Cloud Formation	
21	AWS S3	
22	Amazon MemoryDB (Real-time DB)	

2.2. Capital University of Sciences and Technology (CUST)

The proposed architecture for remote monitoring cardiovascular patients is shown in Figure 2.2. The hardware and software requirements are given below in the relevant sections.

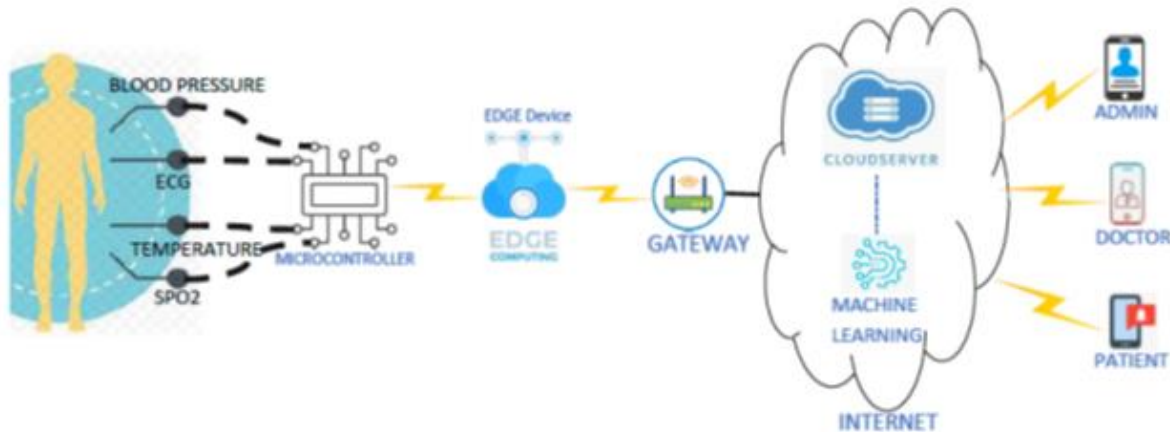


Figure 2.2: Proposed Remote Monitoring System for Cardiovascular Patients by CUST

2.2.1. Hardware Requirements

The hardware requirements are given in the following Table 2.2.1. Similar to NUST the hardware consists of sensor nodes, edge devices, microcontrollers, gateways, high performance computers, smart watches and reference equipment.

Table 2.2.1. Hardware Requirements from CUST

Hardware Requirements		
S/No	Description	Remarks
1.	High-performance Laptops	To collect and process healthcare data
2.	Laptop computer	For site services, report writing, research purposes and data processing
3.	All-in-one computer	For site interactive programs
4.	GPU for AI and ML processing <ul style="list-style-type: none"> NVidia Jetson Nano 	For enhance AI and ML processing
5.	External data storage set e.g. Hard disk, SSD	To collect and backup healthcare data
6.	IoT development equipment <ul style="list-style-type: none"> Sensors (AS7026GG, MLX90614, MAX30102) Microcontroller (ESP32) Raspberry Pi 4 Wireless coordinators (WiFi) Prototyping PCB boards 	IoT devices for healthcare activities measurement
		Microcontroller
		Edge Device
		Communications Module
		Accessories

7.	Linux supported cell phone client side	Wireless gateway for healthcare sites
8.	Linux supported cell phone for application testing	For android development testing.
9.	Wireless Access points or Wi-Fi router	Access point for Wi-Fi and IoT devices
10.	Printer	For printing marketing material
11.	Reference ECG and BP monitors	To have some reference values
12.	Smart Watches	

2.2.2. Software Requirements

The software requirements consist of desktop development environment, server and client development platforms, data storage, cloud services and machine learning algorithms development platforms. The details of the software requirements are given in the Table 2.2.2.

Table 2.2.2. Software Requirements from CUST

Software Requirements		
S/No	Description	Remarks
Development/Coding Environments		
1.	Windows 10 OS	Desktop Development environment
2.	MS Visual Studio	Server-Side Development Platform
3.	Android Studio	Client-Side Development Platform
4.	SQL Server Database	For Data storage
5.	Arduino IDE	For Microcontroller programming
6.	Raspbian OS	Edge Device Development environment
7.	Anaconda Framework	Machine Learning Algorithm Development
8.	LINUX OS	For test environment
Cloud Services		
9.	AWS	Cloud Services for the deployment of application
Testing and Evaluation		
10.	PUTTY + SSH	For remote OS connection
11.	GMETER	For Performance testing
12.	TEST NG	For Unit testing/function testing
Collaborative work		
13.	Github	For a collaborative working environment

Now let us proceed to pilot case II.

3. Pilot Use Case II- Remote Monitoring of Mobility Disorder Patients

This task is responsible for running a trial of the developed prototype system in Thailand for patients with mobility disorders. The pilot use case will be launched for a period of 4 – 6 weeks where a total of 20 patients will be monitored. The task is equally distributed between CMU and MFU and each University will develop their own system architecture. CMU is going to work on fall risk monitoring of elderly patients at home. While MFU is working towards fall risk assessment at healthcare centres. Though MFU and CMU are working on different use cases, both partners agree on mutual objectives under an umbrella of fall risk prevention in the elderly.

3.1. Chiang Mai University (CMU)

CMU focuses on fall risk monitoring at home for elderly patients. The system architecture is proposed in Figure 3.1.

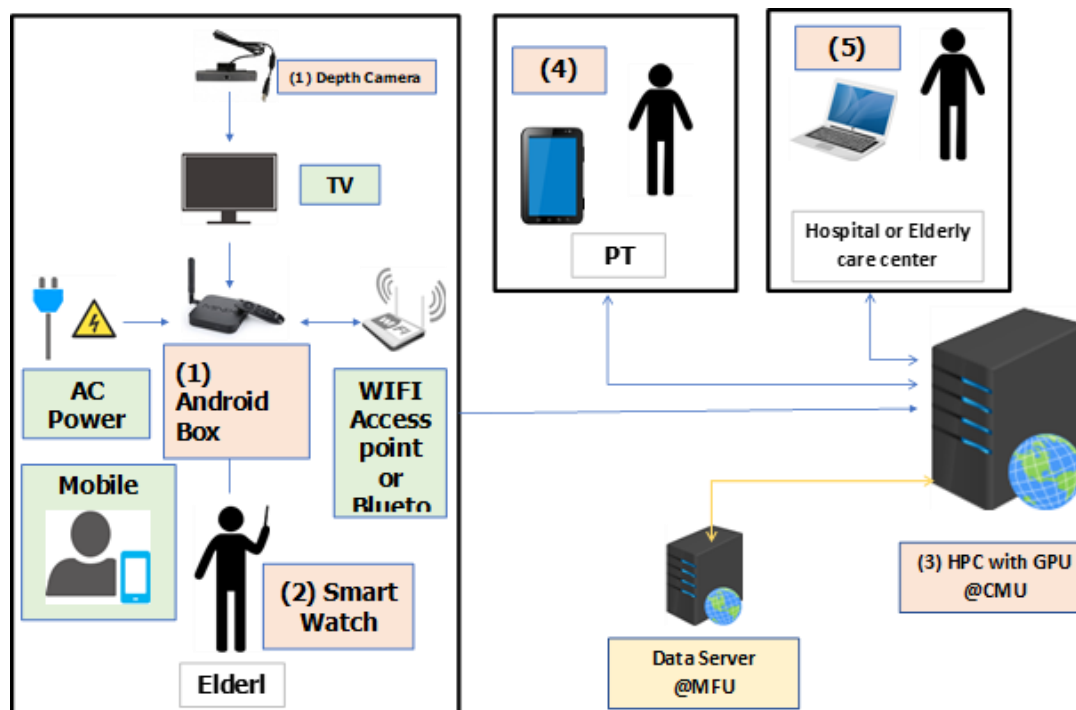


Figure 3.1: Proposed Remote Monitoring System for Mobility Disorder by CMU

3.1.1. Hardware Requirements

The hardware consists of cameras, smart watches, high performance computers, laptops, tablets and mobile devices. The hardware requirements for CMU are shown in the table below.

Table 3.1.1. Hardware requirements for CMU

Hardware Requirements		
No.	Description	Remarks
1	A.I. Camera	Camera and analysis systems for assessment and physical improvement
2	Smart watch	Physical performance assessment for target group and day life activity data collected.
3	High performance computer with GPU processing	Server systems for CMU hub to collect and process healthcare data
4	Tablet	PT and target group communications
5	Laptop Computer	Data processing, service on site.

3.1.2. Software Requirements

The software requirements consist of desktop development environment, cloud computing tools and mobile application development platforms. The details of the software requirements are given in the Table 3.1.2.

Table 3.1.2. Software Requirements from CMU

Software Requirements		
S/No	Description	Remarks
1	Edge Computing	
1.1	Android OS	Version 11 or above
1.2	Depth Camera API	TBC
2	Cloud Computing	
2.1	Linux OS	Ubuntu
2.2	PHP	Version 7 or above
2.3	MariaDB	Version 10 or above
2.4	Sshd	-
3	Mobile Application	
3.1	Android OS	Version 11 or above
3.2	Android Studio	Version 4 or above
3.3	iOS	Version 14 or above
3.4	Xcode	Version 13 or above
4	Wearable Device	
4.1	Ware OS / Watch OS	TBC
4.2	Health Open API	TBC

3.2. Mae Fah Luang University (MFU)

MFU pays more attention on fall risk assessment at healthcare centres while CMU focuses on fall risk monitoring at home. The architecture diagram is shown in Figure 3.2.

Healthcare practitioners will control and advise the tests and could access the testing data on MFU server

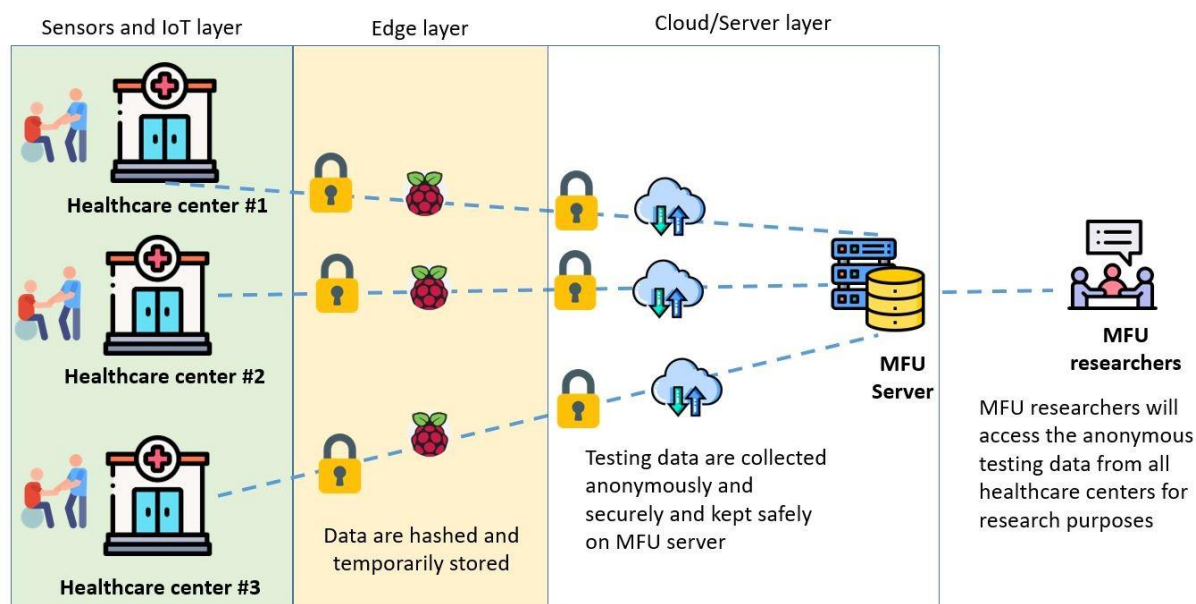


Figure 3.2: Proposed Remote Monitoring System for Mobility Disorder by MFU

3.2.1. Hardware Requirements

The hardware components consist of all-in-one computers, hard disks, GPU for AI and ML processing, IoT development kits, Raspberry PI and Nvidia Jetson Nano development kits. The detailed hardware requirements for MFU are shown in the table below.

Table 3.2.1. Hardware requirements for MFU

Hardware Requirements		
No.	Description	Remarks
1	High-performance computer	For MFU hub to collect and process healthcare data
2	Laptop computer	For site services and data processing
3	All-in-one computer	For healthcare site data access and communication
4	GPU for AI and ML processing	For enhance AI and ML processing
5	External data storage set e.g. Hard disk, SSD	For MFU hub to collect and backup healthcare data
6	IoT development equipment e.g. Microcontroller Unit (MCU), sensors and accessories	IoT devices for healthcare activities measurement
7	Raspberry PI and accessories	Wireless gateway for healthcare sites
8	NVIDIA Jetson Nano Development Kits	For end-point AI and ML processing
9	Wireless Access points or Wi-Fi router	Access point for Wi-Fi and IoT devices
10	3D printer and accessories	For prototyping IoT devices

3.2.2. Software Requirements

Table 3.2.2. Software requirements for MFU

Software Requirements		
S/No.	Description	Remarks
IoT application		
1	Arduino IDE	Programming microcontrollers
AI application		
2	Visual Studio Code	Code editor
3	TensorFlow	Open-source ML software library
4	NumPy	Mathematical computations in Python
5	Sci-kit learn	ML algorithms in Python
6	Pandas	Data processing in Python
Server-side and web application		
7	Visual Studio Code	Code editor
8	Flask	RESTFUL API platform for Python
9	MariaDB	Relational database
10	Nginx	Web server
11	Docker	Container

4. Pilot Use Case III- Remote Consultation of Patients

This pilot use case aims to run a trial of the developed prototype system in Mongolia for patient consultation. The research study will be launched for 4–6 weeks where a total of 20 patients will be monitored. The MNUMS and NUM are planning to develop a unified pilot use case.

4.1. Mongolian National University of Medical Sciences (MNUMS) and National University of Mongolia (NUM)

The proposed architecture for remote consultation of patients is shown in Figure 4.1. The hardware and software requirements are given below in the relevant sections.

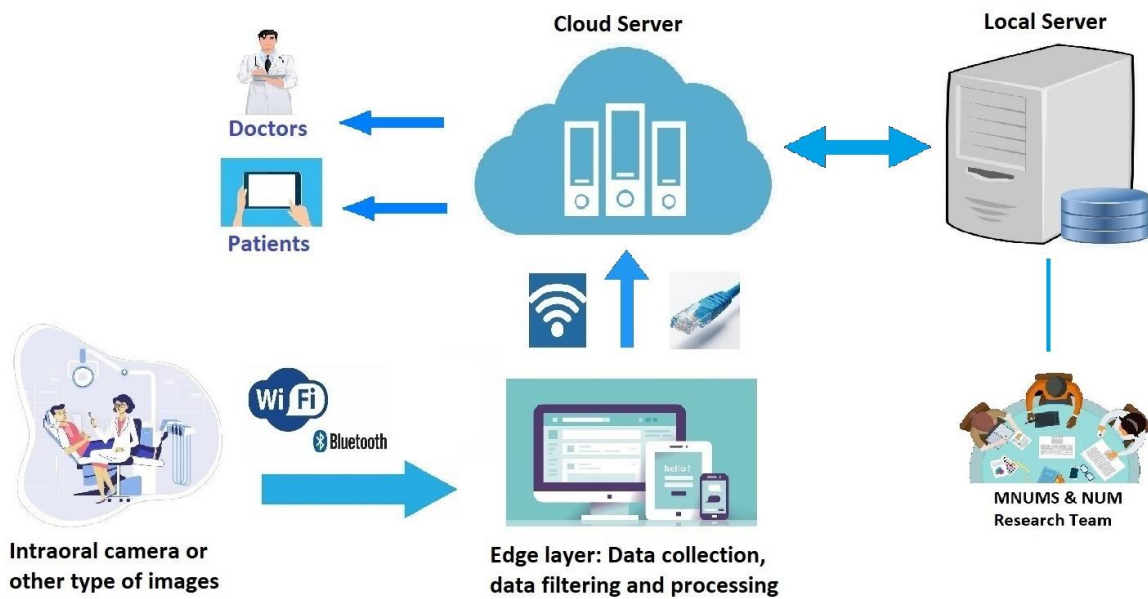


Figure 4.1. Proposed system diagram for the remote consultation of patients

4.1.1.1. Hardware Requirements

The hardware components consist of high-performance computers, laptops, external data storage, GPUs for enhanced AI and ML processing, IoT development kits, Raspberry PI and Nvidia Jetson Nano development kits for end-point ML processing, and intraoral and other cameras. The detailed hardware requirements for MNUMS&NUM are shown in the table below.

Table 4.1.1. Hardware requirements for MNUMS&NUM pilot case

Hardware Requirements		
No.	Description	Remarks
1	Intraoral Cameras or (Qscan Plus, AIOBIO alternative)	For oral examination
2	WIFI Router and Pocket WIFI router	Access point for Wi-Fi and IoT devices
3	MacBook Air Apple M1 Chip, Including Office 2019 Professional Plus, installed	For Site services and data processing
4	High performance computers, workstation	To process healthcare data, to develop AI algorithms
5	Graphics processing unit (GPU)	To enhance ML algorithms
6	External data storage set, SSD	To collect and backup healthcare data
7	NVIDIA Jetson Nano development kit	For end-point AI and ML processing

8	Raspberry Pi and accessories	Wireless gateway for healthcare sites
9	IoT development equipment e.g., Microcontroller Unit, sensors and accessories	IoT devices for healthcare activities measurement
10	Monitors	Supplement to workstations

4.1.2. Software Requirements

The software requirements consist of programming environments, machine learning libraries, required cloud management and services, android and web development applications and libraries. The details of the software requirements are presented in Table 4.1.2.

Table 4.1.2. Software requirements for MNUMS&NUM pilot case

Software Requirements		
S/No.	Description	Remarks
Programming Environments		
1	Windows 10 OS	Desktop development environment
2	Android Studio	Mobile application development
3	Visual Studio Code	Web development
4	Anaconda	ML application for model training
5	PyCharm, Python IDE	Programming on Raspberry Pi
6	Sublime	Code editing and Web development
7	SQL Server Database	For Data storage
8	MATLAB	Production server
Machine Learning Libraries		
9	TensorFlow	Open-source ML software library
10	Pickle	To serialize a python object (ML model) into a binary format
11	Python libraries	Keras, Sci-kit learn, NumPy, Pandas, Matplotlib
Cloud Management and Services		
12	AWS Cloud Services	Athena, IoT core, IoT Analytics, Cloud Formation, Amazon Memory DB, AWS S3, Sage-Maker, Greengrass

5. Conclusion

This deliverable provides a technical requirement on the planned digital health monitoring and care systems in Asia. Three different pilot studies are envisioned in this project: Cardiovascular, mobility disorder and remote consultation. Initially, the proposed architecture of each pilot study is shown followed by the technical requirement. The technical requirement consists of two parts which are the hardware and software requirement of the system. Furthermore, a detailed architecture development and detail of these technical requirements will now be covered in Work Package 2 with more details in Deliverables 2.1, 2.2, 2.3, 2.4, 2.5, and 2.6.