Sensing, ArtiFicial intelligence, and Edge networking towards Rural Health monitoring (SAFE-RH)

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SAFE-Rural-Health-Technology Lab

SAFE-RH Project no. 619483-EPP-1-2020-1-UK-EPPKA2-CBHE-JP

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Abstract

The focus of SAFE-RH technology Lab is on the implementation and assessment of remote health monitoring framework in Pakistan. SAFE-RH technology Lab set up state of the art remote health monitoring Lab in IUB, Pakistan. The Lab will provide a technology transfer interface between Europe and Asian partners. Technological advancements made by the European partners will be assessable through Lab in Asian partner countries, to upgrade their conventional rural health practices. SAFE Rural Health partner (IUB) have collaborated with the pilot of other Universities in Pakistan CUST and COMSATS.

1 Introduction

The SAFE-RH Technology Lab at The Islamia University of Bahawalpur (IUB) is a pioneering facility dedicated to advancing remote health monitoring technologies in Pakistan. As a state-of-the-art laboratory, it stands at the forefront of innovation, offering a collaborative environment where students, researchers, and professionals come together to tackle some of the most pressing healthcare challenges facing rural communities. The lab's primary objective is to serve as a hub for research and development in health-related technologies, with a focus on creating solutions that are both practical and effective in addressing the unique needs of underserved populations.

Students and researchers at the lab are given access to a wide range of advanced tools and resources. These include state-of-the-art computers, specialized equipment, and high-tech sensing devices, all of which are essential for conducting sophisticated health monitoring experiments and developing new technologies. The lab also features modern furniture and a comfortable workspace, ensuring that the participants have a conducive environment for creativity and focus.

One of the key missions of the SAFE-RH Technology Lab is to address the healthcare disparities that exist between urban and rural areas in Pakistan. Rural populations often face significant barriers to accessing quality healthcare, including a lack of medical infrastructure, trained professionals, and timely medical interventions. The lab's research and development efforts are specifically aimed at creating technologies that can overcome these barriers, making healthcare more accessible and effective for those in remote areas.

To achieve this, the lab focuses on three main pilot projects: Women and Maternity, Old Homes for the Elderly, and Infant and Child Monitoring. These projects are designed to tackle some of the most critical healthcare needs in rural communities.

- Women and Maternity Pilot: This project is dedicated to improving maternal healthcare in rural areas. It aims to develop technologies that can monitor the health of pregnant women and provide timely interventions when needed. The project also focuses on educating expectant mothers about health practices and ensuring that they have access to the necessary resources during pregnancy.

- Old Homes for the Elderly Pilot: The elderly in rural areas often face challenges such as limited access to healthcare services and social isolation. This pilot project is focused on developing remote monitoring technologies that can track the health of elderly individuals in old homes, ensuring that they receive the care they need. The project also aims to create a support system that can provide both medical and emotional assistance to the elderly.
- Infant and Child Monitoring Pilot: Infant mortality and child health are major concerns in rural Pakistan. This project is designed to develop technologies that can monitor the health of infants and young children, providing early detection of potential health issues. The goal is to reduce infant mortality rates and ensure that children in rural areas have a healthy start in life.

Each of these pilot projects is supported by comprehensive training programs that are tailored to the specific needs of the project. These programs are designed to educate healthcare workers, caregivers, and community members on how to effectively use the technologies developed in the lab. By providing this training, the SAFE-RH Technology Lab ensures that the technologies are not only innovative but also accessible and usable in real-world settings.

Additionally, the success of the SAFE-RH pilot projects depends heavily on the effective deployment and utilization of the developed technologies. To this end, the lab has established training-enabled programs that are integral to the deployment of each pilot. These programs develop and deliver comprehensive learning materials tailored to the specific needs of each project. For instance, in the Women and Maternity Pilot, training programs are designed to educate healthcare workers on how to use the monitoring devices and interpret the data they collect. Similarly, in the Old Homes for the Elderly Pilot, caregivers are trained on how to operate the remote monitoring systems and provide the necessary care based on the data insights. The Infant and Child Monitoring Pilot also includes training for healthcare providers to ensure they can effectively use the monitoring technologies and respond appropriately to any health alerts.

These training programs are not just about technical instruction; they also focus on the broader context of healthcare delivery in rural areas. Participants are educated about the cultural, social, and

economic factors that can affect healthcare outcomes, ensuring that they are well-prepared to address these challenges in their work. This collaborative setting helps to advance the SAFE-RH project's goals and contributes to the overall improvement of healthcare delivery in remote areas of Pakistan.

2 SAFE-RH Technology Lab

The SAFE-RH Technology Lab was established on February 15, 2022 and became fully operational on February 25, 2022. This lab is a dedicated space equipped with advanced technological tools and resources designed to foster innovation, experimentation, and enhanced learning about remote health in Pakistan. It features state-of-the-art computers, furniture, specialized equipment, sensing devices, and other high-tech gadgets.

3 Aims and Objectives of SAFE-RH Lab

- State of the art lab to demonstrate three different pilots, Women and maternity, Old home for elderly people, infant and children monitoring pilot. This lab is used to demonstrate all three pilots of SAFE-RH projects.
- Oversee the deployment of three pilots of old homes, maternal women and infant care ensuring they are accessible and effective.
- Training-enabled programs develop and deliver comprehensive learning materials tailored to each pilot project.

4 Rationales of SAFE-RH Technology Lab

SAFE-RH technology lab is established for deployment and demonstration of all three pilots and SAFE-RH technology training and dissemination. Various equipment includes IT equipment, sensing devices and medical devices are present in this lab.

SAFE-RH lab is primarily developed for the face to face training of SAFE-RH technologies. In addition, demonstration of smart health technologies in the lab and supplement video of equipment installation are present for the training of health workers, academicians and researchers.

The health workers who will be recruited to the class, will be introduced to the SAFE_RH concept and technology. Health worker will have to attend this class physically. These classes demonstrate how to install sensors and interpret data from sensors for patients' health monitoring.

SAFE-RH lab demonstrates following systems:

i. SAFE-RH online MIS system
ii. SAFE-RH Mobile Application
iii. SAFE-RH Offline MIS system
iv. Pilots of SAFE-RH Projects

4.1 SAFE-RH Online MIS System

The SAFE-RH Online MIS System is a healthcare delivery method that uses technology to transmit information between patients and medical staff (doctors, paramedics and care takers). Online MIS system allows to connect patients and medical staff without geographical limitations. The system requires its users to be registered before using it.

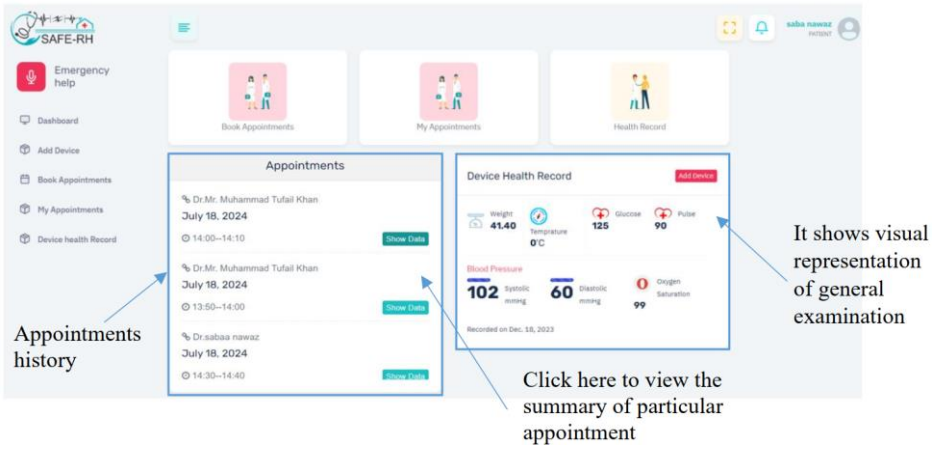


Figure 1: SAFE-RH Online MIS Patient Dashboard

Online MIS system allows patients to contact doctors all over the world. It can communicate via chat, audio call or video call. Patient can view selected doctor's available slots and book its appointment online. It can share its medical history as well as current medical conditions using sensing devices. These devices can observe patients' vitals as well as generate alerts in case of emergency. Figure 1

illustrates the SAFE-RH Online MIS patient's dashboard which is showing patient's history and current vitals.

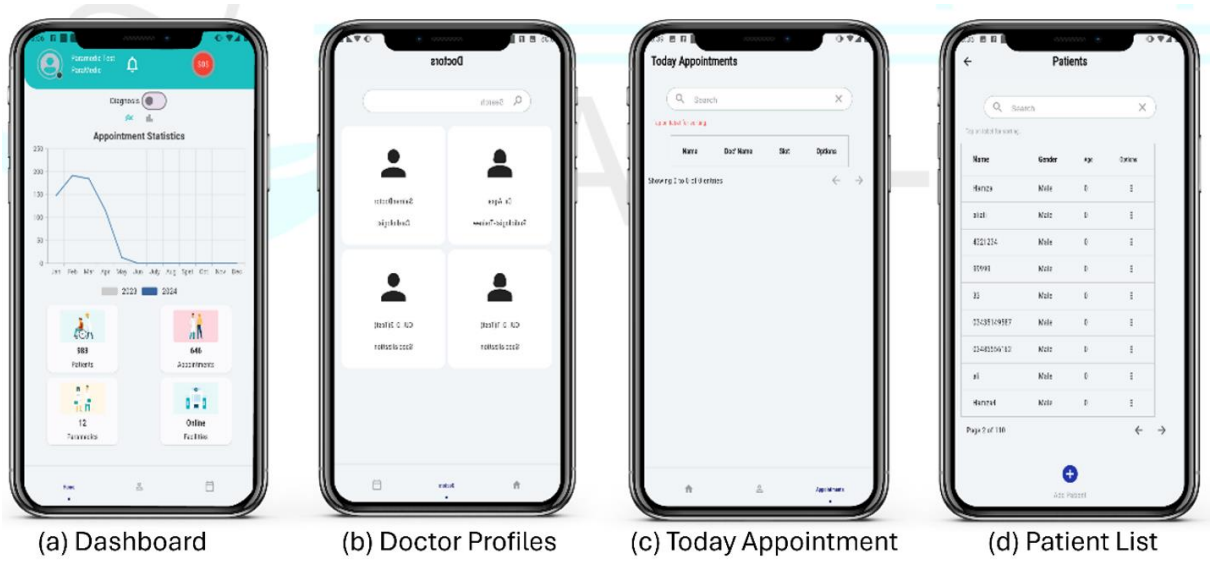
Figure 2: SAFE-RH Online MIS appointment summary

Figure 2 demonstrates a patient's appointment summary which is provided by the patient at time of booking appointment. The doctor can view this information for patient appointment.

Similarly, Online MIS system provides interfaces for doctors, paramedics and caretakers. These can view information according to their role. Online MIS system can interact with IOT devices which are supported by AI components to pre-emptively predict health abnormality. These devices are attached to patients and their information is uploaded to the cloud server. The manual for this system is available at The Safe-RH Management Information System User Guide.

4.2 SAFE-RH Mobile Application

SAFE-RH mobile application is developed for handheld android devices. It has same functionalities as of SAFE-RH Online MIS system. It is tailored for patients, doctors, paramedics and caretakers. Few screen shots of SAFE-RH mobile application paramedic view are given in Figure 3. The manual of mobile application is available at The Safe-RH Mobile Application User Guide.



(a) Dashboard (b) Doctor Profiles (c) Today Appointment (d) Patient List

Figure 3: SAFE-RH Mobile Application Paramedic Views

4.3 SAFE-RH Offline MIS System

The motive for SAFE-RH Offline MIS system as follows:

i. Developed for remote area where availability of internet and electricity is scarce.
ii. This system can work in no connectivity areas to gather patients' data.
iii. Collected data can be uploaded to MIS later as soon as internet is available.
iv. Doctors and paramedics are the only user for this system.
v. This application can connect to Bluetooth Medical devices for gathering patients' vital signs.

SAFE-RH Offline MIS System is designed for the collection of patients' inform visiting remote heath centres. This system is designed so that it can locally store walk in patients' information which can be later transmitted to SAFE-RH Online MIS system. This system plays a critical role in ensuring efficient and effective patient care by providing healthcare professionals with timely and accurate data, catering to environments with limited or no internet connectivity.

The offline system is designed to replicate the comprehensive capabilities of the online MIS. Key functionalities include:

i. **Data Collection:** The data is collected with sensors and input methods to collect a wide range of patient data, including vital signs, medical history, and ongoing treatment details.
ii. **Data Storage:** The system securely stores collected data locally, ensuring that patient information is preserved even when internet connectivity is unavailable.

iii. **Data Transmission:** Once connectivity is restored, the system facilitates the seamless transmission of stored data to the central SAFE-RH information system, ensuring data synchronization and integration.

To integrate the offline system with the SAFE-RH system, a specialized service is designed. This service acts as a bridge, connecting the patch to the broader MIS framework. The integration process involves:

i. **Data Synchronization:** Upon regaining connectivity, the service automatically synchronizes locally stored data with the central SAFE-RH system. This ensures that all patient information is up-to-date and accessible to healthcare providers.
ii. **Real-time Updates:** The service facilitates real-time updates once connected, allowing for immediate reflection of any changes or additions to patient data in the central system.
iii. **Security and Compliance:** The service ensures that data transmission adheres to strict security protocols, maintaining patient confidentiality and compliance with healthcare regulations.

The offline system offers numerous advantages, particularly in challenging healthcare environments:

i. **Continuity of Care:** By enabling data collection and storage without the need for constant connectivity, which ensures that patient care continues uninterrupted.
ii. **Accessibility:** Healthcare providers in remote or underserved areas can access and manage patient information effectively, improving the overall quality of care.
iii. **Data Integrity:** The system's ability to store data locally and synchronize with the central system maintains the integrity and completeness of patient records.
iv. **Scalability:** The offline system can be deployed in various healthcare settings, from Rural Health Centre RHC and Basic Health Unit (BHU), providing a scalable solution for diverse needs.

The Offline MIS system represents a significant advancement in patient management systems, particularly for environments with limited connectivity. By replicating the functionalities of the online MIS and integrating seamlessly with the SAFE-RH information system, the Offline MIS system ensures that patient care remains efficient and effective, regardless of internet availability. This innovative solution underscores the importance of adaptability in healthcare technology, offering a reliable and scalable approach to managing patient information in diverse settings.

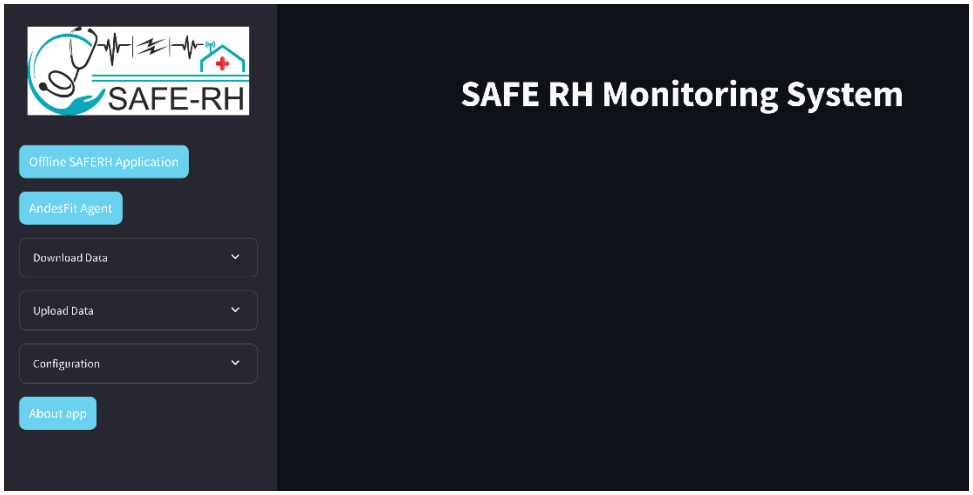


Figure 4: SAFE-RH Offline MIS System

Figure 4 is SAFE-RH Offline MIS System desktop view. The actual application is started by "Offline SAFERH Application" button. This application is started in separate process. Bluetooth devices agent is initiated by the "AndesFit Agent" button. Offline database is configured using "Configuration" tab. Doctors and paramedics data is acquired using "Download Data" tab. Patients data is synced using "Upload Data" tab. Details of this system is presented in The SAFE-RH Offline MIS User Guide.

4.4 Deployment of Pilots in SAFE-RH Technology Lab

There are (3) three different pilots that serves the rural area community. These are infant and children monitoring pilot, women and maternity pilot and old home for elderly people pilot. This lab is used to demonstrate all three pilots of SAFE-RH projects. As these projects are under-developed so these technologies are still to be transferred here.

4.4.1 Infant Monitoring Pilot

Patient Monitoring Patch (PMP) shown in Figure 5 is developed for collection, storage, and transmission of patients' information. A patch is developed to collect body temperature, SpO2, pulse rate and environment temperature and humidity etc. Patch collects target patient's credentials and transmit it to remote online MIS server.

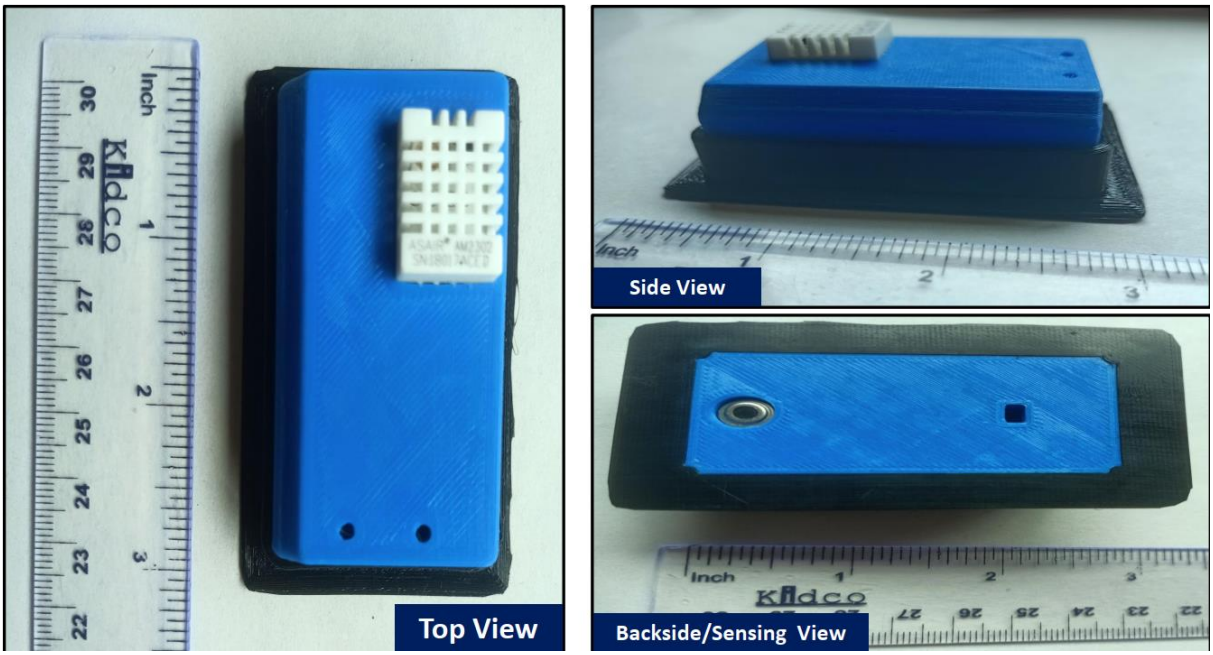


Figure 5: Patient Monitoring Patch

The patch needs WIFI connection to connect to server. A mobile application (shown in Figure 6) is used to set SSID and Password so that in future patch can be connected to network. Another application (shown in Figure 7) is used to set device name and monitor data gathering.

Figure 6: WIFI_CREDENTIALS

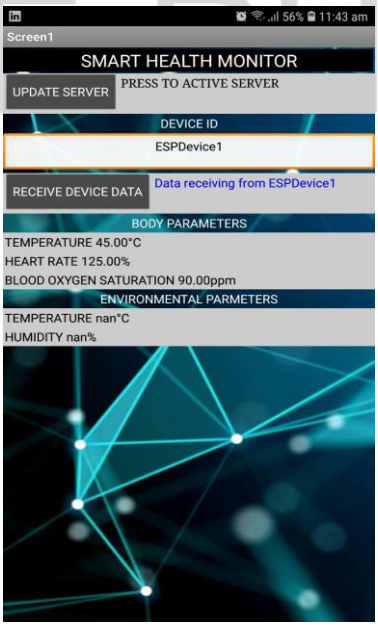


Figure 7: UDP_SERVER

Patient Monitoring Patch readings are not very accurate and stable and needs improvement. For these reasons, it is not deployed with SAFE-RH Online MIS system and SAFE-RH Offline MIS system.

SAFERH Sensing Devices are used to gather patient data. Details of Patient Monitoring Patch is available at Smart Healthcare Patch/Band.

4.4.2 Maternal and Infant monitoring pilot

The main objective of this task is to design and develop remote sensing and monitoring of maternal women pilot. Maternal and fetus health monitoring is a critical aspect of ensuring the well-being of pregnant women during prenatal care. It involves the regular assessment of various health parameters to detect any potential complications early and provide timely interventions. Maternal and fetus health monitoring is address in this pilot in two scenarios: BHU (Basic Health Unit), which involves physical monitoring, and remote sensing utilizing wearable sensors.

In rural areas where consultants and expert doctors are not available, there is a system of health units with trained health workers. This scenario, maternal health monitoring is within BHUs in which patient visits physically and examined by the health worker. At BHUs, healthcare providers use multi-parameter to measure the vitals of pregnant woman that include ECG (Electrocardiogram), PR (Pulse Rate), Resp. (Respiration Rate), NIBP (Non-Invasive Blood Pressure), SpO2 (Oxygen Saturation), and TEMP (Temperature). Fetus Doppler is used to monitor the fetus heartrate. Healthcare workers record the patient data in the central server using a web application (MIS) as well as mobile application that is developed as part of this pilot.

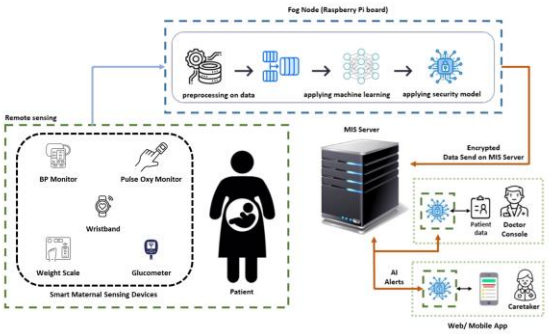


Figure 8: Remote Maternal Health Monitoring

In the second scenario, maternal and fetus health monitoring extends through remote sensing technology. Set of wearable devices are used acquire the data of fetus and mother, which is then transmitted to the server. SAFERH Sensing Devices (SSD) consists of wearable devices to track various vital signs of pregnant women. These sensors are used to continuously monitor parameters such as heart rate, blood pressure, temperature, weight, and oxygen saturation levels. For remote motioning

of fetus a fetus Doppler and Remote Monitoring Fetus Movement Belt is developed that can detect fetus heartrate and fetus movements in high risk pregnancies. It is portable IOT based wearable belt that detects the movement of fetus in high risk pregnancies. The belt detects fetus movements in terms of movements and kick count, intense high pressure is considered as kick and relatively less intense is considered as movement. It can transmit data to the central server to be viewed by consultant remotely. A fetus Doppler is modified to send fetus heart rate measured to the server for the record and monitoring by health care providers.

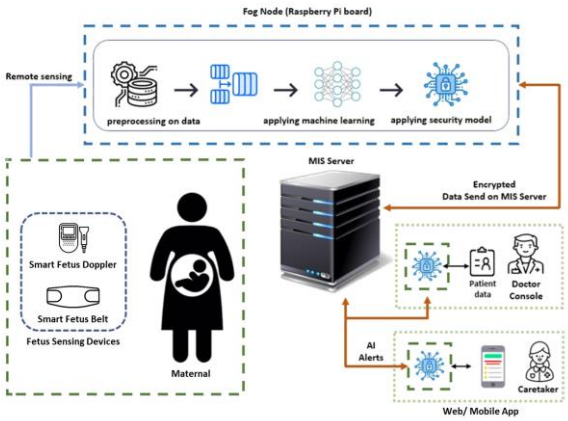


Figure 9: Remote Fetus Health Monitoring

In the remote patient monitoring system artificial intelligence based alters are generated to intimate the caretakers and healthcare providers. Some predictive model has been developed to that can provide real-time assessments of maternal health status it includes (a) Overall pregnancy risk prediction, (b) Gestational Diabetes Mellitus, (c) Pre-eclampsia and (d) Fetus health prediction based on fetus heartrate. This predictive capability enables healthcare providers to identify potential health risks early and intervene proactively, thereby improving maternal outcomes and reducing the likelihood of complications during pregnancy.

A mobile application is also developed as part of the pilot that provides an interface to input and view the patient data using four distinct consoles: Patient console, Doctors console, Paramedic console, and caretaker console. It is replica of web application developed in Deliverable 2.3. Moreover, the detail of the Maternal monitoring pilot is in Deliverable 2.2.

4.4.3 Old Home Monitoring Pilot

According to the World Health Organization (WHO), elderly people are defined as individuals who are 60 years of age or older. They commonly have physical, mental, and emotional illnesses, elderly people frequently have difficulty performing fundamental everyday tasks. To make their lives easier

and maintain their quality of life, they require the right facilities and technologies. Old homes monitoring pilot focuses on setting up a pilot project to significantly improve the quality of old people by use of remote healthcare monitoring.

The goal of the project is to solve new research issues in the creation of non-invasive wearable and non-wearable sensors that can offer critical measurements about elder users in addition to sending out emergency alerts in cases like fall or extended periods of inactivity. A security middleware layer has been designed to address the interaction between the various levels, including the sensor tier, edge/fog components, and the cloud. This layer makes it possible for multi-vendor devices to communicate effectively and efficiently while also acquiring and processing smart data. The design and interaction of the two tiers: fog and cloud, is an open research question, where the design has to determine the priority of each task, and where it is performed, based on criticality, privacy issues, complexity to guarantee security and reliability.

This pilot improves the quality of life for elderly by using technology to track their health status and provide early interventions. Regular monitoring of vital signs, medication adherence and symptoms remotely to detect any health issues or deviations from the baseline, enabling timely intervention and preventive care. Providing caregivers, whether family members or healthcare professionals, with real time information and alerts about the elderly patients' health status.

Finally, a complete record is then passed through the AI/ML prediction models that are deployed on fog node, then the analytic software is used to analyse the health data and identify any patterns or abnormalities. This information is used to trigger alerts or notifications for healthcare professionals or family members. Users can also access their health data through a user device, such as a personal computer. This allows them to monitor their own health and receive notifications about any changes or concerns. Patients can also upload their reports, prescription etc.

Finally, artificial intelligence (AI) and machine learning (ML) are emerging technologies that have been widely accepted to be the next key technology in network performance enhancement. Through training in e-commerce and ICT, health workers and patients will be trained to use latest tools of communication. Moreover, the detail of the Old home Monitoring Pilot is in Deliverable 2.3.

4.4.4 Cross Pilot (UL)

This pilot focuses on bringing diverse pilots from IUB, CUST and COMSAT pilot to share best practices within Remote Health Monitoring system and well-being of patients. This pilot will form a hub enabling partners and neighbouring countries to gain insight to the usage and benefits of Remote Health Monitoring technologies.

The consortium has envisioned to create impact at national level by disrupting conventional health practices. At the national level, SAFE-Rural-Health technologies will be adopted by medical practices beyond the pilot. In neighbouring countries, the hub will create awareness and collaboration opportunities around remote health monitoring in rural areas. Moreover, the detail of the Cross Pilot is in Deliverable 2.4.

4.5 Conclusion

The SAFE-RH Technology Lab at IUB is a cornerstone of innovation in remote health monitoring in Pakistan. Through its advanced technological resources and collaborative environment, it provides a platform for the development of ground-breaking health-related technologies that can significantly improve healthcare outcomes in rural areas. By focusing on the critical areas of maternal health, elderly care, and infant monitoring, the lab addresses some of the most pressing healthcare challenges facing rural communities. The lab's commitment to training and education ensures that these technologies are effectively deployed and utilized, making a tangible impact on the lives of those in need. As the lab continues to evolve and expand its work, it holds the promise of transforming healthcare delivery in Pakistan, setting a new standard for remote health monitoring and care in the region.

5 Trainings in SAFE-RH Lab

5.1 Technical session of SAFE-RH with Pakistani's Partners

On February 26, 2022, a technical session of SAFE-RH was held at newly inaugurated Lab of SAFE-RH in the new campus of the Islamia University of the Bahawalpur. Three partner universities of Pakistan participated in SAFE-RH joint technical session. During this technical session all teams presented their recent contributions in research and development of SAFE-RH. Different challenges and their solutions were discussed, and contingency plans were discoursed. The technical session was chaired by Dr. Nayyar Masood. In this joint technical session following SAFE-RH team members participated and presented progress on their respective responsibilities, challenges, their solution and contingency plans:

Islamia University of Bahawalpur – Dr. Dost Muhammad Khan, Dr. Najia Sehr, Dr. Omer Riaz, and Mr. Salman Shah, Mr. Faisal Shahzad.

Capital University of Science of Technology, Islamabad – Dr. Nayyar Masood, Dr. Nadeem Anjum, Mr. Suleman, and Mr. Muhamad Ali

COMSATS University Islamabad, Wah Campus – Dr. Ehsan Ullah Munir, Dr. Tassawar Iqbal, and Mr. Zulfiqar.

5.2 Initial demonstration of Pilots was held on December 31, 2022, in IUB

The third hybrid plenary meeting of Sensing, Artificial Intelligence and Edge Networking towards Rural Health (SAFE-RH) project was held on December 31, 2022, in Islamia University Bahawalpur (IUB) Baghdad-ul-Jadeed Campus.

The third hybrid plenary meeting of Sensing, Artificial Intelligence and Edge Networking towards Rural Health (SAFE-RH) project was held on December 31, 2022 at SAFE-RH Lab, in Baghdad-ul-Jadeed Campus of IUB. The participants from University of the West of Scotland (UWS) UK and Islamia University Bahawalpur (IUB) were present physically whereas, Capital University of Science and Technology (CUST) and COMSATS University Islamabad (CUI) Wah Campus participated online. It was

a daylong meeting, in which all partners presented progress of their respective pilots to main SAFE-RH coordinator Prof. Dr. Naeem Ramzan from UWS.

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5.3 Demonstration of SAFERH to Software Industries of Pakistan

On January 30, 2024 a delegation of Software Industry from UK and Bahawalpur visited SAFE-RH Lab. They were welcomed by IUB Team Members, Prof. Dr. Dost Muhammad Khan, Prof. Dr. Najia Saher, Dr. Omer Riaz, Mr. Faisal Shahzad and Mr. Muhammad Suleman. Associate Prof. Dr. Malik Muhammad Saad Missen was also present at that occasion. The delegate was introduced about the project and a demo of online MIS and Offline MIS was also given. The delegations' members were keen to foster

academic collaboration, facilitate knowledge exchange, and enhance mutual understanding and cooperation in Artificial intelligence. The delegation comprised of Mr. Hassan Khalid (Founder & CEO Cloudini, UK), Mr. Tauqeer Ahmad (Founder & CEO of Enigmatix, BWP), Mr. Saad Bin Abid (CTO Enigmatix), Mr. Muhammad Nabeel Khan (Head of Global Strategy, Planning and Partnerships-Enigmatix), Mr. Moiz Ali (COO Enigmatix), Ms. Aasma Moiz Ali (CBA Enigmatix) and Mr. Mujahid Rasool (Co-founder WebXmeta).

5.4 Pilots' Deployment/Demonstration in SAFE-RH Lab

The SAFE RH team visit the RHC for the Implementation of its three pilots in SAFERH-LAB and different RHCs of Bahawalpur on Thursday, July 11, 2024.

Remote Maternal Women Monitoring Pilot

Old Home Monitoring Pilot

Remote Infant Monitoring Pilot

5.5 Pilots' Deployment/Demonstration in Different RHCs

5.5.1 Demonstration/Dissemination of Rural Health Centre at Khanqah Sharif

The SAFE RH team visit the RHC for the Implementation of its three pilots in different RHCs on Thursday, July 11, 2024.


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خانقاہ شریف

5.5.2 Demonstration/Dissemination of Rural Health Centre at Khutri Bangla

6 Conclusion

SAFE-RH Technology Lab developed under this project is playing substantial role in health monitoring particularly, in remote rural health. All three pilots are deployed in this lab and the patient's vitals are gathered through Bluetooth based on SAFERH sensing devices. Furthermore, the project is disseminated in medical colleges, nursing colleges, basic health units and rural health centers in rural areas of southern Punjab, Pakistan. In future, this lab will be an AI based medical diagnostic center.

Annexure

Equipment's in SAFE-RH Technology Lab

The following are the Equipment's of SAFE-RH Lab enlisted in Table 1.

Table 1: SAFE-RH Technology Lab Equipment

Sr. #	Name	Description	Quantity
1.	Andesfit IOT medical equipment.	ADF-MSA100 → Wireless Spirometer (04), ADF-B180 → Upper Arm Electronic Blood Pressure Monitor (01), ADF-103W → Wireless Blood Pressure Monitor (04), ADF-B05 → Wireless Pulse Oximeter (04), ADF-B27 → Wireless Blood Glucose Monitor (04), ADF-B33A → Wireless Non-Contact Infrared Body/Surface Thermometer (04), ADF-B34 → Wireless Infrared Ear/Forehead Thermometer (04), ADF-B885T → ITO Wireless Body Fat Scale (01), ADF-B883 → Wireless BMI Scale (04), ADF-PM10 → Portable ECG Monitor (03)	04 Sets
2.	Desktop PC	These are provided by IUB and used for software and firmware development and testing.	05
3.	Laptop	These are used for data entry and dissemination activities.	04
4.	Printer	Canon LBP6000	01
5.	Projector	Provided by IUB	01
6.	Thermometer	MicroLife FR1MF1	01
7.	BP Monitor	Beurer M28 to verify wrist band results	01
8.	SpO2 Monitor	Beurer PO30 to verify O2 saturation	01

9.	Hardware	Components required for developing Patch. (Esp32 WEMOS, DHT22, MAX30102, Max 30205, KY013 etc.)	
Remote Maternal Women Monitoring Pilot			
10	Gluco Monitor	Dusun	2
11	Blood Pressure	Dusun BIOLIGHT	2
12	Pulse Oximeter	Dusun Jumper JPD-500G	2
13	Smart Watch	Dusun Sensing247	2
14	Weight Scale	Dusun Jumper JPD=BS300	2
15	Smart Gateway	Dusun Smart Gateway DSGW-021	1
16	Maternity Belt	COMSATS in house development (belt + raspberry pi)	1 set
17	Fetal doppler	Portable light weight fetal heart rate monitor	1
Old Homes Monitoring Pilot			
18.	L-Serial Smart Gateway	WI-FI+BLE5.0 support available and it will send data through MQTT protocol	2
19.	Smart Watch	Send data through Bluetooth Low Energy (BLE)	2
20.	Samsung Watch 6	To get the heart rate, temperature, ECG, Accelerometer and Gyroscope data from sensors through Wi-Fi.	2
21.	Pulse Oximeter	To get Fingertip Pulse and Oximeter data through BLE	2
22.	Blood Glucometer	To get the blood glucose data through BLE	2
22.	BP Monitor	To get the systolic and diastolic data through BLE	2
23.	Weight Monitor	To get the Weight data through BLE	2
24.	ESP32 Micro Controller	Used to receive data from pi perform operations and send signal to relay	2
25.	Single Channel Relay	Used to receive data from ESP32 and perform the action according to signals received.	2
26.	PIR Motion Sensor	Detect Motion and send signals and sends signal to gateway.	2

27.	Temperature and Humidity Sensor	Detect temperature and humidity and sends signal to gateway.	2
28.	Environmental Gateway	Receive data from sensors and send to raspberry Pi.	2