Inter-IIT Techmeet 10.0

Silicon Labs' Social Entrepreneurship Challenge

Team ID 10

BRAHMA

Biometric Rapid Automatic Health Monitoring Assistant

Contents

Abstract

Holistic biometric-monitoring is an ever-present, time-sensitive issue that all healthcare systems must grapple with. Sudden deterioration in the condition of patients can often result in serious and irreversible injury, or even worse, death. Health outcomes are improved when the appropriate medical attention is provided to a patient. Therefore, increasing the efficiency of health monitoring of the patients and decreasing the response-time in the hospitals, allowing the doctors and nurses to provide them better healthcare, is of paramount concern. It is a fairly common practice to observe patients who require intensive care. On the other hand, for general ward patients, the readings are taken over considerably long intervals that induce a risk-factor to the patients. Enabling an IoT-based system to continuously check vital parameters like heart rate, breathing, oxygen levels, etc. of a patient will help in early detection of deterioration of patient's health and will give more time to the doctors and the medical staff to respond and take appropriate steps. When the workforce of the hospital is notified about an emergency, this device will make sure that the other patients are not left unattended as it will continue to measure their vital parameters. With continuous monitoring, it can be assured that the patient gets attention at the right time, improving the healthcare quality and preventing deaths. Continuous monitoring also helps the mental state of the patients as they will be assured of their safety since vitals are being monitored all the time.

1 Problem Identification

India is a densely populated country with an underdeveloped healthcare system that is currently unable to serve the current needs of the masses. Currently, our medical infrastructure is not strong enough to constantly monitor the sick. There exists an insufficiency of the nursing staff and those available are greatly overworked. The medical staff has to prioritize patients based on their condition. Sometimes patients are also prioritized based on personal bias and their status in society. Hence, many patients are unable to get timely care which can lead to deterioration of their condition, serious problems and in some cases even death.

Numerous such cases occur every day and filling this loophole in the current structure has the potential to save thousands of lives daily. Another example of this lack of monitoring is the ongoing pandemic in which many people lost their loved ones due to a shortage of healthcare monitoring.

2 Extent of the Problem

According to ICM (Intensive Care Medicine) 55, a medical journal covering intensive care or critical care and emergency medicine, a greater percentage of patients from the general wards (47.6%) died than from Operation Room (19.3%) and Emergency Department (31.5%)[1]. The patients from the general wards had a greater number of serious antecedents before admission to intensive care (72%) than those from OR 150 (64.4%) or ED 126 (61.8%). Also, almost three-quarters of patients from the general wards had at least one potentially life-threatening antecedent factor during the 8 hours before admission to the ICU. A large proportion of patients from OR (64%) and ED (62%) also had at least one of these factors present.

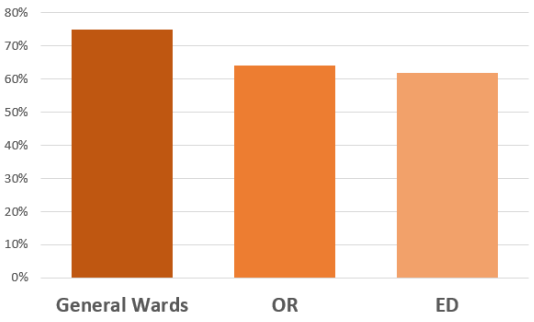


Figure 1: Percent of patients who had at least one potentially life-threatening antecedent factor during the 8h before admission to the ICU

According to the AJN (American Journal of Nursing), continuous physiological monitoring improves patient outcomes [2].This study conducted presents a survey, the results of which state that **74%** of the nurses were satisfied with the use of continuous monitoring devices and **97%** of patient deterioration events were recognized and treated as a result of this continuous monitoring and response system.

According to [3], heavy workload of hospital nurses is a major problem for the health care system. Nurses are experiencing higher workloads than ever. India needs to add more than 4.3 million nurses by

2024 to meet the prescribed WHO norms. India has over three million registered nurses and midwives who are responsible for the country's 1.3 billion population, which is grossly inadequate. This is less than the WHO norm of three nurses per 1,000 people. The optimum nurse-patient ratio recommended by the Centre and the Indian Nursing Council (INC) has not been implemented and as a result, one nurse is looking after 20 to 30 patients. It is adversely impacting the credibility of India's healthcare system [4]. According to the corresponding research [5] and Systems Engineering Initiative for Patient Safety (SEIPS) model of work system and patient safety shows that a heavy nursing workload adversely affects patient safety [6; 7]. A heavy workload may also reduce the time spent by nurses collaborating and communicating with physicians, therefore affecting the quality of nurse-physician collaboration. It also leads to poor nurse-patient communication.[8; 9; 10]

According to the study made by a scholar of Journal of Marine Medical Society on nurse-to-patients ratio, they have found that the nurse-to-patients ratio was 1:10 [11] where the recommended ratio is 1:3.

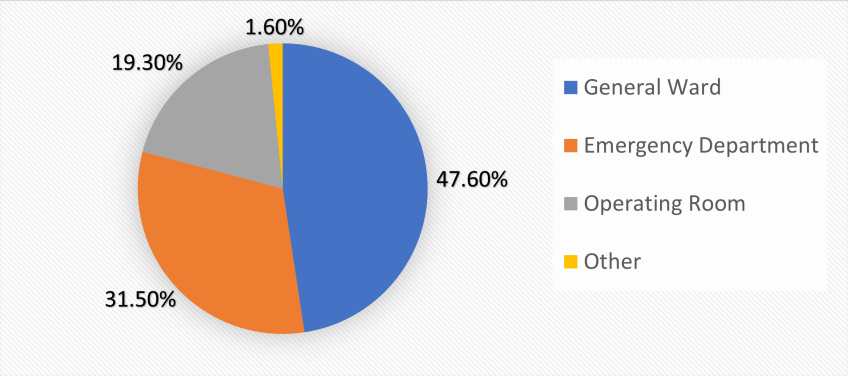


Figure 2: Percentage of Death in different wards

Mechanisms	**Description**	**Examples**
Time	Nurses who have a heavy workload may not have sufficient time to perform tasks safely, apply safe practices, or monitor patients, and may reduce their communication with physicians and other providers.	No or little time to double-check medications
Motivation	Nurses who have a heavy workload may be dissatisfied with their job, thus affecting their motivation for high-quality performance.	No or little motivation and commitment to high levels of performance High workload creating frustration and contributing to the development of negative attitude toward one's job.
Stress and burnout	Nurses who have a heavy workload may experience stress and burnout, which can have a negative impact on their performance.	Reduced physical and cognitive resources available for nurses to perform adequately
Errors in decisionmaking (attention)	High cognitive workload (one dimension of nursing workload) can contribute to errors, such as slips and lapses or mistakes	Forgetting to administer medications
Violations or work-arounds	High workload conditions may make it more difficult for nurses to follow rules and guidelines, thus compromising the quality and safety of patient care.	Inadequate hand washing

Table 1: Relationship Between Nursing Workload and Patient Safety[3]

3 Current Approaches to the Problem

Hospitals generally adopt a policy wherein utmost care and monitoring is done in Intensive Care Units (ICUs), but there is a significant deficit of nurses and doctors in the general wards. In the current scenario, nurses measure various vital parameters after about 4-6 hours, leading to delayed identification of the morbidity. The idea of hiring more staff is unrealistic due to financial constraints as well as due to severe nation-wide shortage of nurses in India. [4]

Presently, for homecare, some companies like Portea Medical provide in-home medical care in India, including geriatric care, post-operative care, palliative care, and physiotherapy. But this facility is very costly and only affordable to a small segment of the nation's population.

4 Our Solution

To tackle this problem, we propose an automated health monitoring system - Biometric Rapid Automatic Health Monitoring Assistant or "BRAHMA". It efficiently tackles the issue of the shortage of medical staff in India. The BRAHMA will take readings of vital parameters from a particular patient and send these to a cloud, where a risk score will be calculated. This score, along with the sensor readings, will be sent to the relevant medical staff. The doctor can also set up automated alerts on a case-to-case basis through an app. This data will be encrypted and will be accessible only to those concerned. They can access it by logging on to the app. The cloud, as mentioned earlier, will also store all this data privately for future use as a dataset for more advanced applications such as the prediction of whether a patient requires an Intensive Care Unit or not in the near future using health metrics.

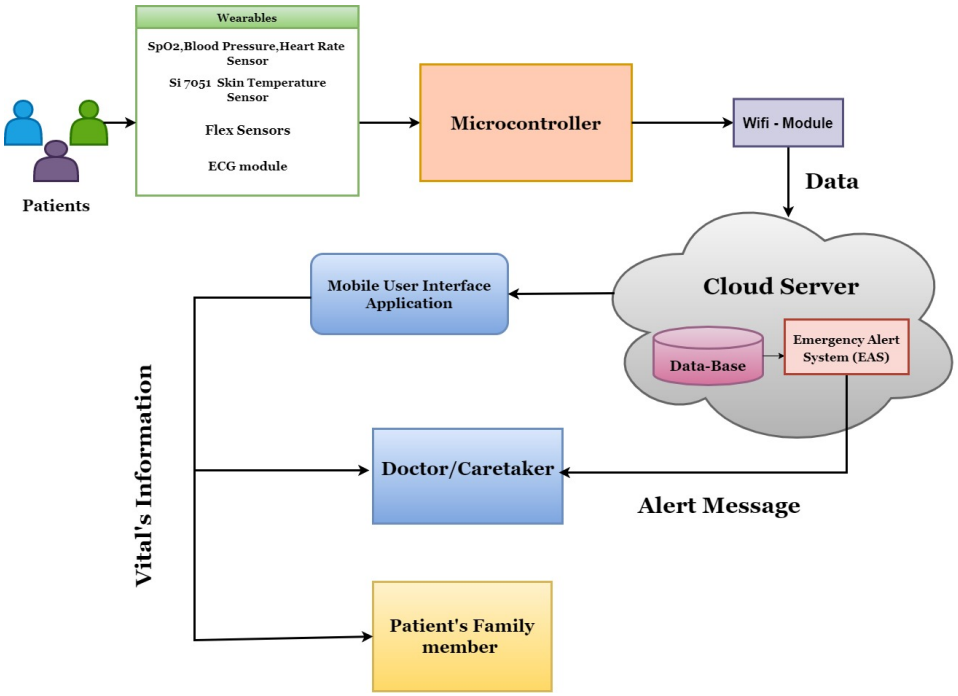


Figure 3: The data acquired from integrated sensors, is sent to a microcontroller.TThe data is then stored on the data-base in the cloud server through Wifi module attached to the microcontroller. The collected data in the Data-Base will generate the alert message accordingly as per the vital analysis through Emergency Alert System present in the IoT Server, where the message will be sent to the available doctors and caretakers. Moreover the information about the vitals is being shared and displayed through Mobile Applications. The Doctors/caretaker and Patient will enter their login information to see past reports and current vital state.

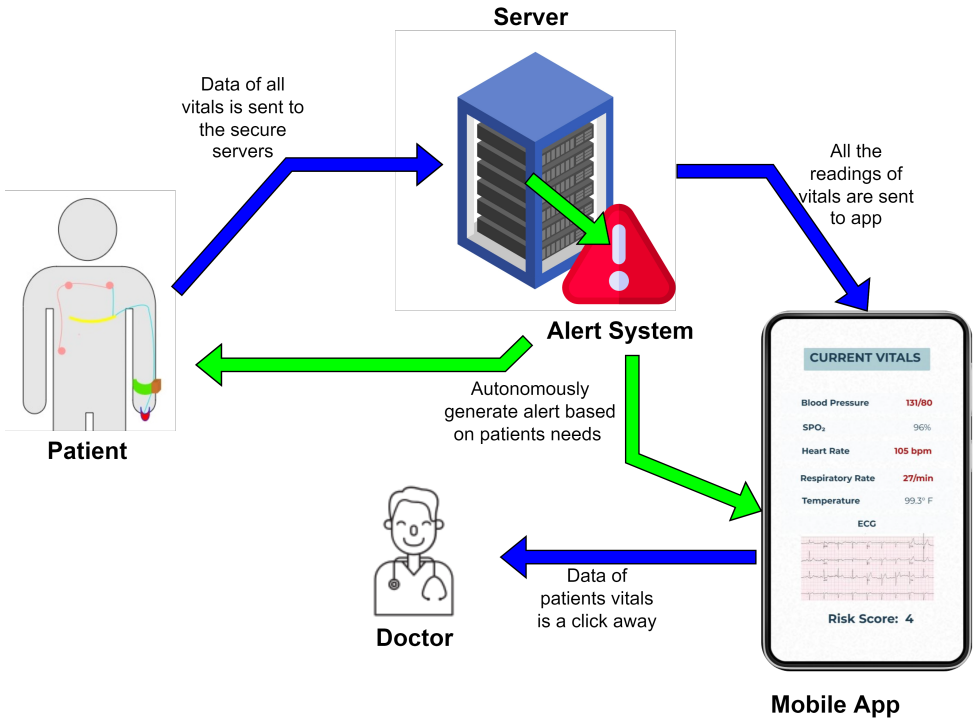


Figure 4: Our device which consists of 4 different sensors to measure 6 important vitals is put on by the patient. The data from all the sensors is sent to our secure servers. The readings of the necessary vitals are then sent to an app from the servers which can be accessed by the doctors and the necessary medical staff. There also exists an alert system which notifies the doctors and the other obligatory medical staff about any emergency which may come up.

5 Design

5.1 Electrical Components

BRAHMA monitors six vitals for which we used various sensors available in market. We use MAX32664D to monitor SpO_2, Pulse rate, Blood pressure (cNIBP) and placed it on the tip of finger. To monitor heart waves we use 3 electrode ECG and connect it to a central system ADA8232. We derived all the ECG data through them. We applied flex sensor near right chest cavity to monitor respiratory rate of the patient. As the average error value of the module for placement of the sensor position in the right chest cavity is 6.6%, in the left chest 6.85% and in the middle chest cavity 7.92%. The average error value for all positions has a value that is still below the maximum Respiration Rate reading threshold of 10%. We use Arduino Nano as the microcontroller to connect all the sensor modules and use the ESP8266 WiFi module to send data to the central server. Skin temperature sensor is placed at the base of central box to observe temperature.

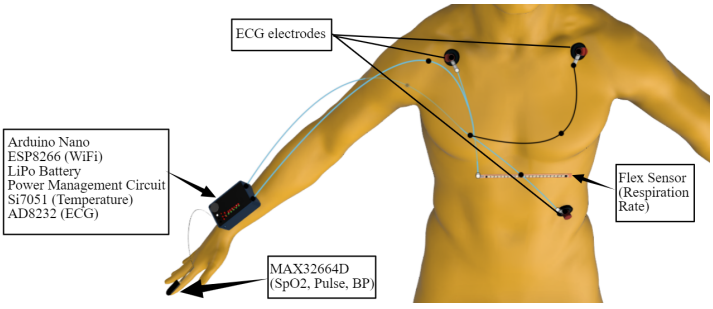


Figure 5: Percent of patients who had at least one potentially life-threatening antecedent factor during the 8h before admission to the ICU

5.2 Encapsulating Components

The core of BRAHMA lies within the central box attached at the wrist with a strap.

5.2.1 Central Box

The central box of the device is designed to hold the following components: Arduino nano, ESP8266 WiFi Module, LiPo Battery, battery management circuit, Temperature sensor. All these modules are internally connected and external ports are provided for connecting the remaining sensors with the microprocessor. It has 3 ports to connect all the sensors to arduino nano: charging port, ECG and Flex sensor connection. It is designed to be spill proof to ensure safety of the patient in any condition and unrestricted monitoring of the vitals throughout its working. The central box is 3D printed for our first prototype according to the dimensions to perfectly fit all the modules.

There are LEDs on the top panel to show: On/Off, Wifi Connectivity, Sensor breakdown alert, Critical situation alert. It will get attached to the patient wrist via Wrist strap using clip mechanism.

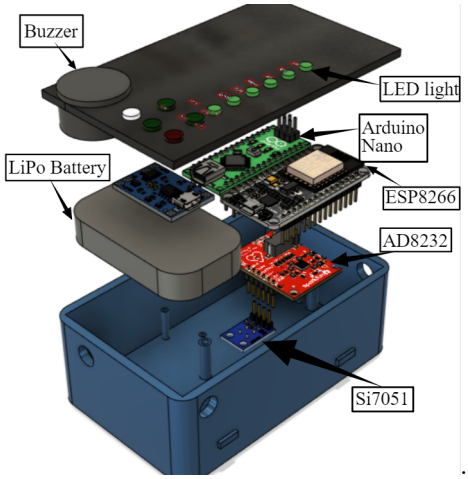
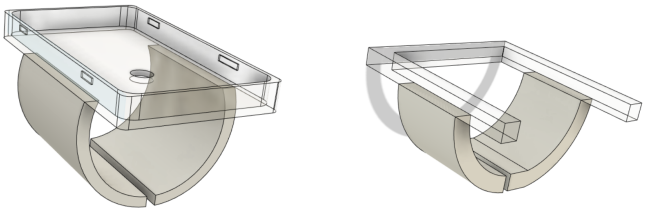


Figure 6: Wrist case

5.2.2 Straps

The material used for making the straps is Polyvinylidene fluoride (PVDF). These straps will be comfortable even if it is worn for a long time. The flex sensor will be attached using a health strap.



((a)) Wrist strap ((b)) Finger strap

Figure 7: Straps

6 Prototype

6.1 Operation of Device

- **Procedure**
  The device essentially consists of four modules. A strap that has to be worn on the wrist, a wrap to cover the finger and electrode to be placed on the surface of the chest. Wires connect various modules together. The device is normally powered using wall outlet, but for emergency cases there is a LiPo battery for backup that can power the device for 3+ hours. Vitals measured by the various sensors are then sent to the cloud which can be viewed on the app by those concerned.

- **Reusability**
  After replacing some components, BRAHMA will be ready for use on another patient. There are four points of contact with human skin in BRAHMA.

  1. Wrist wrap of central box
  2. Finger wrap of MAX32664D
  3. Three electrodes of ECG
  4. Flex sensor's patch

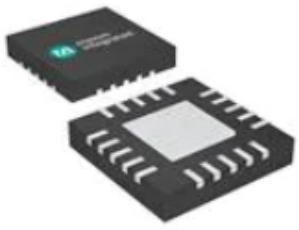
  After each use either these components are replaced or thoroughly cleansed with alcohol to ensure maximum protection. The wrist wrap and finger wrap will be cleaned with alcohol, all the electrodes of ECG will be replaced, the disposable part of the flex sensor's health patch will be replaced.

6.2 Components

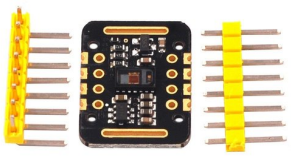
6.2.1 Hardware

The BRAHMA monitors the patient with the device integrated with the following vital measuring sensors:

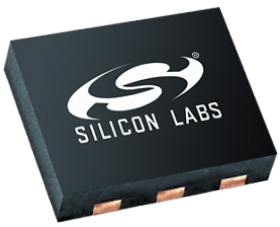
- **SpO_2, Pulse and Blood Pressure Sensor**
  SpO_2, also known as oxygen saturation, measures the amount of oxygen-carrying haemoglobin in the blood. Pulse is the number of times the heart beats in a minute. Blood Pressure (BP) is the force of blood pressing against the artery's walls. We have used the MAX32664 Version D sensor to measure these three parameters along with MAX30101/MAX30102. This sensor measures parameters from the surface of the finger and is a part of the wrap that covers the finger.



((a)) MAX32664 Sensor



((b)) MAX30102 Sensor

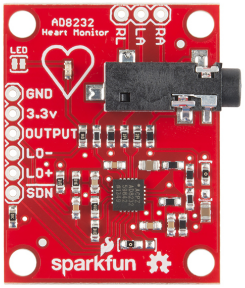


((c)) Si7051 Sensor

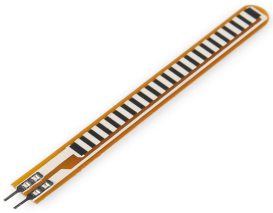
- **Skin Temperature**
  The Si7051 Digital Temperature Sensor offers industry-leading, low-power consumption, a maximum accuracy of ±0.1 °C within human body temperature range of 35.8 °C to 41 °C.

- **ECG Module**
  ECG (electrocardiography) is a test to check the heart's electrical activity. The AD8232 sensor has been used to monitor ECG data. It's made to extract, amplify, and filter tiny bio-potential

signals in noisy environments like those caused by mobility or remote electrode placement. For proper functionality AD8232 sensor includes a two-pole high-pass filter, uncommitted operational amplifier, and a fast restore function.



((a)) AD8232 Sensor



((b)) Flex sensor

((c)) ESP32 Module

- **Flex sensor**

  A flex sensor or bend sensor is a sensor that measures the amount of deflection or bending. It is connected near the chest to bend as the person breathes. The bending of the flex sensor changes its resistance which can be used to detect breathing rate and patterns.

- **WiFi module (ESP32)**

  The ESP32 chip has many functions in the field of IoT. The module enables WiFi and Bluetooth connectivity to embedded devices for data sharing. It also enables data processing from analog and digital sensors. It is used in smart security systems such as surveillance cameras and in smart medical devices such as health monitors.

The SPO_2, Pulse and Blood Pressure sensor measure the vitals from the fingertip. The ECG Module and the Flex sensor (calibrated to show respiration data) measures the necessary vitals near the chest. The wristband contains buzzer (rings an alarm for notifying nearby nurses for a quicker attention), WiFi module (needed for transferring all the measured data to the cloud).

6.2.2 Software

Once the data collected by the sensors is sent to the cloud, it is converted to the appropriate format before it can be viewed on the application by the medical staff. Our software will calculate a "**Risk Score**" after taking in the sensor readings and make it accessible for the concerned doctors, nursing staff, and the family members of the patients. An alert notification will be generated if the Risk Score is high (>=4) and the patient needs to be taken care of urgently. The bounds on the metrics taken by the sensor that will elicit different risk scores are tabulated in table 2. Table 3 shows the corresponding status for different risk scores.

Table 2: Risk scores

Risk scores →	3	2	1	0	1	2	3
SPO2	<91	92-93	94-95	>96			
BP	<70	71-80	81-100	101-199		>200	
HR		<40	41-50	51-100	101-110	111-129	>130
RR		<9		9-14	15-20	21-29	>30
Temp		<35		35-35.4		>38.5	

Table 3: Status

Total score	Status
0 - 3	Normal
4	At Risk
>4	Alert

6.2.3 UI of app

The BRAHMA app prompts the user to enter the User ID and password when opened. The user is directed to the Patient profile on entering the Patient ID. On logging in, the Doctor/Nurse can see the list of all the patients allotted to them along with their status. Further, the Doctor can view any of their patients' profiles and current vitals. The application also provides past details of the vitals in a constantly updating chart. BRAHMA will predict a risk score based on all the vitals and their deviation from regular. A high Risk-Score will alert the Doctors and Nurses with a push notification on their smartphones.

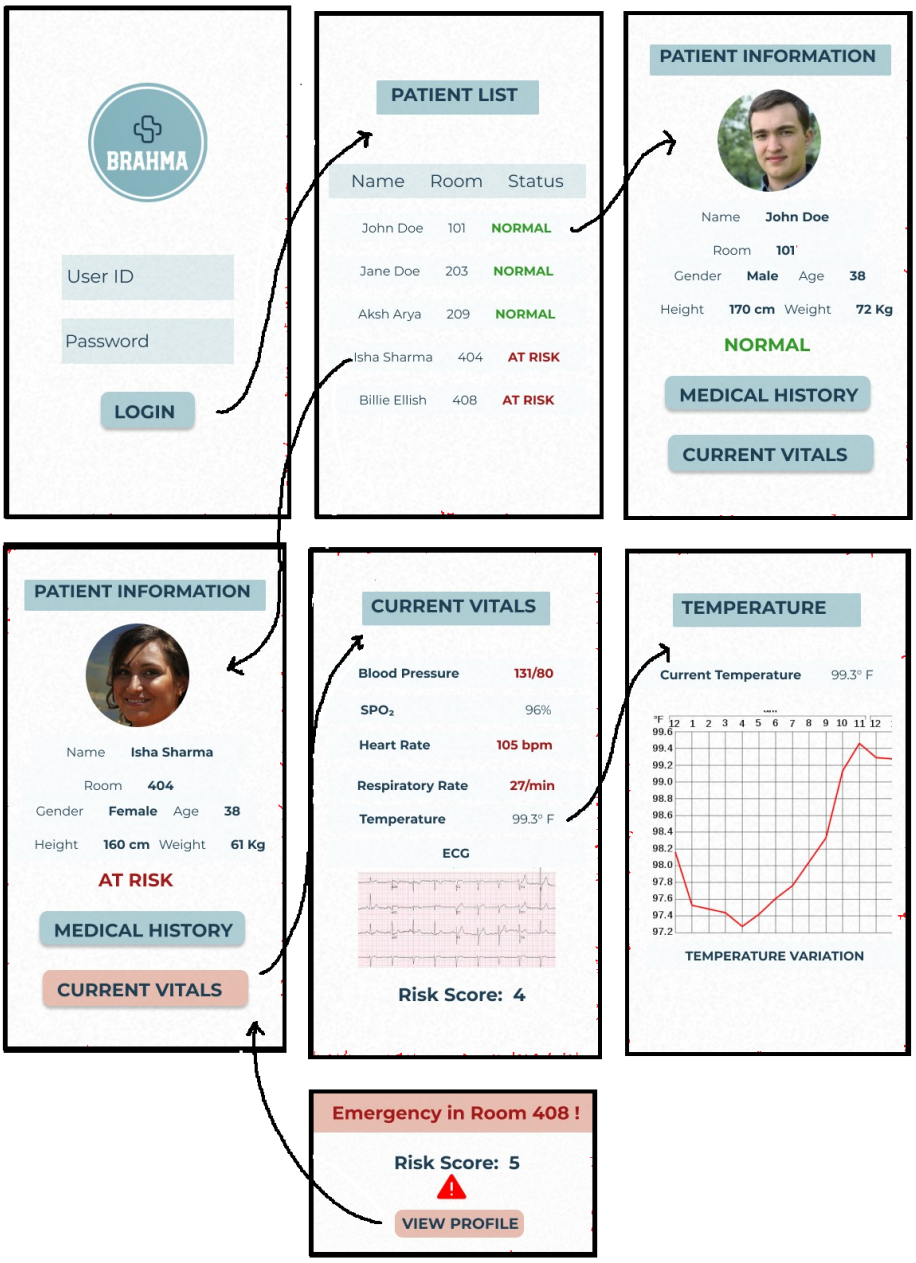


Figure 8: Mobile app workflow

7 Features

7.1 Fail Proofs

Since this device is intended to be used in the healthcare industry where a small mistake can prove to be very costly for a patient, it is very important to have safeguards in place in case any of the systems fail to operate flawlessly.
There is a buzzer and LED module, both of which are turned on in the following cases:

- **Sensor malfunction**
  If any of the sensors used becomes faulty, alerts are shown on the device and the BRAHMA mobile application. Also, using Machine Learning (via Unsupervised Anomaly Detection), we can detect and flag data abnormalities due to sensor malfunction and hence improve overall accuracy.

- **Internet connection is lost**
  On losing internet connection, the device shows an alert. A warning is also shown on the BRAHMA mobile application. The data is stored on the local database on the device and will be uploaded to the remote database as soon as the internet is restored.

- **Battery Warning**
  The device will primarily run on the power outlets present in the patient's vicinity. In addition to this, we have equipped it with a LiPo battery in case there is a power cut in that area or the patient needs to be shifted to a different room. In extreme cases, the battery might drain out, then a warning will be generated, which will be sent to the app. Thus, we can quickly get alerted as soon as the battery is about to die.

7.2 Data Privacy Mechanism

Data security and privacy are more important in healthcare than in almost any other field. Patients' health data may be held by various medical organizations, such as hospitals and clinics. All users, including patients, medicare experts, healthcare staff, and medical staff, must be able to request patients' health records within the medical care information system.

We will use end-to-end encryption (E2EE) to maintain privacy of the patient's health data. The RSA algorithm will be used for E2EE and AES256 will be used to encrypt the data on the server. The health data will then be stored in a blockchain to make it immutable. We will use light-weight operations, such as the hash function and chaotic mapping technique, to increase computational efficiency. If a doctor wants to access the patient's health data then the encrypted data stored in the blockchain will be accessed and then decrypted to get the patient's health data. This mechanism will ensure that patient's data will be safe and secure. [12]

While training our machine learning models, we will employ techniques like federated machine learning to ensure privacy of the patient's health data.

7.3 Early Prediction of deterioration of patient's condition

We use machine learning for predicting deterioration in the condition of patients. Based on the previous Electronic Health Records (EHR's) of the patients, the model takes in a dataset of the patient's vital signs over a period of time as input and predicts the patient's condition in the near future. The data can be further analyzed for preempting if the vitals can be critical and hence will alarm the patient beforehand. This way, we intend to implement an Early Warning System (EWS) that would effectively warn the patients of any complications they might face, and hence they could take relevant precautions.

As quoted in the monograph [13], the developed artificial intelligence based on deep-learning, early warning system accurately prognosticated degradation of patients in a general ward and outperformed conventional techniques. It shows the potential and effectiveness of artificial intelligence in a rapid response system, which can be applied together with electronic health records.

We intend to use the DEWS architecture includes three bidirectional recurrent neural networks (RNN) layers with a long short-term memory unit, four fully connected layers with a rectified linear unit, and the Softmax layer at the end to output a score between 0 and 1; the risk score is obtained by multiplying

the Softmax output by a proportional unit. Before passing the RNN output to the fully connected layer, we can use the output of the last step only. An Adam optimizer can be used to train the DEWS with default parameters and binary cross-entropy as a loss function.

In the next stage, after we have collected sufficient labeled data, we will be able to replicate the results and achieve an early warning detection system through which we can predict deterioration of patients health.

8 Business model

Our solution eyes Hospitals/Clinics as its target market segment. Our business model aims to generate recurring revenues so that the organization is financially stable and can reach out to as many number of hospitals and people as possible. We are using a fee-for-service business model.

- **Customers**: The customer base of the product mainly includes various hospitals and clinics who would be benefiting from BRAHMA.
- **Partners**:
  - Our key partners include multi-speciality hospital chains who will buy our product for each of their hospitals and in turn we will provide them a certain concession on each device bought.
  - We will also pitch our product to the government, which can then integrate our system with their newly launched **National Health Card Plan** as a part of **ABHA** (Ayushman Bharat Health Account) Plan.
    - Presently, hospitals that are linked to National Health Card Plan upload patient reports as diagnosed by their doctors. The government servers then facilitate data exchange among different hospitals.
    - Since every doctor's perception of a patient's condition is subjective, it will be very beneficial if the raw data of vitals could be transferred to the other hospital so that the new doctor can see the crude data of the patient and then diagnose them.
    - BRAHMA will work hand in hand with National Health Card scheme and raw data will also be transferred with patient's consent.
- **Government subsidy**: The yearly registration fee that we charge from each patient can be subsidized by the government for patients below poverty line. This would ensure that no one is denied this facility due to income barriers and thus promote social welfare. At the same time, subsidization would lead to our product being used by more number of patients and thus increasing the profits.

8.1 Cost Structure

- **Device Cost Analysis**

Part	**Price**
MAX32664D+ IC	₹ 310
MAX30102	₹ 100
ECG Module - AD8232	₹ 549
ECG Electrodes	₹ 30
Temperature sensor - SI7051	₹ 533
Flex Sensor	₹ 200
Buzzer	₹ 69
ESP32 WiFi Module	₹ 100
Arduino Nano	₹ 385
2-cell Li-Po Battery	₹ 99
Manufacturing Cost	₹ 500
TOTAL	**₹ 2,875**

We could further reduce the hardware costs by suitably choosing hardware supplier and giving bulk orders.

- **Cloud Service subscription** - AWS cloud - ₹ 2.58 (per device per month)

8.2 Revenue Model

We propose to provide this solution to hospitals on a service-based model. There would be a minimal one time fee to acquire the device in addition to which there shall be a monthly recurring charge for the service. The monthly recurring charge would be collected per device. Additionally, each patient would be charged a yearly fee to maintain their data on the server. The charges are as follows :

One time fee	₹ 2000
Monthly Subscription fee	₹ 500
Patient yearly registration fee	₹ 50

8.3 Stakeholder Analysis

Our solution will have a direct impact on the four major groups of people the patients, the doctors, the nursing staff and the hospitals

- **Hospitals**
  The hospitals can now make sure that deaths due to improper monitoring can be reduced from their side by using this device for continuous monitoring of patient's health. This will also help in reducing liability issues caused by human negligence.
- **Nursing staff**
  Nurses' workload will be reduced by BRAHMA because they will no longer be required to check on all patients on a frequent basis.
- **Patients and their family**
  Patients' health will now be monitored and discussed with their family on a regular basis.
- **Remote patients**
  Patients who are admitted to the hospital but are at home should rest certain that their vital signs are being closely checked.

8.4 Marketing Strategy

We have devised the following marketing strategy to spread awareness about BRAHMA.

- **Seminars**
  We will be conducting seminars targeted towards doctors and medical professionals. This would be helpful in increasing the reach and awareness regarding BRAHMA in the medical community.
- **Healthcare innovation expos**
  We will be showcasing our product in several healthcare innovation symposium and expos to make the public and medical professionals aware about our product that would be beneficial in increasing the scalability.
- **Hospital visits**
  The first part will be to go to the higher-end hospitals and prove the effectiveness of our product. We will be able to demonstrate the usefulness of our product and show how our product is not only helpful in keeping better and constant care of patients but also reducing the workload of work staff. The positive results from these hospitals will encourage the medium or lower-level hospitals to invest in the product as our product is affordable to most patients and saves the hospital resources as well.

- **Advertisement via Partner Hospitals**
  Partner Multi-speciality Hospitals will also advertise BRAHMA as Hospitals availing our services will attract more customers by advertising continuous monitoring of the patients.

8.5 Why hospitals will buy our product

A major objective of a hospital is to provide good quality health-care system to its patients along with earning profit. Our product aligns itself with both these objectives:

- The utilities provided by BRAHMA will help monitor vitals and predict deterioration of patient's condition and will provide patient's details to doctors on a easy-to-use user friendly app.
- Patients and their families will also prefer hospitals which advertise continuous monitoring, and so this will also increase the profit of hospitals.
- Our App will also show the patients the list of hospitals that are connected to our organization which will directly affect the choice of patient while choosing the hospital for his/her treatment. Hence, more hospitals would like to buy our services to increase their number of patients.

8.6 KPI/Success Metrics

- **Number of subscriptions and products sold**
  To measure the total number of patients using the product and to get an idea about the influence and spread of the product within hospitals.
- **Ratio of subscription renewals to total products sold**
  It will be a direct measure of customer retention and measure of patient trust in the product.
- **Ratio of products sold to total number of beds occupied in general ward of each hospital**
  The Higher this ratio, higher the hospital depends on our product to facilitate its patients. It will be a direct measurement of hospital trust in the product.

9 Social Impact

We provide a solution to the shortage of workforce in health-care services. It instills a sense of safety as the patient is monitored at all times. The prototype is user-friendly in terms of use; thus serving a lot of unprivileged hospitals who are deprived of nurses, midwives and nursing assistants.
People who will be affected by BRAHMA are :

- **Doctors, nurses and related hospital staff**
  BRAHMA is reducing the workload of nurses and related hospital staff as they will no longer be required to check on all the patients regularly. They will focus on more pressing issues (such as assisting doctors and paying attention to patients that require human assistance). Therefore, it will help in overall hospital management and improve efficiency.
- **Patients and their family**
  The health of patients will now be constantly monitored and will also be shared with their family members. It prevents any delay in sensing the sudden deterioration of patients and their family members are also convinced about the well being of patients all the time, leading to a better hospital experience.
- **Remote patients and patients who are unable to access hospitals**
  Patients who are admitted at home can be assured that their vitals are constantly monitored and help will be called automatically in case of some emergency. It will also help in spreading medical aid to remote places where the patients can not be admitted in full-fledged hospitals.

10 Other Focus Areas

Along with hospitals and clinics, we can expand our domain to target Care homes for the elderly, differently-abled, etc. Care homes providing and advertising continuous monitoring of vitals will help attract and reassure people and their families that the person is being cared for. We can also approach NGOs focusing on medical care, the differently-abled and the elderly to improve the overall well-being and quality of life.

11 Future Prospects

We would be using an output module as an app, which serves as the medium to provide the patient with his detailed preliminary diagnostic report received from the doctor, based on the data recorded. The data of the patient's vitals will be analyzed using an integrated input module, where it will be sent to the machine learning model to give a detailed early vital analysis to the patient.

In future, we can develop early warning systems of particular disease that can occur through detailed data analysis of vital data being collected, which can be implemented from highly advanced Machine Learning algorithms. Mostly, we have doctors to give their reviews which are based on any data recorded, but once the model starts giving sufficiently accurate predictions, we can replace the doctor's reviews with the predictions made by the model in cases where we need a quick review, or sufficient doctors are not available. Moreover, it also allows patients to keep a digital record of their medical treatment.

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