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# IoT based Smart Healthcare Band

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**Abstract**

***IoT in healthcare enables information exchange, machine-to-machine communication, and data movement that make healthcare service delivery effective. Real-time health monitoring via health care bands helps us to monitor health continuously and alerts us in case of emergencies. Smart healthcare bands enable self-monitoring of physical activity, vitals and fitness metrics. These bands are powered by IOT technologies which captures various vital body signals like body temperature, heart rate, blood pressure, ECG data, humidity, emotional content, and location of the person using sensors and internet connectivity. These systems communicate with the user, doctor and medical officers or guardian over a mobile or web application. Doctors can prescribe actions or medication to help the patient maintain health and handle emergencies. In view of the current corona pandemic, doctors can use these health-bands to quarantine and diagnose the covid-19 symptoms remotely.***

***Keywords— Arduino, IoT, Smart Healthcare Band, sensors.***

## I. INTRODUCTION

In recent times self-monitoring is essential to continuously monitor the overall health. Smart healthcare bands help us to monitor the key vitals of the person and alert in case of emergency. The overall health is tracked based on the vital signs and action is suggested accordingly. To enable the collection of vital signs from patients and to be conveyed to a prime location, some medical monitoring systems have already been developed, which helps the doctors to monitor multiple patients in different areas simultaneously. However, many of such prior systems have not authorized the monitored patients to move outside the Hospital. So, here the smart health care band helps us to monitor the patient continuously remotely. This data will be stored and updated in the mobile or web application.

### *A. Related Work*

In the year 2017, Siddharth Sathe, Arjun Gade and Ajay Jadhev, "Arduino Based Smart Watch," the paper focuses on building a smart watch which not only shows watch but also monitors heart rate at a much cheaper price. The user interface of this smart watch is very simple to use. It also alerts call, SMS and e-mail notifications by using vibration motor present in the smart watch. It is powered by a 1000 mah Lithium-ion rechargeable battery. It also has the heart rate sensor which measures the heartbeat of a person. Various data from the Arduino microcontroller is communicated to the mobile using HC-06 Bluetooth module. They made a watch at a minimum cost which monitors the heart rate of the person and also displays time and notifications from apps like e-mail, SMS etc. [2]

In the year 2015, Magnus Bang, Katarina Solnevik and Henrik Eriksson, "The Nurse Watch: Design and Evaluation of a Smart Watch Application with Vital Sign Monitoring and Checklist Reminders," this paper

developed a smart-watch system in close collaboration with the team of nurses working in a Swedich ICU. This smart-watch system enables the features like vitals monitoring, to-do reminders and threshold alarms. This system also provides overviews of completed and upcoming tasks. This system is used by the ICU nurses and basic function of this system to provide us the set of issues related to remainders and checklists. This system improves the patient awareness at ICU. [3]

In the year 2018, Matin Kheirkhahan and 8 others, "A Smartwatch-Based Framework for Real-Time and Online Assessment and Mobility Monitoring", this paper focuses on building the smartwatch-based framework for real-time and online assessment and mobile monitoring (ROAMM). This ROAMM framework will include a smartwatch application and server. The smart watch application is used to collect the data and process the data and the server will store and retrieve data for administrative purposes. With the help of collected data from the users, the ROAMM framework allows for data visualization and summary statistics in real-time. [4]

## II. HARDWARE DESCRIPTION

### *A. Arduino*

Arduino Nano is a microcontroller board; it is one of the smallest boards designed by Aduino.cc. Arduino Nano uses Atmega328 microcontroller, which is similar to the one used in Arduino UNO. It has different applications because of its small size and flexibility. Size matters a lot in Embedded as well. Embedded devices are preferred to be smaller in size. Arduino Nano is in-built with a crystal oscillator of frequency 16 MHz It is used for producing a clock of precise frequency using constant voltage. The one limitation present in Arduino Nano, i.e., it doesn't come with D.C. power jack means you cannot give external power source through a battery. [5]

*fig-1 – Arduino UNO*

*a) Features*

- The operating voltage is 5 volts.
- The recommended input voltage will range from 7V to 12V.
- Digital input/output pins are 14, and analog input pins are 6.
- Flash memory is 32 K.B.
- Clock Speed is 16 MHz.

### *B. Block Diagram*

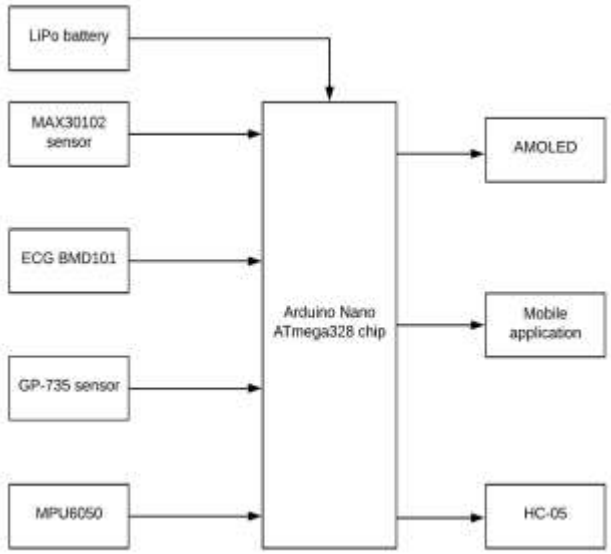


*fig-2 – Block Diagram of the prototype*

Arduino is powered by LiPo battery. The different sensors connected to Arduino are MAX30102, ECG BMD101, GP-735 sensor and MPU6050 sensor. These sensors measure vital body signs such as body temperature, heart rate, ECG, Blood Pressure and SpO2. It can also give data of user location. The AMOLED screen is used to show measured body vitals. Bluetooth module sends the data collected from the various sensors and communicates that data to the mobile application and web interface.

### *C. Sensors*

a) MAX30102 sensor

The sensor named MAX30102 is used for measuring heart rate and SpO2. The MAX30102 is in-built with pulse oximetry and heart-rate monitor biosensor module. It includes internal LEDs, photodetectors, optical elements, and low-noise electronics with ambient light rejection. The MAX30102 is operated at 5V and can communicate with both 3.3V and 5V microcontrollers. It uses the I2C interface. When a finger is kept on the sensor, red and infrared lights

are passed. Based on the ratio of absorption of both the rays, the oxygen level is measured. It can calculate heart rate by analyzing the time series response of the reflected red and infrared light.[18]


*fig-3.1 –MAX30102 sensor*

*b) GP-735 sensor*

The GP-735 is a small, thin, high performance, easy to use GPS smart antenna receiver. With only 29 second cold start time and, -162dBm tracking sensitivity, the GP735 is a very small, yet powerful piece. The thin and sleek design makes it perfect for many applications where the workspace will be less. This GPS module, based on the uBlox 7th generation chipset, has 56-channels, has an operating voltage of 3.3~5.5V, an antenna onboard, and connects to the system via TTL serial. The 1Hz update rate is quick enough for the majority of applications (and can be increased to 10Hz if you need). [7]

*fig-3.2 –GP-735 sensor*

c) MPU6050 Gyro sensor

MPU6050 sensor which is compactable with Arduino microcontroller has MEMS accelerometer, MEMS gyro and temperature sensor. It is 6-axis motion tracking device. It combines 3-axis accelerometer, 3-axis gyro in a small package. It is an analog sensor but it is very accurate while converting from analog to digital because of its 16-bit analog to digital hardware. It measures x, y, z co-ordinates at the same time. It can also measure temperature in centigrade scale. I2C interface is present on the chip to communicate with Arduino or other microcontrollers. [6]


*fig-3.3 –MPU6050 sensor*

*d) BMD101 ECG chip*

BMD101 is a cardio chip which captures ECG from the user's wrist or fingertips. It is a single chip, and no additional components are needed to connect the chip. It can be easily integrated with mobile phone using Bluetooth wirelessly. Data in the chip can also be transferred to microcontroller using inbuilt Bluetooth present in the chip. This chip is worn on the wrist and transmitter on the chip transfers the data from the chip to Arduino microcontroller. Then using Bluetooth this data is communicated wirelessly. This cardio chip is supported by an easy-to-use SDK on iOS, Android and Windows Platforms.

From ECG signal, various parameters like Heart rate, Heart Rate Variability (HRV), Stress, Respiration Rate, BP etc., can be derived. [8]

Features:

- Single 3.3 volts power supply with on-chip
- 3mm * 3mm 8 pin package
- High Resolution (16-bit) ADC
- Low-input referred noise
- IOS, Android, Windows supported.


*fig-3.4 –BMD101 Chip*

*D. AMOLED Display*

AMOLED stands for Active-Matrix Organic Light Emitting Diodes. Now a days this display technology is being using in smartphones and smartwatches. Normal

touch displays have a layer that recognizes touch on the top of the screen, but these AMOLED displays have the layer that is integrated into the screen itself. AMOLED displays has good contrast ratio, and it is clearly visible in the sunlight. This AMOLED display in our smartwatch displays various data obtained from Arduino Nano. AMOLED screen consumes more battery than normal LCD screen because of its high contrast ratio.


*fig-4 –AMOLED screen*

*E. HC-05 Bluetooth module*

One of the best technologies used for wireless communication is Bluetooth. HC-05 is the Bluetooth module compactable with Arduino Nano. This module uses serial communication to communicate with devices. It has USART serial port which is used to communicate with Arduino Nano microcontroller. The module works on 3.3 volts, and we can also connect it in 5 volts supply since it has the voltage regulator that converts 5 volts to 3.3 volts. This module can be used in master or slave configuration. Bluetooth module is used for sending the data from Arduino Nano to mobile application.

*fig-5 –HC-05 Bluetooth module*

*F. LiPo Battery*

A lithium-polymer battery (LiPo) is a rechargeable battery. It uses polymer electrode instead of liquid electrode which is used in normal batteries. It is being used in many smartwatches because of its rechargeable capacity, small size, light weight and high power. The qualities of this LiPo battery makes it compactable to be used in smartphones and wearables. LiPo batteries have bad temperature range from (0ºC – 60ºC) and discharging LiPo batteries to ultra-low voltages can be dangerous.

*fig-6 –LiPo Battery*

## III. SOFTWARE DESCRIPTION

*A. IDE*

The Arduino Integrated Development Environment (IDE) is an open-source platform application for Windows, macOS, Linux that is used write and upload code in C or C++ language. Arduino IDE enables the user to write codes for the program in C or C++ and it also has inbuilt compiler in it which compiles the program. We can also upload the code to Arduino compactable boards. Arduino is connected to the laptop through micro-USB cable. Every Arduino board accepts the information in the form of code. IDE has two parts, editor and compiler. We wrote code for each sensor in the Arduino IDE editor and compiled it. After the successful compilation of the code, we checked the values obtained from the different sensors in "serial monitor" and we also checked plots on "serial plotter". We corrected some of the errors in the values to improve accuracy and then we removed micro-USB cable connected to Arduino board. Then, we attached a LiPo battery to Arduino to work.

*B. C++*

C++ is further improvement of C language which has more features and functions than C. It is an object-oriented language that can be used to create high-performance applications. C++ is extension to C where there are more inbuilt functions and features. We used C++ language in Arduino IDE application. We coded the program for every sensor in C++ language. We wrote functions for every sensor in the Arduino IDE application and then compiled the code and checked the result obtained.

*C. Software development*

A mobile application is required for monitoring the data produced by sensors. Data produced by the sensors is collected by the Arduino Nano and it is sent to mobile

application by using HC-05 Bluetooth module. We used Java language for building the mobile application. We first tested the sensor values in MIT app inventor which is an online platform for developing mobile applications in an easy way. The App is created by dragging and dropping the required components into a design view and using visual blocks language to program application behavior. The GUI used by the MIT app inventor is very similar to programming languages like Scratch and Star Logo. When the sensor sends the data to Arduino Nano, HC-05 Bluetooth module sends the data to the app

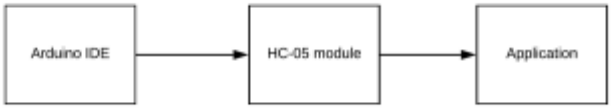


*fig-7 –Block diagram of Data transferring between Arduino and Application*

## IV. IMPLEMENTATION

The Arduino is powered by the LiPo battery. All the sensors, AMOLED display and the Bluetooth module are connected to the Arduino Nano board. Sensors connected to the Arduino collect different data like heart rate, ECG, SpO2, temperature of the body, and the location of the person. The data collected can be seen on the AMOLED display. The data from the sensors is collected by the Arduino and then data collected from the Arduino is sent to the mobile application or web server using Bluetooth module. Normal or otherwise called threshold values of each sensor are recorded in the application and whenever the collected sensor values from the patient crosses the threshold values, mobile application alerts the person by sending notification alert and GPS sensor sends the location of the person to one of his/her emergency contact.

## V. CONCLUSION

We want to implement a system that can help us track the vitals, using a wearable health band, continuously and alert the doctor or medical officer immediately in case of emergency. The built in GPS sensor helps to find the location of the user in case doctor wants to reach out to patent and provide personal medical care. The system includes sensors for each vital, a Bluetooth module for internet connectivity and user application for users and doctors to review the overall health.

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