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Design and Development of Wearable device using Bluetooth Low Energy

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Abstract: Bluetooth Low Energy (BLE) is an emerging low-power wireless technology developed for short-range control and monitoring applications that is connected with the billions of devices in the next few years. This paper describes the main features of Bluetooth Low Energy, explores its various applications. Using short range communication, user can receive calls and Text messages by using pressing switch of the Wearable device. Wearable notification performed by vibration motor, LED, Liquid Crystal Display for the incoming calls and messages as well as some other calendar events. Device is directly connected to the mobile via Bluetooth.

Keywords: Bluetooth Low Energy, Wireless communication, OLED display, Accelerometer, Gyroscope

I. INTRODUCTION

Bluetooth Low Energy is developing wireless technology developed by Bluetooth Special Interest Group for short range communication. BLE has been designed for monitoring application and low power solution. BLE is the distinctive feature of the Bluetooth 4.0 specification. The rapid growth of BLE is easy, as compared to other wireless technology. [1] The Power efficiency of Bluetooth with low energy functionality makes it perfect for devices that run for long periods on power sources, such as coin cell battery.

In June 2010, the Bluetooth Special Interest Group introduced Bluetooth Low Energy 4.0. The first update, Bluetooth 4.1, was released in December 2013. Bluetooth 4.1 is compatible with the Bluetooth 4.0. In BLE has two types of device (1) Single mode (Bluetooth Smart) device (2) Dual mode (BLE) device. In single mode, device that implements BLE, which can communicate with single mode and dual mode devices but not with devices supporting BR/EDR only. In Dual mode, device that implements both BR/EDR and BLE, communicate with any Bluetooth device. It supports many operating systems such as iOS 5 and later, Android 4.3+.

ESP32 is a single chip with 2.4 GHz frequency as well as Wi-Fi and Bluetooth combo chip designed with TSMC ultra low power 40 nm technology. It is designed and optimized for the best power performance, RF performance, features and reliability for a wide range of applications and different power profiles. ESP32 designed for mobile, wearable electronics, and Internet of Things applications. It is the most integrated solution for Wi-Fi and Bluetooth applications in the industry.

Table 1: Difference between BLE and Bluetooth [2]

Parameter	BLE	Bluetooth
Frequency	2.4 GHz	2.4 GHz
Distance	Greater than 100 m	100 m
No. of Device	More than 1	Only 1
Power consumption	< 30 mA	< 15 mA
Modulation	GFSK	GFSK

II. PROBLEM DEFINITION

If user is away from mobile or sometimes user is busy, then device will vibrates when call and messages coming in the mobile and notifies via different color LED blinking. So user will not missed any important call and messages at any time.

2.1 FLOW CHART

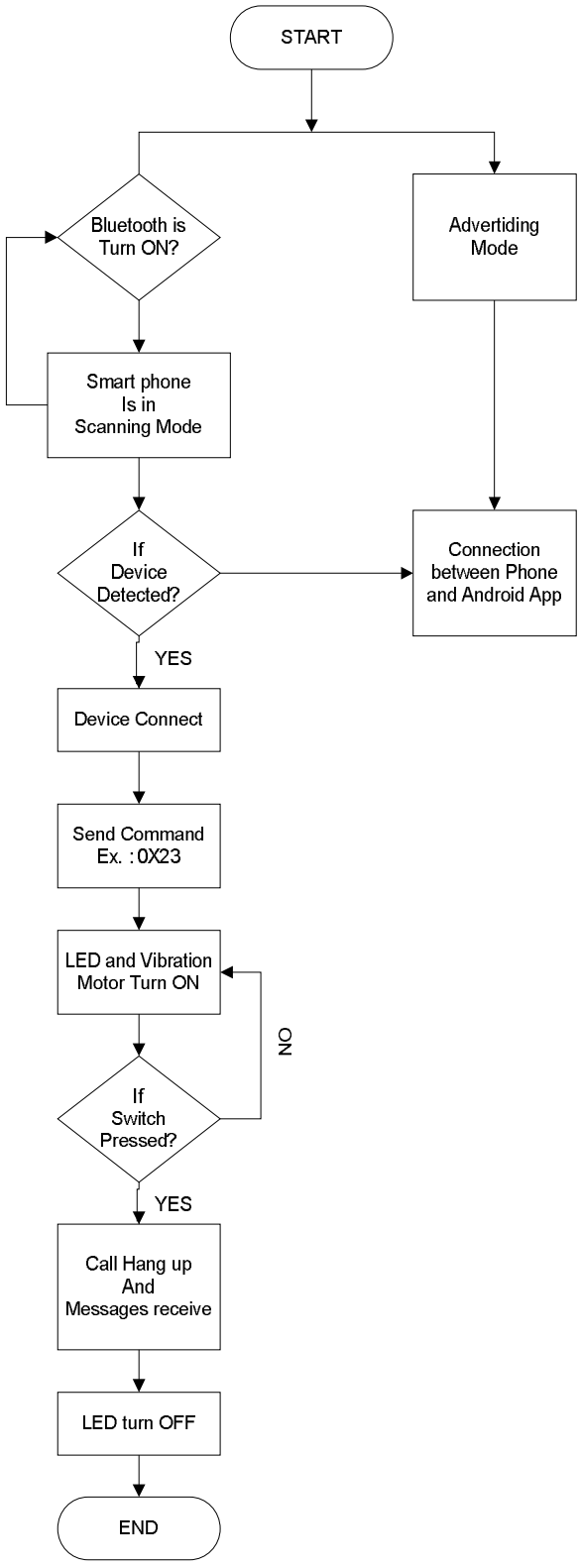

Fig. 2 Flow Chart

III. ARCHITECTURE

The main idea of this system is to give notification alert for the call and message via vibration and LED blinking on the Wearable Device. This system is consists of ESP32, Liquid Crystal Display, LED, Accelerometer and Gyroscope (BMI160) as shown in figure.

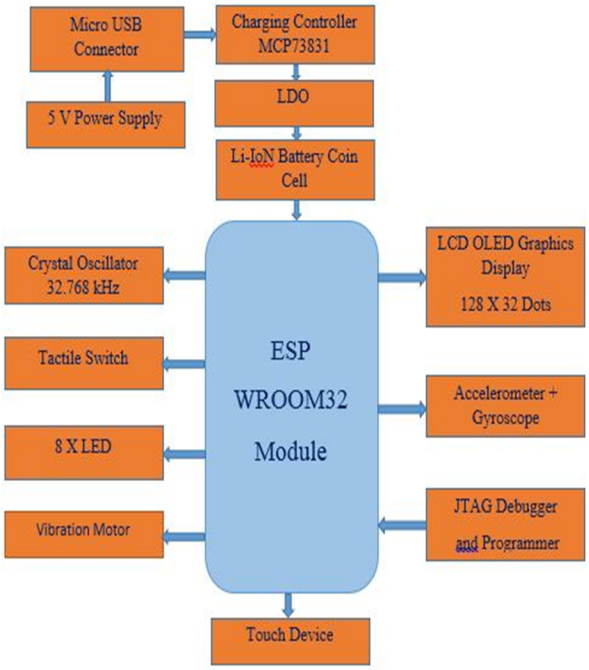

Fig. 3 Block Diagram of the system

If cell-phone is away from the user then wearable device gives notification of the call and messages by vibrating device and LED blinks. By using LCD, It shows the caller information and text messages. With the help of the Accelerometer and Gyroscope can be used to sense the movement of the user. We can charge the device using USB cable. Battery backup of this device is 4-5 days depend on the user. We can connect the mobile phone to the Wearable device via Wi-Fi and Bluetooth both.

Call, Text messages and also Calendar event notifications can be displayed on wearable device but your phone must be nearby the wearable device. It is challenge to design a wearable communication devices to provide access to the users the rich set of features available on a phone, answer and place calls, sending and receiving messages, and also be notify calls and messages while phone is away from the user or in a pocket.

In wearable device using Bluetooth Low energy, Activity tracking is also implemented. Currently wearable device battery will last up to 5 days depending on use.

Table 2: Technical Specification of the Wearable device

Parameter	**Specification**
Frequency	2.4 GHz
Bluetooth	V4.2 BR/EDR & BLE
Operating Voltage	2.2 – 3.6 V
Operating Current	80 mA
Module Interface	SD card, Motor, UART, I2C, LED PWM, SPI, Capacitive touch sensor
Temperature Range	-40 C to 80 C

IV. HARDWARE AND SOFTWARE DESCRIPTION:

4.1 ESP32 [2]:

ESP32 can perform as a complete standalone system or as a slave device to a host MCU, reducing communication stack overhead on the main application processor. It adds priceless functionality to application with minimum PCB area requirements [2].

Key features of ESP32 is:

- 2.4 GHz dual core Tensilica LX6 microcontroller
- 520 KB SRAM
- 16 MB Flash
- 2.2 V to 3.6 V Operating Voltage
- -40 C to +125 C Operating Temperature
- On-Board PCB antenna

Schematic Circuit:

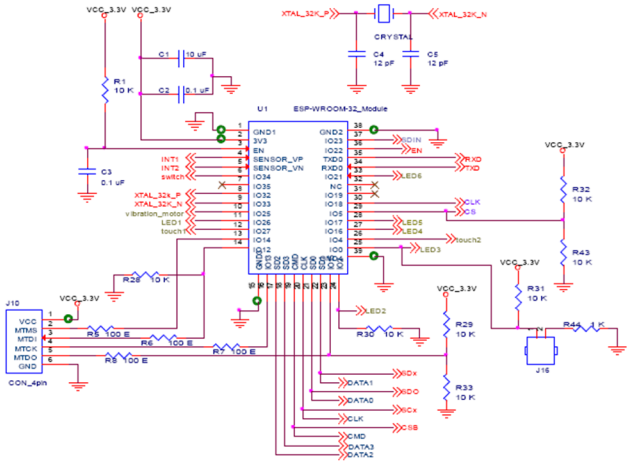

Fig.4 Schematic of ESP32

4.2 LED:

Schematic Circuit:

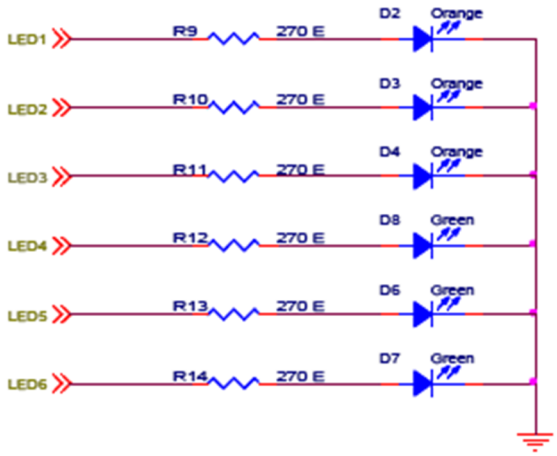

Fig.5 Schematic of LED connection

4.3 Liquid Crystal Display:
LCD is used to display the caller information and text messages.

Schematic Circuit:

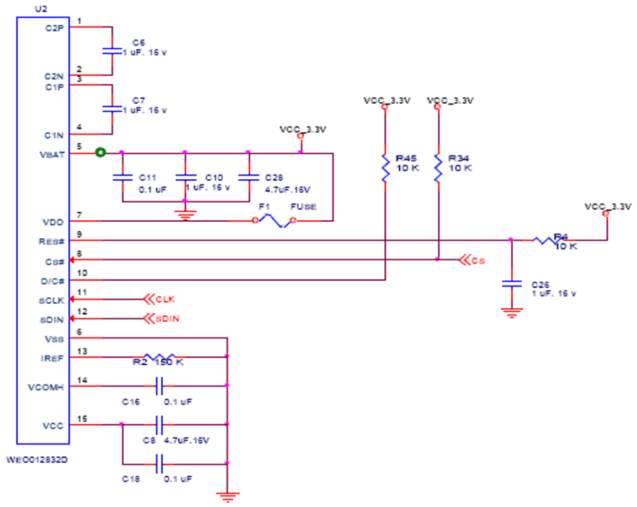

Fig.6 LCD Schematic

4.4 Accelerometer and Gyroscope (BMI160):
Wearable device can improve the efficiency of your workout by measuring speed [4].

Schematic Circuit:

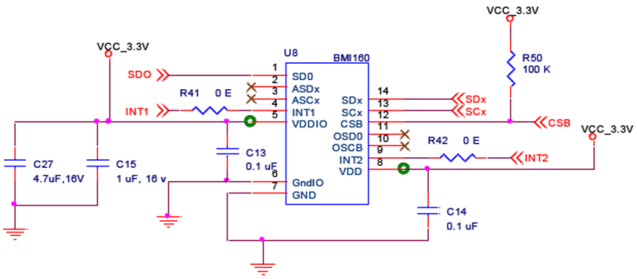

Fig.7 Schematic of Accelerometer and Gyroscope

4.5 Vibration Motor:
Using Vibration Motor, Device will be vibrate when call and messages coming in the mobile**.**

Schematic Circuit:

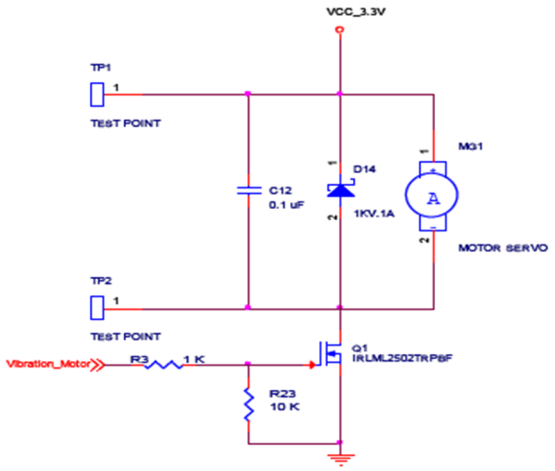

Fig.8 Schematic of Vibration Motor

4.6 Power Supply:
In, Power supply, we used MCP73831 IC. It is highly advanced linear charge management controller. STAT pin of the IC is connected to VDD with LED and series resistor which is value of 64.9 ohm. LED will turn ON, while resistor is pull up. We can charge the device using Micro-USB port and is connected to 5 V power supply. For protection, we used

TVS Diode. While device is in low battery condition, RED LED will blink. Device is in charging condition, GREEN LED will blink.

Schematic Circuit:

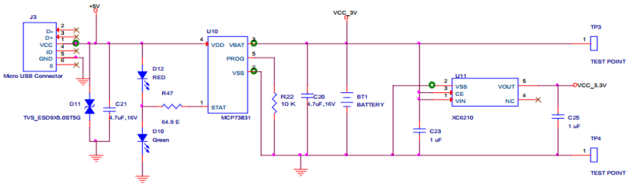

Fig.9 Power Supply Schematic

4.7 Software:

ESP32-IDf is official development framework for the ESP32. In this tool, user can set the profile and attribute by GAP (Client) and GATT (Server) [5].

V. RESULTS:

Wearable device (ESP32) is paired with the mobile through Bluetooth. If we want to pair between mobile and Wearable device via Bluetooth then we have to enter passkey and pairing will be successfully done.

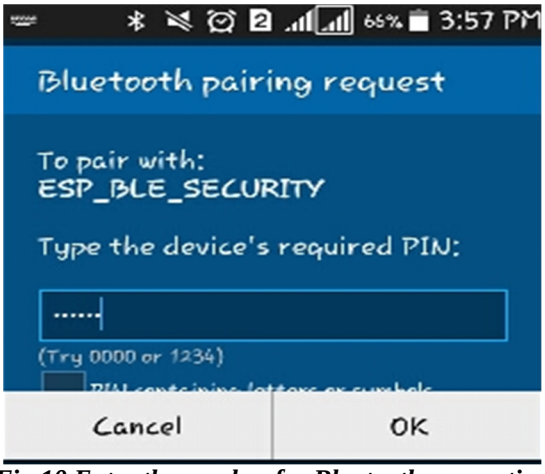

Fig.10 Enter the passkey for Bluetooth connection

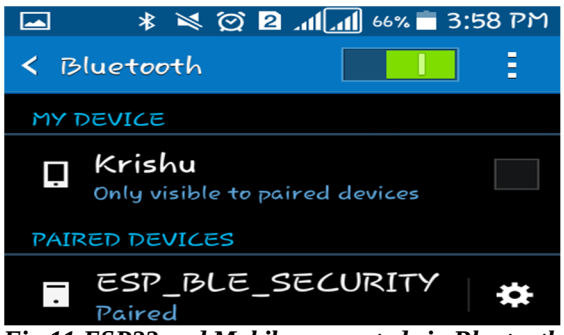

Fig.11 ESP32 and Mobile connected via Bluetooth

Fig.12 Send value from app to ESP32

When a value send from app and received at ESP32 then LED starts blinking for call and messages notification and observe output at serial terminal and it will be turned off whenever switch will get pressed.

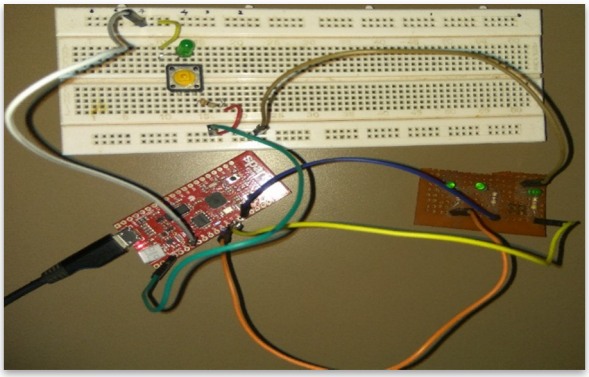

Fig. 13 LED and switching circuit implementation when call and messages coming on Smart Phone

Fig. 14 LED blinking output on the serial terminal

We also get notification from the device of call and messages using Wi-Fi connection so that we can receive the call and messages using button.

Fig.15 Call Hang up through Wi-Fi Connection

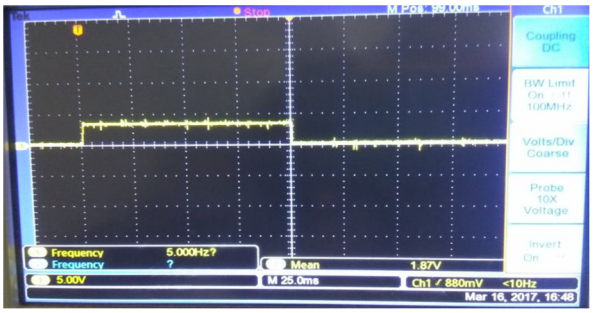

Fig. 16 Hardware implementation

We also connected ESP32 chip to wearable device via Wi-Fi with security and without security. New features will be updated soon.

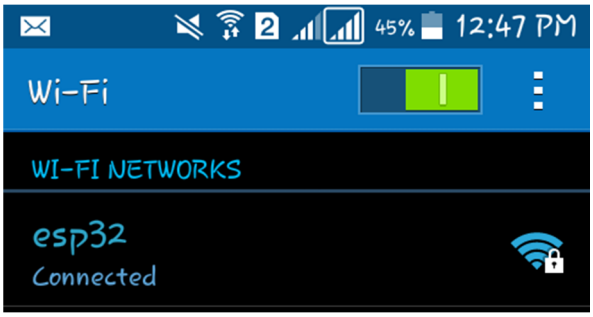

Fig. 17 ESP32 connected with the Device using Wi-Fi with Security and without security

VI. CONCLUSION AND FUTURE SCOPE

It concludes that Wearable Device will be vibrates and LED starts blinking when call and messages coming in the smart phone. By pressing switch, user can receive call and Text messages.

For the future overall important will be given to increase battery life using coin cell and also able to gives notification from social media like Mail, Facebook, and etc.

VII. REFERENCES

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