

# Smart T-Shirt using ESP32

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**Abstract:** *This project introduces a Smart T-shirt, an innovative wearable technology designed to integrate IoT and mobile computing using an ESP32 microcontroller, voice recognition module, GPS, and a MAX7219 dot matrix LED display. The T-shirt is capable of dynamically displaying messages, animations, and real-time information on an LED matrix, controlled through voice commands, an Android app, or a web application. The ESP32 microcontroller serves as the central hub, processing inputs from the voice module and GPS while controlling the LED matrix. The GPS module tracks the wearer's location, allowing real-time updates to be viewed on a connected Android app or web platform. The MAX7219 dot matrix display enables scrolling or static messages to be shown on the T-shirt, offering both personalization and practical uses such as emergency messaging, navigation, or event promotions. The Android app and web application allow users to interact with the Smart T-shirt remotely. Users can send customized messages to the LED display, track location data, and issue voice commands. The system leverages the Wi-Fi and Bluetooth capabilities of the ESP32 to ensure seamless communication between the wearable device and the user interfaces.*

**Keywords:** Smart T- Shirt, ESP32, Voice Recognition Module, MAX7219dot matrix, LED Display

## I. INTRODUCTION

Wearable technology has rapidly evolved, merging fashion with advanced computing capabilities, creating a new wave of innovation in areas such as health monitoring, communication, and entertainment. The Smart T-shirt is one such innovation, designed to integrate real-time interaction, communication, and location tracking through embedded systems. This project leverages the power of the ESP32 microcontroller, along with a voice recognition module, GPS, MAX7219 dot matrix LED display, an Android application, and a web interface to create an interactive and multifunctional garment. The ESP32 serves as the central processing unit for the Smart T-shirt, providing connectivity through its built-in Wi-Fi and Bluetooth capabilities. It allows for communication between the hardware components of the T-shirt and external devices such as smartphones and computers. The MAX7219 dot matrix LED display is used to dynamically display text, symbols, and animations, enabling the user to personalize their wearable or communicate information visually. Additionally, the integration of a voice module allows the user to control the displayed content hands-free by using pre-set voice commands, enhancing the ease of use. The GPS module embedded within the T-shirt provides real-time location tracking, which can be used for safety purposes or location-based applications. This data is transmitted to the user's mobile device through the Android app or web interface, enabling remote monitoring. The Android app and web application act as control hubs, where users can interact with the T-shirt remotely. They allow users to customize the content displayed on the LED matrix, monitor GPS location, and issue voice commands. This communication is facilitated by the ESP32, ensuring a smooth interaction between the wearable and the control interfaces.

## II. THEORY

In today's digital era, there is a growing need for wearable devices that enable real-time communication, personalization, and safety. Traditional clothing lacks interactive features such as dynamic information display, voice-based control, and location tracking. Existing wearable systems are often limited in functionality, user interaction, or real-time monitoring capabilities. There is a need for a smart wearable solution that integrates message display, GPS



tracking, and remote control in a single platform. This project addresses these challenges by developing a smart T-shirt using ESP32 with LED display, voice control, and mobile/web connectivity.

### III. OBJECTIVES

- To provide a smart wearable solution for real-time communication through dynamic message display.
- To enable hands-free control of displayed information using voice commands.
- To improve personal safety by integrating real-time gps location tracking.
- To allow remote monitoring and control using an android application or web interface.

### IV. HARDWARE ARCHITECTURE

#### 1. Components

Component	Function
<b>ESP 32</b>	It controls Wi-Fi communication, GPS data, voice modules, and display.
<b>Voice Module 1 &amp; Voice Module 2</b>	These modules are used for voice announcements or alerts
<b>MAX7219 Dot Matrix Display</b>	It displays messages, status information, or alerts.
<b>Wi-Fi Module (Built-in ESP32 Wi-Fi)</b>	It connects ESP32 with the Android App and Web Application. Used for real-time data transmission and remote monitoring.
<b>GPS Module</b>	GPS module provides location information. ESP32 receives latitude and longitude data from GPS.
<b>Power Supply (LM2596)</b>	It converts higher input voltage into required regulated voltage. It provides stable power supply to ESP32 and other modules.

#### 2. Block Diagram

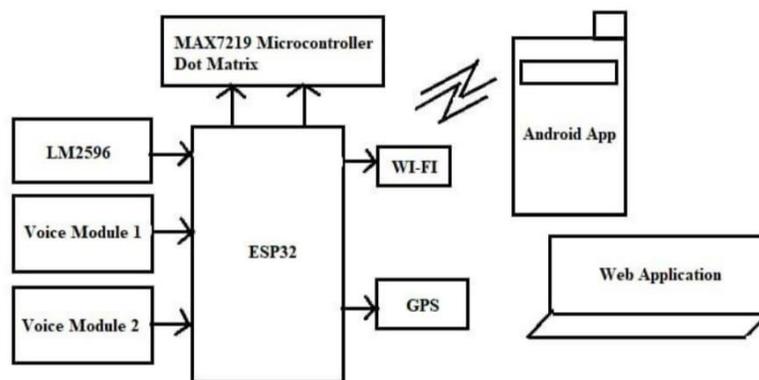


Fig.1 Block Diagram of Circuit



### 3. ESP32



Fig.2 ESP32s Module

The ESP32s IoT Development Board is designed for seamless connectivity in projects requiring both Wi-Fi and Bluetooth. It features the ESP WROOM32 chip, enabling easy integration with capacitive touch sensors and Hall sensors. With a 3.3V power regulator and onboard CP2102 USB to TTL converter, programming is straightforward. This module is ideal for battery-powered applications, consuming less than 5 $\mu$ A, making it perfect for wearable electronics.

Developers can utilize the ESP32s IoT Development Board for diverse applications, including home automation and innovative IoT solutions. Its scalability and low-power consumption make it a reliable choice for connecting devices to the internet. Explore its capabilities for your next project and see how it can enhance your IoT applications.

### 4. ISD1820 Voice Record Module



Fig.3 ISD1820 Voice Record Module

Voice Record Module is based on ISD1820, which is a multiple - message record/playback device.

It offers true single - chip voice recording, non-volatile storage, and playback capability for 8 to 20 seconds. The sample rate is 3.2k and the total 20s for the Recorder. This module is very easy to use, which you could directly control by push button on board or by Microcontroller such as NodeMCU, ESP32, Arduino, STM32, ChipKit etc. From these, you can easily control record, playback and repeat and so on.

#### Feature of ISD1820

Push - button interface, playback can be edge or level activated

Automatic power - down mode

On - chip 8  $\Omega$  speaker driver

Signal 3V Power Supply

Can be controlled both manually or by MCU

Sample rate and duration changeable by replacing a single resistor

Record up to 20 seconds of audio

Dimensions : 37 x 54 mm



### 5. GPS Module With External Antenna



Fig.4. GPS Module

### GPS Module With External Antenna

This is a GPS Module with External Antenna. It is based on Skytra S1216 Module. This is a plug and play easy to use GPS Module with RS232 output. Just power up the module and it will start sending data serially in NMEA format. Works on 9-12V DC supply and can be interfaced directly to PC via Serial Port. It can also be interfaced to any micro-controllers like 8051, PIC, AVR or ARM via MAX232 IC.

### 6. MAX7219 Dot Matrix Display



Fig.5 MAX7219 Dot Matrix Display

The MAX7219/MAX7221 are compact, serial input/ output common-cathode display drivers that interface microprocessors ( $\mu$ Ps) to 7-segment numeric LED displays of up to 8 digits, bar-graph displays, or 64 individual LEDs. Included on-chip are a BCD code-B decoder, multiplex scan circuitry, segment and digit drivers, and an 8x8 static RAM that stores each digit. Only one external resistor is required to set the segment current for all LEDs. The MAX7221 is compatible with SPI™, QSPI™, and MICROWIRE™, and has slew-rate-limited segment drivers to reduce EMI.

### 7. LM2596 Adjustable DC to DC Buck Converter Module



Fig.6. LM2596 Adjustable DC to DC Buck Converter Module

LM2596 Buck Converter Module offers adjustable output from 1.5V to 35V with 2A current capacity for efficient voltage regulation. The LM2596 Adjustable DC to DC Buck Converter Module provides reliable voltage regulation for various electronic applications. This non-isolated step-down module allows you to adjust the output voltage from 1.5V to 35V, making it perfect for battery chargers, LED drivers, and DIY electronics projects. With a maximum current rating of 2A, it ensures stable power supply for your devices. Designed for high efficiency and compactness, the LM2596 Adjustable DC to DC Buck Converter Module reduces power loss while enhancing the performance of your circuits. Its dimensions of 43mm x 21mm make it easy to integrate into your projects. This module operates efficiently



with input voltages ranging from 4.5V to 40V, making it versatile for various applications. Explore the benefits of the LM2596 Adjustable DC to DC Buck Converter Module to elevate your electronic projects. This module is a reliable choice for effective voltage regulation. Experience seamless performance and efficiency in your circuits today.

### 8. 12 Volt 2Ah LI-Ion BATTERY PACK



Fig 7. 12 Volt 2Ah LI-Ion BATTERY PACK

A 12V 2Ah Li-Ion Battery Pack is a rechargeable lithium-ion battery system composed of multiple 18650 (or similar) cells connected in a specific configuration (typically 3S1P – 3 cells in series, 1 in parallel) to provide a nominal voltage of 11.1V to 12.6V and a total capacity of 2Ah (2000mAh). These battery packs are compact, lightweight, and designed for medium-power applications that require reliable energy storage.

### 9. Tactile Push Button Switch 12x12x12mm-



Fig 8. .Tactile Push Button Switch 12x12x12mm-

The Tactile Push Button Switch 12x12x12mm – 10 Pcs is a reliable momentary switch designed for PCB mounting. With a compact size of 12x12x12 mm, this switch offers a tactile click response, making it ideal for user input in various electronic devices. It operates with a force of approximately 3-5 N and boasts a mechanical life of over 300,000 cycles, ensuring durability in applications. This switch is perfect for user input on consumer electronics, PCB-mounted control panels, and prototyping. It features a normally open SPST configuration and can handle operating voltages up to 250 VAC/DC. The Tactile Push Button Switch 12x12x12mm – 10 Pcs is suitable for industrial instruments and testing equipment as well, making it a versatile choice for electronic assemblies.

### Prototype T-Shirt



Fig 9..Prototype T-shirt



## V. CONCLUSION

The Smart T-Shirt is an advanced and innovative wearable technology that successfully combines IoT and mobile computing to create a smart, responsive, and user-friendly safety and communication system. By integrating an ESP32 microcontroller, voice recognition module, GPS tracking system, and MAX7219 dot matrix LED display, the project demonstrates how modern technology can be embedded into everyday clothing to provide real-time assistance and support. The ESP32 microcontroller acts as the central processing unit, ensuring efficient connectivity, fast data processing, and smooth communication between all components.

One of the most significant advantages of the Smart T-Shirt is its ability to provide real-time location tracking using GPS technology. This feature enhances personal safety by allowing users to share their location instantly during emergencies or dangerous situations. The inclusion of a voice recognition module further improves accessibility by enabling hands-free operation, making it especially useful when the user is unable to manually control the system. Additionally, the MAX7219 dot matrix LED display allows visual communication through text or symbol display, which can be used to send alerts, warnings, or emergency messages effectively.

The Smart T-Shirt also highlights the growing importance of wearable technology in modern society. It provides practical applications in various fields such as personal safety, healthcare monitoring, assistive support for differently-abled individuals, and emergency communication. The system promotes convenience, portability, and ease of use while maintaining technological efficiency. Furthermore, the project demonstrates how IoT-based wearable solutions can enhance the interaction between humans and smart devices, making technology more personalized and responsive to user needs.

## REFERENCES

- [1]. Kumar et al., "Smart Wearable Systems for Real-Time Communication and Monitoring," IEEE Access, 2023.
- [2]. This paper explains the use of smart wearable devices for real-time communication and remote monitoring using wireless technologies.
- [3]. Patel et al., "ESP32-Based Wearable Devices for IoT Applications," IJES, 2022.
- [4]. The study highlights ESP32 as an efficient microcontroller for wearable IoT systems due to its Wi-Fi and Bluetooth features.
- [5]. Zhang et al., "LED Matrix Displays for Wearable Communication," Elsevier, 2021.
- [6]. This work discusses LED matrix displays used in wearables for dynamic and personalized message display.
- [7]. Singh et al., "GPS-Based Wearable Safety Devices," IEEE Sensors Journal, 2020.
- [8]. The paper focuses on GPS integration in wearables for real-time location tracking and safety applications.
- [9]. Johnson et al., "Voice-Controlled Wearable Interfaces," ACM, 2021.
- [10]. This study presents voice control techniques in wearable devices to enable hands-free operation.

