

Design and Implemented Iot Based Solar Bus Monitoring System

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Abstracts. The proposed project, IoT-Enabled Solar Bus Monitoring and Location Tracking System, aims to develop an intelligent, eco-friendly transportation assistance system powered entirely by renewable energy. The system utilizes a solar panel to supply clean, continuous power to all electronic modules, reducing dependency on conventional electricity and promoting sustainable public transport operations.

A GPS module continuously tracks the bus's geographical position, while a GSM module transmits location updates or notifications to a central control station via SMS or the internet. The As the bus approaches predefined locations, the system automatically triggers a DF Player Mini audio module to deliver a voice announcement indicating the current and next stop, thereby assisting passengers,

Introduction: The Solar-Based Smart Bus Monitoring System is an advanced and eco-friendly solution designed to improve public transportation efficiency and passenger convenience. This system uses renewable solar energy as its primary power source, reducing dependency on conventional electricity and make the system sustainable .

The core of the system is the ESP32 microcontroller, which integrates various modules such as a GPS module, DF Player Mini, LCD display, and sensors. The GPS module continuously tracks the real-time location of the bus by providing accurate latitude and longitude coordinates. Overall, this project combines IoT, renewable energy, and embedded systems to create an intelligent and automated bus monitoring and announcement system that enhances passenger experience, improves communication, and supports sustainable technology.

II. SYSTEM DESCRIPTION AND BLOCK DIAGRAM:

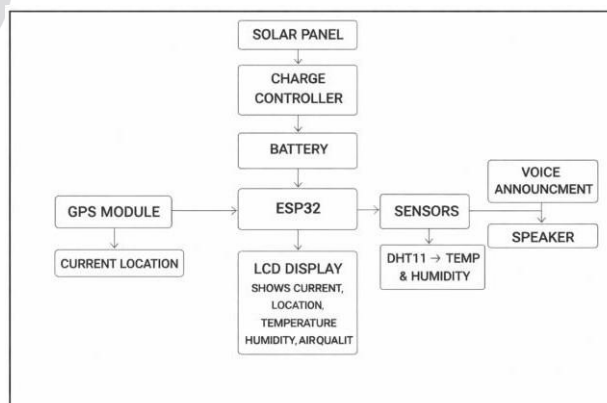


Fig: Solar based bus Monitoring System

Solar Panel:

Fig. solar panel

The solar panel serves as the primary power source for the system, converting sunlight into electrical energy via the photovoltaic effect. This process generates a DC voltage, which is then used to charge a lithium-ion battery through a charge controller. A 6W panel is typically adequate for low-power embedded systems, such as those based on the ESP32.

Charge controller (TP 4056):

Fig. charge controller

The TP4056 module is utilized for the safe charging of lithium-ion batteries from a solar panel. It effectively regulates both charging current and voltage, thereby preventing any damage to the battery. Furthermore, it incorporates essential protection features, including safeguards against overcharging, over-discharging, and short circuits.

Lithium Battery (3.7V):

Fig. charge controller

The lithium-ion battery is designed to store energy captured by the solar panel for later utilization, thereby ensuring a consistent power supply even when sunlight is unavailable, such as during nighttime or overcast weather. A 3.7V battery is frequently chosen for its high energy density and its rechargeable capabilities.

Voltage Regulator (LM2596 Buck Converter):

Fig. voltage regulator

The LM2596 buck converter is employed to reduce the battery voltage down to a consistent 5V output. This ensures that delicate components, such as the ESP32, receive the correct voltage. The module is adaptable, allowing users to adjust the output voltage via a potentiometer. By minimizing power loss, it enhances overall efficiency.

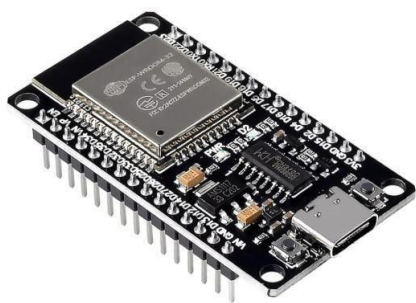
RTC Module (DS3231):

Fig. ESP 32

The The ESP32 serves as the central controller, overseeing all system operations. It is responsible for processing incoming data from GPS and various sensors, as well as managing the output to devices such as the LCD and DF Player. Its integrated Wi-Fi and Bluetooth capabilities contribute to its advanced functionality.

LCD Display:

Fig. LCD Display

The I2C LCD display is used to show system information such as student details, entry status, and bus stop updates. It communicates with the ESP32 using minimal pins through the I2C interface. This reduces wiring complexity and provides clear, real-time visual output for monitoring.

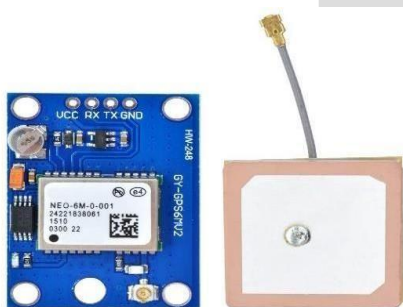
GSM(NEO 6M):

Fig. GSM

The NEO-6M GPS module offers real-time location data, specifically latitude and longitude coordinates. It interfaces with the ESP32 through serial communication. By utilizing satellite signals, the module accurately determines precise positions, making it a common component in tracking and navigation systems.

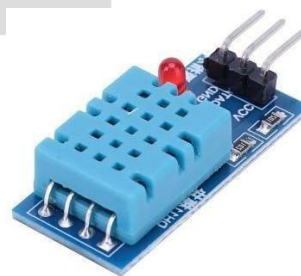
Temperature & Humidity Sensor (DHT11):

Fig. DHT sensor

The power supply unit provides stable voltage to all components of the system, ensuring reliable operation. It converts input power into required levels for ESP32, RFID, and other modules. Proper regulation and filtering protect devices from fluctuations, supporting continuous and efficient system performance.

DF Player Mini (MP3 Module):

Micro SD Card:

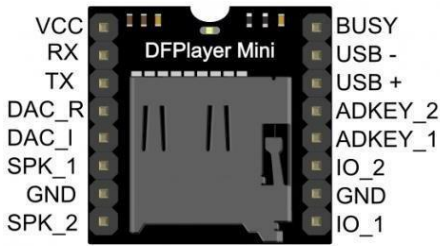


Fig DF player

The DF Player Mini is a compact module designed for playing audio files from an SD card. It can be controlled via serial communication, for example, from an ESP32 microcontroller, and supports the MP3 format for easy playback.



Fig sd card

The micro SD card is used to store audio files for announcements. It must be formatted in FAT32 format for compatibility. The DF Player reads MP3 files from the card and plays them when required. Files should be named in sequence (0001.mp3, 0002.mp3, etc.). It provides reliable and compact storage.

Speaker (8W):



Fig Speaker

This speaker translates electrical signals from the DF Player into audible sound, making it ideal for delivering clear voice announcements. An 8-ohm speaker is a common choice for these modules, offering sufficient volume for smaller spaces. When triggered, it plays pre-stored audio messages and connects directly to the DF Player module.

The steps of proposed work as given below:

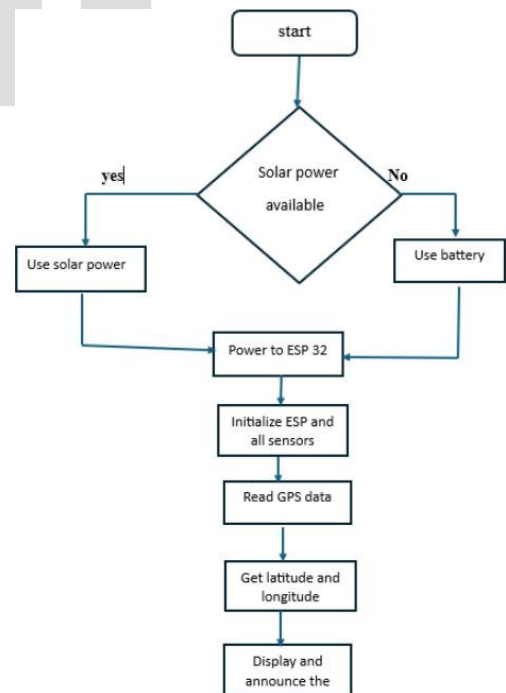


Fig: flow chart of Solar Based Bus monitoring

Step 1: Power Generation and Supply

The solar panel successfully converts sunlight into electrical energy, which is regulated and stored in the battery. The system receives a stable power supply through the voltage regulator, ensuring continuous operation of all components.

Step 2: System Initialization

After powering ON, the ESP32 initializes all modules including GPS, DHT11 sensor, LCD display, and DF Player Mini. The LCD displays an initial message indicating that the system is ready for operation.

Step 3: GPS-Based Location Tracking

The GPS module continuously receives satellite signals and provides accurate latitude and longitude values. The ESP32 processes this data, achieving the objective of real-time bus location tracking.

Step 4: Environmental Monitoring

The DHT11 sensor measures temperature and humidity inside the bus. The obtained values are processed and displayed on the LCD, fulfilling the objective of monitoring environmental conditio

Step 5: Data Display on LCD

The LCD successfully displays real-time information including location coordinates, temperature, and humidity. This ensures that passengers receive clear and updated.

Step 6: Voice Announcement System

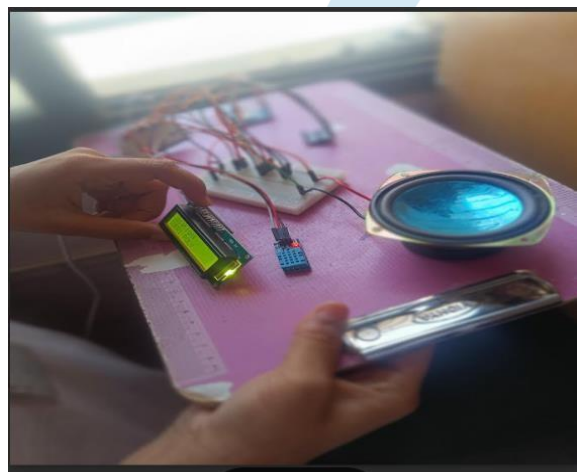
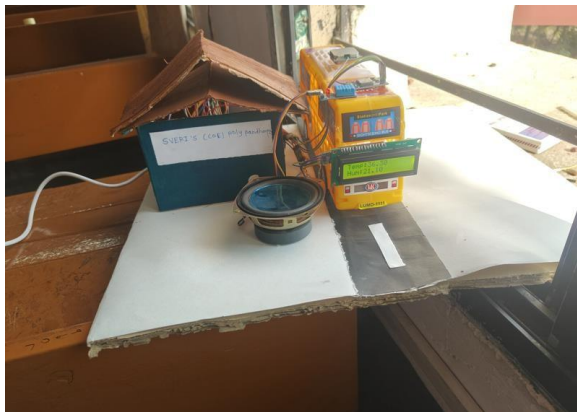
When the bus reaches predefined locations, the ESP32 triggers the DF Player Mini to play corresponding audio files. The speaker clearly announces bus stops, achieving the objective of automatic voice announcements.

III. RESULTS AND DISCUSSIONS

The Solar-Based Smart Bus Monitoring System is to develop an efficient, automated, and eco-friendly solution for public transportation. This project focuses on real-time bus location tracking using a GPS module, which helps passengers identify the current position of the bus and reduces waiting time. It also includes an automatic voice announcement system using the DFPlayer Mini, which announces bus stops, making it highly useful for passengers, especially for new users and visually impaired individuals.

IV. ACTUAL RESULT





CONCLUSION :

The proposed system successfully demonstrates a solar-powered IoT-based bus monitoring and location tracking solution. It effectively utilizes renewable energy to operate the system, reducing dependency on conventional power sources. The integration of GPS technology enables real-time tracking of the bus location, improving passenger awareness and convenience.

The system also monitors environmental conditions such as temperature and humidity, ensuring a comfortable travel experience. The LCD display provides real-time information, while the automatic voice announcement system enhances accessibility for passengers. The use of ESP32 ensures efficient processing and control of all modules. Overall, the system is cost-effective, eco-friendly, and reliable.

It can be widely implemented in public transportation systems. The project also has the potential for future enhancements and smart city integration.

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