Design and Implementation of IoT based Smart Mirror

1st Swarali Chavan
Electronics and Telecommunication
SVERI's College of Engineering (Poly), Pandharpur
Pandharpur, India
Swaralichavan2908@gmail.com

2nd Snehal Patil
Electronics and Telecommunication
I's College of Engineering (Poly), Pandharpur
Pandharpur, India
snehalpati172813@gmail.com

3rd Saloni Jadhav
Electronics and Telecommunication
SVERI's College of Engineering (Poly), Pandharpur
Pandharpur, India
salonijadhav7878@gmail.com

4rd Pandurang Valte
Electronics and Telecommunication
RI's College of Engineering (Poly), Pandharpur
Pandharpur, India
psvalte@cod.sveri.ac.in

5th Santosh Mane
Electronics and Telecommunication
SVERI's College of Engineering (Poly), Pandharpur
Pandharpur, India
Sbmane333@gmail.com

Abstract

The IoT-based Smart Mirror project aims to design and develop an interactive mirror that displays useful information such as time, date, and environmental conditions on its reflective surface. The system uses a two-way mirror with an LCD display placed behind it, creating a smart and modern interface that combines technology with daily life. A microcontroller like Node MCU is used to control the system and process real-time data. Sensors such as the DHT22 are used to measure temperature and humidity, while an ultrasonic sensor is used for object detection. When a person comes near the mirror, the system can automatically turn on the display, making it user-friendly and energy efficient. Unlike many IoT-based systems, this smart mirror works without internet connectivity, which makes it more secure, reliable, and easy to use in offline environments. The project also helps students understand the basics of embedded systems, sensors, and automation. Overall, this project provides a simple, low-cost, and effective solution for smart home applications, showing how technology can be integrated into everyday objects to improve convenience and modern living.

Keywords: IoT-based Smart Mirror, Node MCU, Embedded Systems, DHT22 Sensor, Ultrasonic Sensor, Automation, Smart Home Technology

1. INTRODUCTION

In today's fast-moving world, people want quick and easy access to important information like time, date, and environmental conditions while performing daily activities. However, traditional methods such as checking mobile phones or separate devices can be inconvenient and time-consuming. At the same time, there is a growing demand for smart home systems that can improve comfort, automation, and efficiency in everyday life. Many existing smart systems depend heavily on internet connectivity, which can lead to issues like security risks, higher cost, and dependency on network availability. To solve this problem, the concept of a smart mirror is introduced. A smart mirror allows users to view essential information directly on a mirror surface while doing routine tasks like getting ready. By integrating sensors such as DHT22 for temperature and humidity and an ultrasonic sensor for object detection, the system becomes interactive and responsive. This project focuses on developing a simple, low-cost, and offline smart mirror system that provides useful information without the need for internet connectivity. It helps in improving convenience, saving time, and introducing automation in daily life in a practical and efficient way.

2. LITERATURE REVIEW

The rapid growth of the Internet of Things (IoT) has enabled the transformation of traditional devices into smart and interactive systems. One such innovation is the smart mirror, which integrates a reflective surface with a digital display and internet connectivity to provide real-time

information and services. In [1], Dr. Chanda V. Reddy et al. proposed an IoT-based smart mirror system designed to simplify daily routines by displaying essential information such as time, weather, and updates. The study highlights how IoT improves communication between devices but also points out security challenges due to increased connectivity. The work "REFLECTECH: The Smart Mirror" by Dr. A. Patil et al. [2] focuses on user centred design and interactive features. The system integrates APIs such as calendar synchronization and provides real-time updates, making the mirror a useful personal assistant in smart home environments. In [3], Satyajit Rout et al. developed a Raspberry Pi-based smart mirror capable of displaying dynamic content like news, date, and weather. The research emphasizes cost-effective implementation and ease of use for practical applications. The student project using the Blynk platform [4] demonstrates how mobile applications can be integrated with smart mirrors to enable remote control and monitoring features. This approach improves accessibility and enhances smart home automation. Jadhav et al. [5] presented a smart mirror using IoT with features like face detection and real time information display. Their work highlights the use of technologies such as OpenCV and Raspberry Pi for intelligent interaction. Kumari et al. [6] designed an IoT-based smart mirror with additional functionalities such as motion detection and security features. Their system also supports online news display and environmental data monitoring. Kalekar et al. [7] developed a smart mirror integrated with voice assistants, allowing hands free interaction. The system displays weather updates, music, and news through a user-friendly interface. Shah et al. [8] proposed a multipurpose IoT smart mirror incorporating artificial intelligence and facial recognition. Their system extends applications to retail, education, and hospitality sectors, showing the versatility of smart mirrors. 2 Viswanatha et al. [9] introduced an advanced smart mirror using Raspberry Pi and YOLO algorithm for interactive display and object detection. This research highlights the integration of AI techniques to enhance system performance. Batool et al. [10] developed a smart mirror system with voice assistant support and multimedia features. The study shows how smart mirrors can improve productivity by providing multiple services in a single platform.

4.BLOCK DIAGRAM

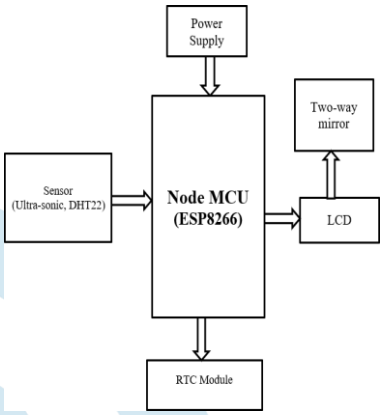


Fig Block Diagram of IoT based Smart Mirror

1. Node MCU (ESP8266)

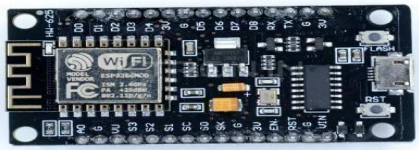


Fig Node MCU

Node MCU is the main controller of the smart mirror system and acts as the brain of the project. It collects data from sensors like DHT22 and ultrasonic and processes it. It also receives time and date from the RTC module. After processing, it sends the output to the LCD display and controls the relay module for automation. It is compact, low-cost, and easy to program using Arduino IDE. Due to its efficiency and flexibility, Node MCU is widely used in IoT and embedded system projects like the smart mirror.

2 Two-way Mirror:

Fig Two-Way Mirror

The two-way mirror is a special type of mirror that is used to create the smart mirror effect. It works like a normal mirror but also allows light from the display placed behind it to pass through. This helps users see both their reflection and the displayed information at the same time. It enhances the overall look and functionality of the system. The mirror plays an important role in combining

aesthetics with technology, making the project appear modern, innovative, and user-friendly.

3. LCD Display (20x4):

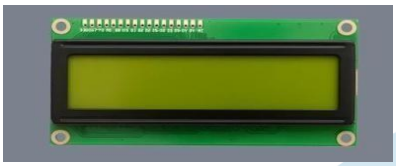
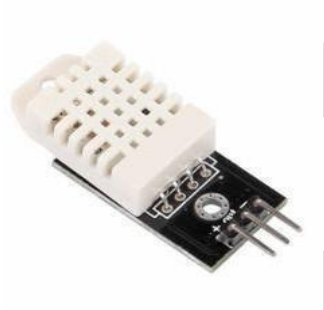


Fig LCD Display

The LCD display acts as the output unit of the smart mirror system. It receives processed data from the Node MCU and displays important information such as time, temperature, humidity, and other real-time updates. The display is placed behind the two-way mirror, allowing the information to be visible while still maintaining the reflective property of the mirror. It ensures that the data is presented clearly and in an easy-to-read format for the user.

4. DHT22 Sensor:

Fig DHT22 Sensor



The DHT22 sensor is used to measure temperature and humidity from the environment. It provides accurate and reliable data to the Node MCU. This data is then displayed on the LCD screen for the user. It helps in monitoring environmental conditions in real time. The sensor is easy to interface and widely used in IoT projects. It improves the functionality of the smart mirror by adding environmental awareness, making the system more useful and informative for everyday use.

5.RTC Module (DS3231):

Fig RTC Module

The RTC (Real Time Clock) module is used to provide accurate time and date information. It has a built-in battery that allows it to keep running even when the system is powered off. This ensures that the correct time and date are always available. The Node MCU reads this data and displays it on the LCD. Since the system works without internet connectivity, the RTC module is very important for maintaining proper time tracking in the smart mirror system.

6.Ultra-sonic Sensor:

Fig. Ultra-sonic Sensor

An ultrasonic sensor is used to detect the presence of an object or person by using sound waves. It sends ultrasonic waves and measures the time taken for the waves to return after hitting an object. Based on this time, it calculates the distance. In the smart mirror project, it is used to detect when a person comes near the mirror. When an object is detected within a certain range, the sensor sends a signal to the Node MCU, which turns ON the display or performs other actions.

METHODOLOGY:

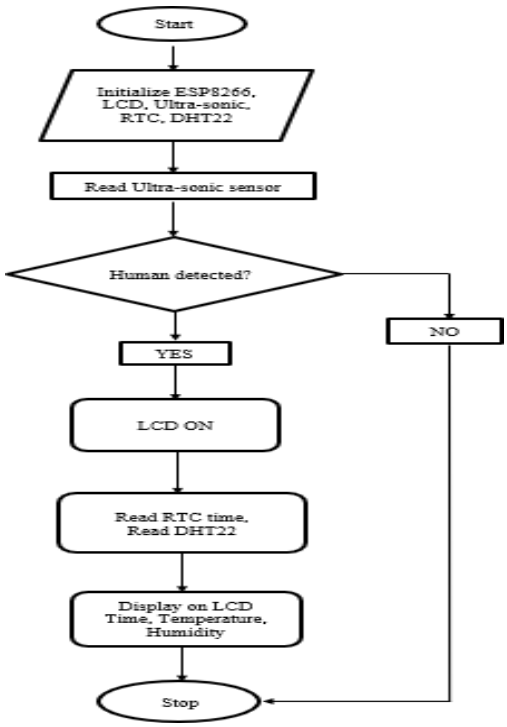


Fig. Flow Chart of IoT based Smart Mirror

Step 1: Start

The system is powered ON and the process begins.

Step 2: Component Initialization

The Node MCU (ESP8266) initializes all components like LCD display, ultrasonic sensor, RTC module, and DHT22 sensor.

Step 3: Presence Detection

The ultrasonic sensor continuously checks for human presence in front of the mirror.

Step 4: Idle State

If no person is detected, the system stays in idle mode and the display remains OFF to save energy.

Step 5: Display Activation

When a person comes within range, the system detects it and turns ON the display.

Step 6: Data Collection

The Node MCU collects real-time data from the RTC module (time & date) and DHT22 sensor (temperature & humidity).

Step 7: Data Display

The processed information is displayed on the LCD screen through the two-way mirror.

Step 8: Continuous Monitoring

The system keeps monitoring for human presence and repeats the process continuously.

5.RESULTS AND DISCUSSION:

The IoT-based Smart Mirror system was successfully designed, implemented, and tested. It effectively displays real-time information such as time, date, temperature, and humidity on the mirror surface using an LCD behind a two-way mirror. The ultrasonic sensor accurately detects human presence and automatically turns the display ON and OFF, ensuring energy efficiency. The DHT22 sensor provides reliable environmental data, while the RTC module maintains accurate time without internet connectivity. The Node MCU controls and processes all operations smoothly. Overall, the system works efficiently in offline mode and offers a secure, low-cost, and user-friendly solution for modern smart home applications.

6.CONCLUSIONS:

The IoT-based Smart Mirror is a useful and innovative system that combines a regular mirror with smart features. It provides real-time information like date, time, temperature, and reminders, making daily tasks easier. The system is simple, cost-effective, and user-friendly, making it suitable for everyday use. Overall, this project improves productivity and demonstrates how IoT can be applied in daily life.

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