Mini-project report

for

IoT Based Systems

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ABSTRACT

Smart Glasses represent a significant leap in mirror technology, combining convenience and innovation through the integration of IoT. This project focuses on designing and implementing Smart Glasses that display real-time notifications and other information directly onto the lens, providing users with a hands-free information delivery system. The hardware comprises an Arduino Nano microcontroller, a 0.96-inch OLED display, and an HC-05 Bluetooth module, seamlessly integrated within a lightweight and ergonomic frame.

The Arduino Nano serves as the processing hub, managing data and coordinating communication between components. Notifications such as messages are transmitted wirelessly from a smartphone or other Bluetooth-enabled devices using the HC-05 module. The OLED display projects the notifications and other information clearly while ensuring minimal power consumption, making the glasses efficient and practical use.

This project emphasizes simplicity, portability, and functionality, aiming to enhance user productivity and connectivity without disrupting daily routines. By leveraging IoT and smart glass technology, the Smart Glasses provide a glimpse into the future of smart mirrors, showcasing their potential to revolutionize human-device interaction. This report details the design, development, and challenges of the project, demonstrating its practical applications and scope for future enhancements.

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ABBREVIATIONS

S.NO.	ABBREVIATIONS	FULL FORM
1.	ARSG	Augmented Reality Smart Glasses
2.	BMP	Bitmap (Image File Format)
3.	GFX	Graphics Library (often refers to Adafruit_GFX library for OLED displays)
4.	HC-05	Bluetooth Serial Port Profile-Bluetooth Module HC-05
5.	12C	Inter-Integrated Circuit
6.	ICT	Information Communication Technology
7.	IDE	Integrated Development Environment
8.	IOT	Internet Of Things
9.	OLED	Organic Light Emitting Diode
10.	RFCOMM	Radio Frequency Communication
11.	RX	Receive Pin (in communication protocols)
12.	SCL	Serial Clock Line (used in I2C communication)
13.	SDA	Serial Data Line (used in I2C communication)
14.	SSD	Solid State Drive (or sometimes refers to SSD1306 OLED Driver IC)
15.	TX	Transmit Pin (in communication protocols)
16.	UART	Universal Asynchronous Receiver-Transmitter
17.	USB	Universal Serial Bus

INTRODUCTION

The rapid advancements in mirror technology and the Internet of Things (IoT) have opened new avenues for enhancing convenience and connectivity in daily life. Smart Glasses, a revolutionary IoT application, represent a seamless integration of modern technology into conventional interaction. This project aims to develop Smart Glasses capable of displaying notifications directly through the lens, magnifying the content, offering a hands-free, real-time information delivery solution.

The proposed Smart Glasses are built using an Arduino Nano as the central microcontroller, paired with a 0.96-inch OLED display and an HC-05 Bluetooth module. The Arduino Nano, known for its compact form factor and efficient processing capabilities, acts as the core unit, managing the flow of data between the components. The OLED display provides a crisp and low-power visual interface for projecting notifications. The HC-05 Bluetooth module facilitates wireless communication between the Smart Glasses and a connected device, such as a smartphone.

Real time data is transmitted wirelessly to the glasses or mirror via Bluetooth and directly through the arduino app, since working on small scale projects. This setup ensures that users can interact without needing to check their smartphones repeatedly, enhancing convenience and productivity. The Smart Glasses are designed with a focus on usability, ensuring that the components are lightweight, durable, and integrated seamlessly into the frame for comfort and aesthetic appeal.

This project demonstrates the potential of IoT technology in everyday use devices and resources, showcasing how connected systems can simplify and enrich everyday activities. The report explores the design, assembly, and implementation of the Smart Glasses, detailing the hardware architecture, system functionality, and the innovative solutions adopted to overcome technical challenges.

OBJECTIVE AND PROBLEM FORMULATION

Objective: To develop a multi-functional, interactive smart mirror system that integrates essential daily utilities such as real-time text updates, time tracking, and entertainment. This system uses an Arduino, Bluetooth module, and OLED display to enhance the functionality of a conventional mirror by seamlessly blending technology into everyday life.

Problem Formulation: Traditional mirrors lack the capability to provide interactive or utility-based features beyond their primary reflective purpose. Users often rely on multiple devices for accessing time, date, text notifications, and minor entertainment, leading to inefficiency and inconvenience. The challenge is to design a cost-effective, compact system that can:

1. Display real-time notifications or text via Bluetooth.
2. Act as a counter/timer for various purposes.
3. Show time with an analog clock and date with a calendar display.
4. Offer entertainment features such as animations and bitmap images(BMP).
5. Integrate all functionalities into a mirror setup, ensuring usability and aesthetic appeal.

This solution aims to redefine the smart mirror experience for modern households.

Component List:

Sr. No.	Component name	Specifications	Quantity
1.	Oled display	0.96 inch display	1
2.	Bluetooth module	HC-05	1
3.	Arduino Pro Mini	Nano V3	1
4.	Mirror Glass	Normal	1
5.	Magnifying Glass	normal/ 100 mm	1
6.	Cardboard and other stationery supplies	-	-

Table 1.1: Components Used in the Project

Communication Protocol Used:

- **I2C (Inter-Integrated Circuit) Protocol**

  Used for: Communication between the Arduino Nano and the OLED display.

  Purpose: I2C is a two-wire protocol where the SDA (Serial Data) line carries the data, and the SCL (Serial Clock) line provides a clock signal to synchronize the communication.

  Benefits: It allows peripherals to communicate with the Arduino using only two wires, making it efficient and low-power for compact devices like smart glasses.

- **UART (Universal Asynchronous Receiver-Transmitter) Protocol**

  Used for: Communication between the Arduino Nano and the Bluetooth module(HC-05).

  Purpose: UART is a simple protocol used for serial communication between the Arduino and the Bluetooth module, with TX (Transmit) sending data and RX (Receive) receiving data.

  Benefits: This allows for bidirectional communication between the Arduino and a smartphone via the Bluetooth module, enabling features such as sending time or notifications to the smart glasses.

- **Bluetooth Protocol (RFCOMM)**

  Used for: Wireless communication between the Bluetooth module HC-05 and the smartphone.

  Purpose: Bluetooth uses the RFCOMM protocol, which emulates a serial port for easy data transfer. This enables the smart glasses to receive data from the smartphone, such as notifications or time updates, and display it on the OLED screen.

  Benefits: Bluetooth provides wireless connectivity, allowing the smart glasses to interact with external devices without physical connections, improving usability and mobility.

LITERATURE REVIEW

Here's a glimpse of some prominent past approaches that helped us formulate the project:

1. ***Oscar Danielsson, Magnus Holm, Anna Syberfeldt, Augmented reality smart glasses in industrial assembly: Current status and future challenges, Journal of Industrial Information Integration, Volume 20, 2020, Z00175, ISSN 2452-414X*:** This research paper delves into the application of Augmented Reality Smart Glasses (ARSG) in industrial assembly. A comprehensive literature review was conducted to assess the current state-of-the-art and identify future challenges. The findings highlight the potential of ARSG in enhancing operator efficiency, reducing errors, and improving overall productivity. However, limitations such as hardware variability, low TRLs of certain components, and a need for improved tracking technologies were identified. Future research should focus on the operator perspective, seamless integration with existing systems, and addressing security and privacy concerns. By addressing these challenges, ARSG can be effectively integrated into industrial settings, revolutionizing manufacturing processes.

2. ***M. M. Yusri et al., "Smart mirror for smart life," 2017 6th ICT International Student Project Conference (ICT-ISPC), Johor, Malaysia, 2017, pp. 1-5, doi: 10.1109/ICT-ISPC.2017.8075339:*** This research paper proposed the concept of a Smart Mirror, an IoT-based smart home system designed to enhance daily living. The Smart Mirror provides users with essential information such as time, date, weather updates, traffic conditions, and location maps, along with the ability to control home lighting. The project employs an Evolutionary Prototyping approach to gather requirements, design, and iteratively improve the system based on user feedback. This methodology ensures a user-centric development process that prioritizes usability and satisfaction. While additional features like advanced voice or camera functionalities were explored conceptually, they are identified as areas for potential future development. The Smart Mirror exemplifies the integration of IoT technology into daily life, offering convenience and efficiency in household management.

PROJECT DESIGN AND IMPLEMENTATION

1.Hardware Setup:

1.1 Component Used:

- Arduino Nano: This serves as the microcontroller for the glasses, managing the operations and controlling the OLED display and Bluetooth module.
- Bluetooth Module: A Bluetooth module HC-05 is used for wireless communication between the setup and a smartphone. This allows the mirror setup to receive real time information.
- OLED Display: A compact OLED display is used to show real-time information, such as the current time, incoming notifications, or animation from the connected smartphone.

1.2. Frame and Glass Construction

- Frame Design: A lightweight, durable frame is selected to house all the components without adding excessive bulk. The design ensures proper distribution of the components for balance and comfort while wearing.
- Glass Involvement: The lens (either prescription or plain) is integrated into the frame. The OLED display is strategically positioned within the user's line of sight, typically on the corner of one of the lenses. The glass acts as the viewing platform for the display.
- Component Mounting: The Arduino Nano, Bluetooth module, and battery are discreetly attached in the frame. The wiring is concealed within the arms of the glasses to maintain a sleek design. Additional care is taken to ensure the wiring and components are secure but lightweight.

2. Software Development:

- Arduino IDE Setup: The Arduino Nano is programmed using the Arduino IDE. The code manages Bluetooth communication, time synchronization, and updating the OLED display.

- Bluetooth Integration: The Bluetooth module is set up to pair with a smartphone. A custom mobile app or existing apps are used to send notifications and time data to the Arduino.

- OLED Display Programming: Libraries like Adafruit_GFX and Adafruit_SSD1306 are used to display the data on the OLED screen. The display shows notifications with simple icons and text, making it easy for the user to read.

3. Testing and Calibration:

After assembling the hardware, the glasses are tested for Bluetooth range, OLED display clarity, and overall comfort. Any necessary adjustments are made to the frame and component placement to ensure the best user experience.

- Assembly: Assemble all components into the smart glasses frame, ensuring that the wiring is secure and components are well-placed.

- Calibration: Calibrate the OLED display to ensure optimal visibility and readability. Adjust brightness and contrast settings if needed.

- Final Testing: Perform final testing to confirm that the smart glasses function as intended, displaying time and notifications correctly and maintaining a stable Bluetooth connection and code design.

Circuit Diagram:

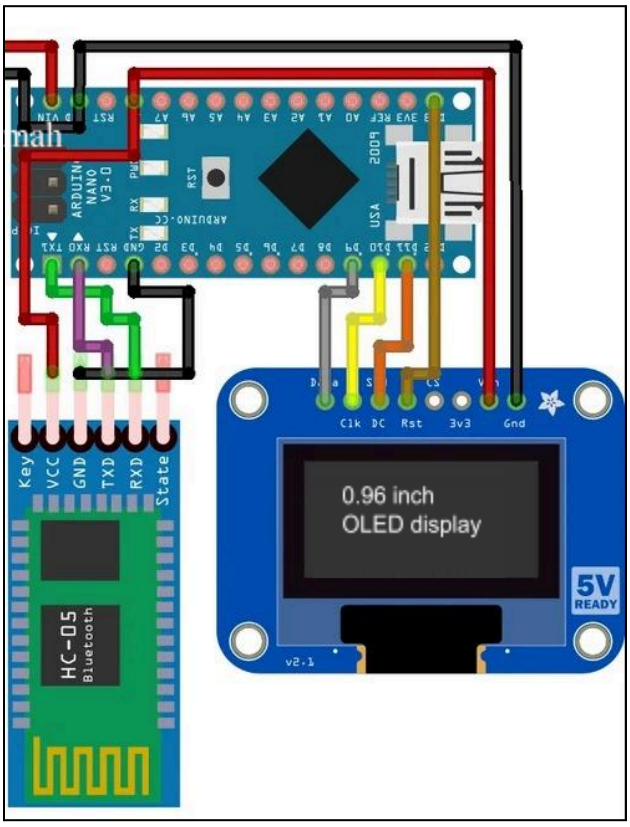

Fig 1.1: circuit diagram of hardware setup

Considering the above circuit diagram, the Circuit Operation are:

1. **Bluetooth Communication:** A Bluetooth-enabled device (e.g., a smartphone) connects to the HC-05 module. The device sends data, such as text or commands, to the module.
2. **Data Transmission:** The HC-05 module receives the data and transmits it serially to the Arduino Nano.
3. **Data Processing:** The Arduino Nano's microcontroller processes the received data. It interprets the commands and prepares the necessary control signals for the OLED display.
4. **Display Control**: The Arduino Nano sends control signals to the OLED display, specifying the content to be displayed. The display then renders the information on its screen.

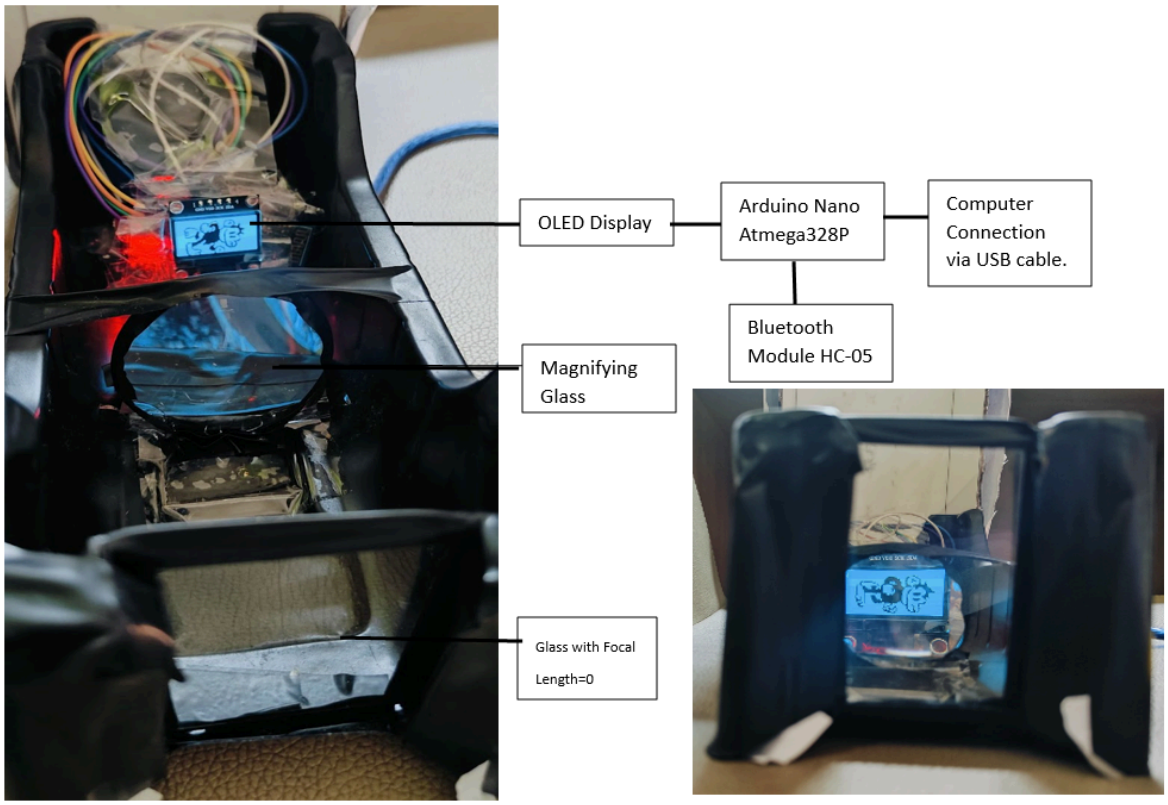

Fig 1.2: Top View of the Hardware Setup

Fig 1.3: Front View through the mirror

Fig 1.2 image shows the top view of the hardware setup. We can see the Arduino Nano board, the Bluetooth module, and the OLED display mounted on a platform. There's also a magnifying glass placed on the platform, suggesting its role in the image capture process.

Fig 1.3 image shows the front view of the setup, as seen through a mirror. We can see the OLED display displaying an image. The reflection in the mirror suggests that the image is being captured through a glass surface.

OUTCOMES AND PROSPECTIVE LEARNING

The specific outcomes observed through the project are:

1. **Display Real-Time Notifications or Text via Bluetooth**:
   The mirror incorporates a Bluetooth module to receive and display real-time text messages or notifications sent from a mobile device. This feature allows users to view important updates, reminders, or personalized messages directly on the mirror without needing to check their phone, enhancing convenience and accessibility.

2. **Act as a Counter/Timer for Various Purposes**:
   A built-in counter/timer functionality provides practical utility for day-to-day tasks. Whether it's timing workouts, cooking, or other activities, users can easily set and monitor the countdown or elapsed time, making the mirror an essential tool for time management.

3. **Show Time with an Analog Clock and Date with a Calendar Display**:
   The mirror seamlessly displays the current time in an elegant analog clock format, adding a classic aesthetic touch. Additionally, the calendar display shows the date, helping users stay organized and on schedule without needing additional devices.

4. **Offer Entertainment Features Such as Animations and Bitmap Images**:
   To add a fun and engaging aspect, the mirror features customizable animations, moving text, and bitmap image displays. These features enhance visual appeal and make the mirror an interactive and entertaining part of the user's environment.

5. **Integrate All Functionalities into a Mirror Setup**:
   All these features are compactly integrated into the mirror's design, ensuring a sleek and aesthetically pleasing appearance. The interface is intuitive, ensuring usability without compromising the primary function of the mirror as a reflective surface. This blend of form and function makes the mirror a practical and visually appealing addition to any modern household.

Perspective Learnings

- **Challenges in Wireless Communication**

  One of the key learning points was ensuring stable Bluetooth communication, especially when the device is paired with multiple devices or in environments with potential interference. Fine-tuning the Bluetooth communication parameters and implementing reliable data handling were crucial for consistent performance.

- **Component Selection and Integration**

  The project emphasized the importance of selecting compatible components for successful integration. For example, choosing the Arduino Nano for its compact size and I2C-based OLED for efficient data transfer were critical decisions. Additionally, selecting the HC-05 Bluetooth module for reliable data transfer was a major learning point in terms of both hardware and protocol compatibility.

- **Real-Time Data Handling**

  Handling real-time data, particularly notifications that must be displayed immediately, taught the importance of efficient data management in embedded systems. Ensuring minimal latency in the transmission of notifications was crucial for user experience and project success.

- **Modern Tech Design Considerations**

  The project highlighted the importance of comfort, weight, and durability in devices or resources we use on a daily basis such as mirrors. The glasses needed to be both functional and comfortable, requiring thoughtful integration of electronic components into an aesthetically pleasing frame.

- **Wireless Security Concerns**

  A key learning was the consideration of security in wireless communication, especially with Bluetooth. Ensuring secure data transfer by implementing pairing encryption

methods and safeguarding against unauthorized access were critical aspects that need attention in future iterations.

- **Functional Prototype of Smart Glasses**

  The project successfully resulted in a working prototype of Smart Glasses capable of receiving and displaying real time information and code generated output. The seamless integration of the Arduino Nano, OLED display, and HC-05 Bluetooth module enabled real-time communication and display of notifications, demonstrating the feasibility of the IoT-based mirror device.

- **Effective Use of Bluetooth for Data Transfer**

  Bluetooth communication was efficiently implemented to wirelessly transfer data between a smartphone and the Smart Glasses along with designed codes for specific outputs and display. The HC-05 module enabled stable communication, ensuring that the glasses displayed notifications reliably.

- **Enhanced Notification System**

  The Smart Glasses provided a hands-free method for users to stay updated on messages, alerts, and reminders, and other uses thereby improving user convenience and productivity. This system reduces dependency on smartphones for everyday work.

CONCLUSION

The "Smart Use" project redefines the concept of a conventional mirror by integrating a range of practical and engaging features that cater to everyday needs. By utilizing an Arduino, Bluetooth module, and OLED display, the system provides a compact and cost-effective solution that merges utility with convenience. The mirror serves as more than just a reflective surface—it becomes a functional smart device capable of displaying Bluetooth terminal text, tracking time with a counter or timer, showing the current time with an analog clock, and presenting a calendar for date management.

In addition to these practical applications, the mirror offers an element of creativity and entertainment through animations, moving letters, and bitmap image displays, making it a visually appealing addition to any household. Its ability to display real-time notifications via Bluetooth further bridges the gap between traditional devices and modern smart technologies.

This project not only addresses the inefficiencies of relying on multiple devices for basic tasks but also demonstrates how simple, accessible technologies can create impactful and innovative solutions. The "Smart Use" mirror is a step forward in smart home design, showcasing the potential of integrating diverse functionalities into everyday objects to improve both practicality and user experience.

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