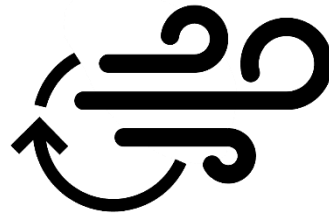University of Moratuwa
Faculty of Engineering
Department of Electronic and Telecommunications Engineering

EN1190 – Engineering Design Project

ECOSYNC

"Enhancing Comfort, Conserving Power, Innovating the Future"
Intelligent AC Temperature Regulator

Final Report

by

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1 Problem Description and Solution

1.1 Problem Identification

 In today's industrial world, one of the major concerns is the energy deficit, leading to rising energy costs and significant wastage. The hotel industry exemplifies this challenge, as it struggles to balance energy efficiency with guest comfort.

Many hotels have implemented a key card system to automatically switch off electricity when guests leave their rooms, aiming to conserve energy. However, this solution is not without its flaws. When guests return, they often find their rooms uncomfortably warm and must manually readjust the air conditioning, **leading to dissatisfaction**. On the other hand, to ensure guest comfort and protect room furnishings, some hotels keep the air conditioning running even after removing the key card. While improving the guest experience, this practice results in **considerable energy wastage**.

Therefore, the hotel industry faces a critical dilemma: achieving energy efficiency without compromising guest comfort. Our startup aims to address this pressing issue by developing an innovative solution that refines energy consumption while maintaining a comfortable environment for hotel guests.

1.2 Proposed Solution

It is obvious that turning off and keeping the AC on are problematic. Therefore, we proposed a solution, a device called "ECOSYNC" to achieve the state between two extremes.

When the keycard is removed from the holder (indicating the user's absence), ECOSYNC increases the AC temperature to a higher value to minimize power consumption. This higher value of the temperature will not make the user uncomfortable either. When the keycard is inserted again the initial low temperature will be obtained. \

2 Technical Feasibility

We use several fundamental modules to achieve the feasibility of the product. especially we designed ECOSYNC to have two separate PCB units: Keycard Presence Detector and AC Controller.

2.1 ATmega 328P-PU Microcontroller

We chose to use this microcontroller chip because of its flexibility in choosing internal and external clock sources and ease of programmability. We use two of these chips for both PCBs. It functions as the main controller for the whole ECOSYNC.

2.2 Power Supply Unit

Since we have two separate PCB units, each needs separate power supply units too. We used two 3.7V rechargeable batteries for both systems. We chose a higher voltage supply for efficiency.

ACC comes with a 12V DC charger, which can be kept connected without needing to charge manually often. The battery pack takes a minimal amount (~5mA) to achieve this specification.

2.3 LM2596S and DC to DC Buck Converter Modules

A buck converter is essential to step down, regulate, and stabilize the supplied voltage since we use a high-voltage power supply.
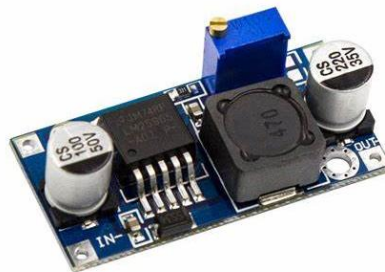
2.4 HC-05, HC-06 Bluetooth Wireless Serial Arduino Modules

HC-05 acts as the transmitter from the Keycard Presence Detector and HC-06 is the receiver, which is placed in the AC Controller unit. We had to use two separate modules because, though HC-05 can function as both transmitter and receiver; HC-06 can only receive Bluetooth signals. The transmitter sends the information about the keycard's presence in the keycard holder to the

receiver. This plays the vital role of triggering the AC Controller to change the temperature of the AC.

Since both units of ECOSYNC are inside a room, we chose Bluetooth modules to communicate with each other, which is cost-effective too.

2.5 IR Proximity Sensor Module

ECOSYNC's one of the main tasks is to detect the Keycard's presence. To achieve this, we could use several proximity sensors; though we stuck with this IR module because it is very flexible and cost-effective, also it fulfills the requirements.
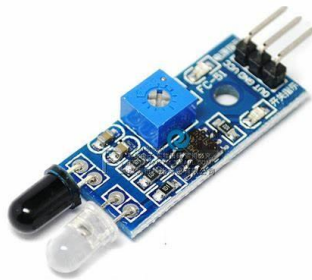
2.6 IR Emitter

ECOSYNC's other main task is to change the temperature of the AC according to the presence of the keycard. It achieves this by emitting relevant IR signal arrays. We use a basic IR Emitter to complete this task.
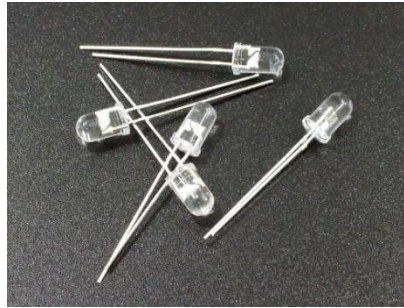
3 Product architecture

The block diagram of the proposed product architecture is as follows

3.1 AC Controller

3.2 Keycard Presence Detector

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┌─────────────────┐      ┌─────────────────┐      ┌─────────────────┐
│                 │      │ MICROCONTROLLER │      │    BLUETOOTH    │
│    IR SENSOR    │ ───► │      UNIT       │ ───► │     MODULE      │
│                 │      │                 │      │                 │
└─────────────────┘      └─────────────────┘      └─────────────────┘
                                  ▲
                                  │
                         ┌─────────────────┐
                         │  POWER SUPPLY   │
                         │      UNIT       │
                         └─────────────────┘
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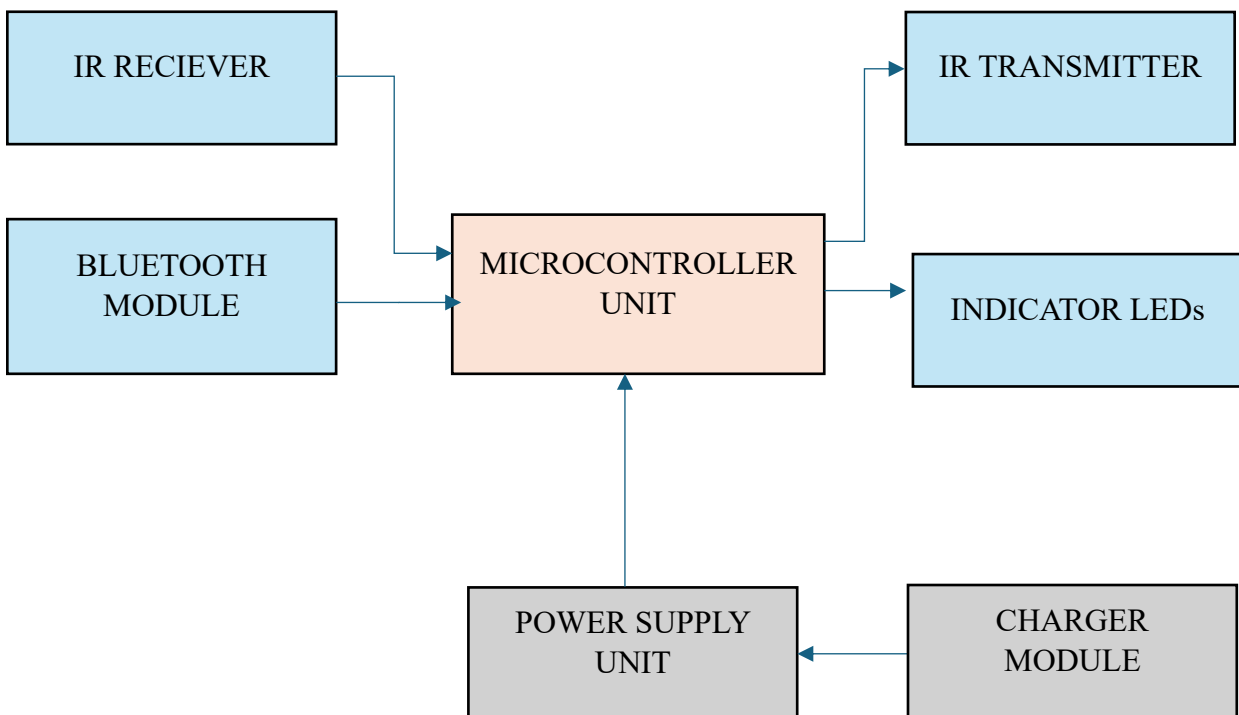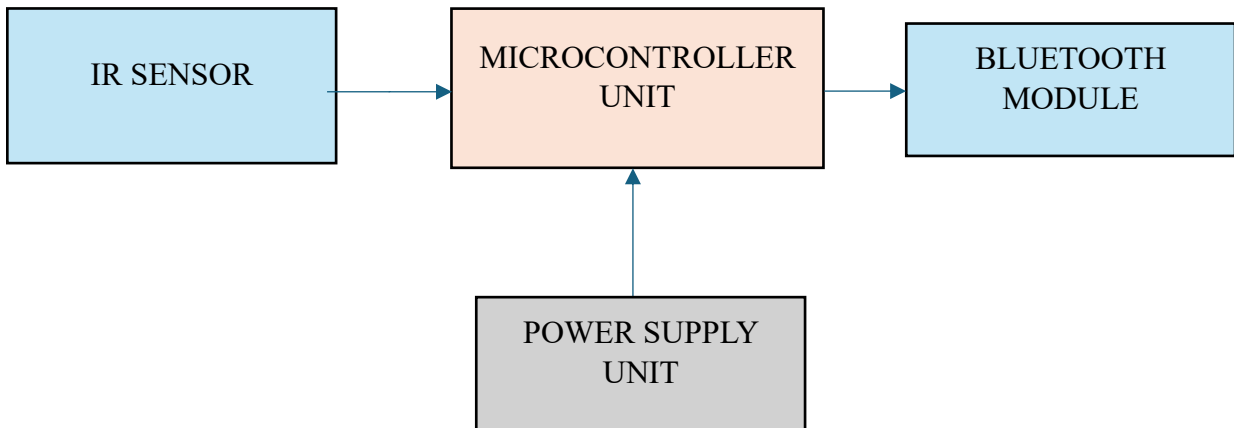
4 PCB Design

We have used Altium software to design our PCB. The following are the schematic and PCB layouts that we developed. During our development procedure, we referred to data sheets of the components used to find their specifications.

4.1   AC CONTROLLER
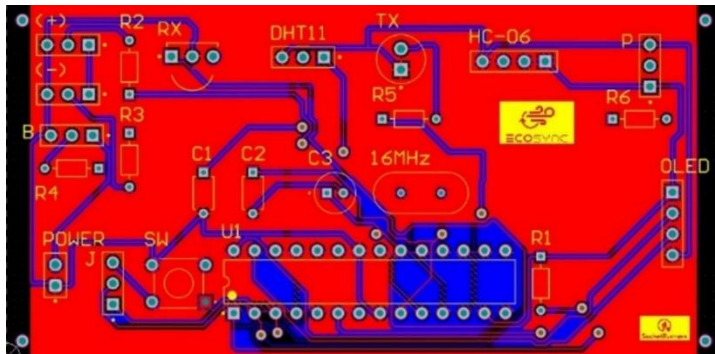
Top layer
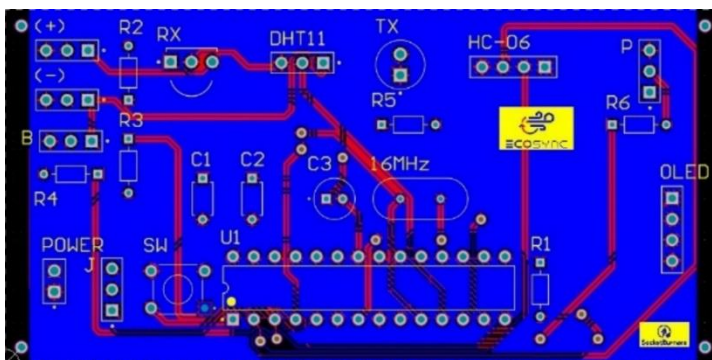
Bottom layer

Schematic of the PCB

4.2 KEY CARD PRESENCE DETECTOR

Schematic of the PCB

5 Enclosure Design

5.1 Design Sketches

5.2 Final enclosure design

6 The Final Product

7 Marketing Approach

7.1 Target Audience

ECOSYNC initially targets luxury hotels that are committed to guest comfort and sustainability. These high-end establishments prioritize offering a luxurious experience while adhering to stringent environmental standards. As we expand our market presence, we will consider the uni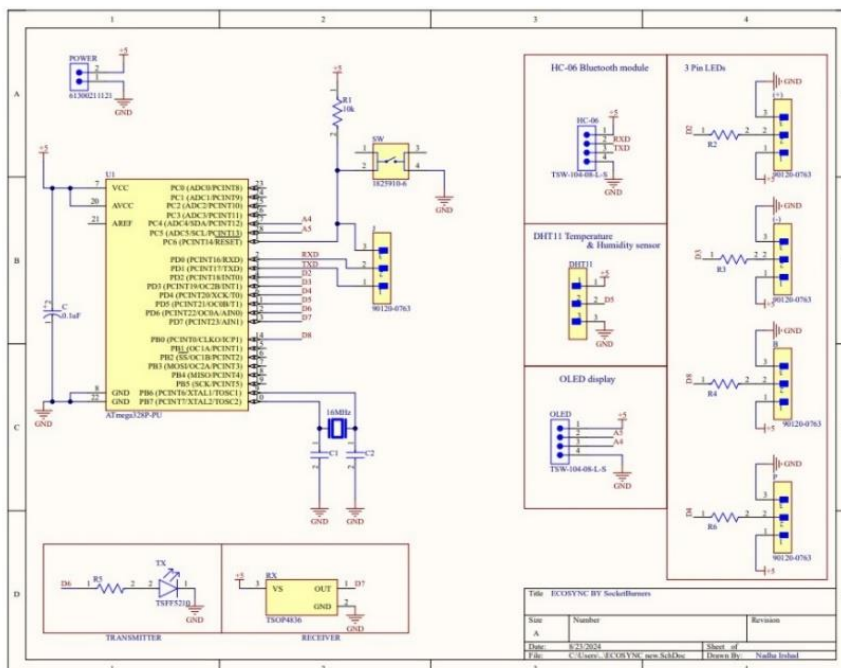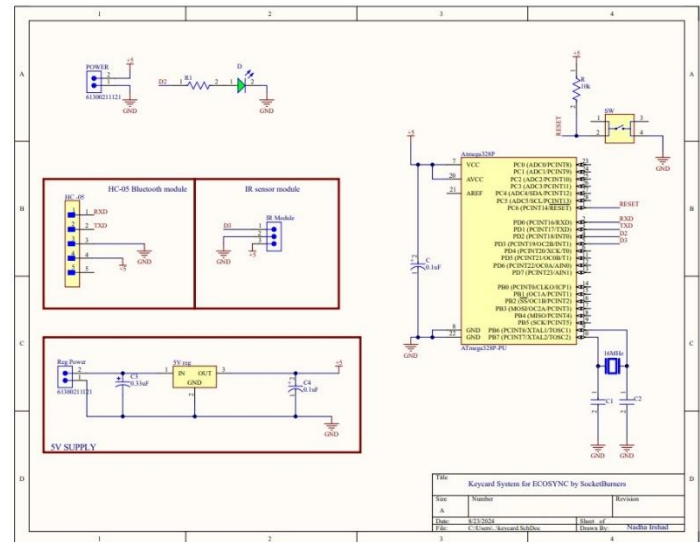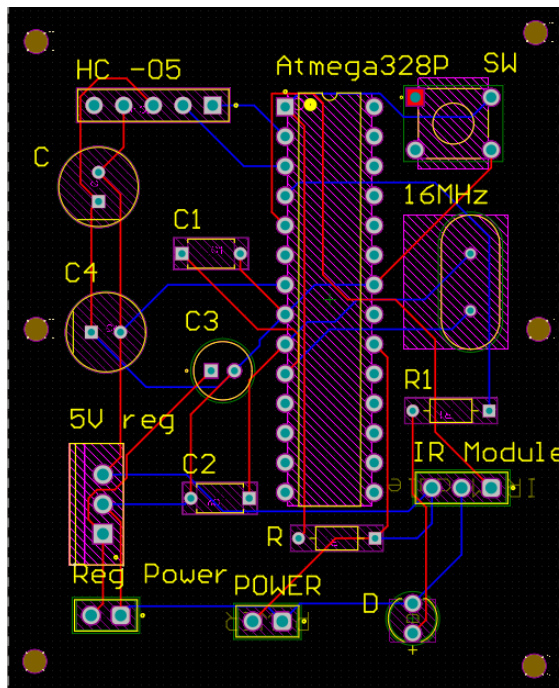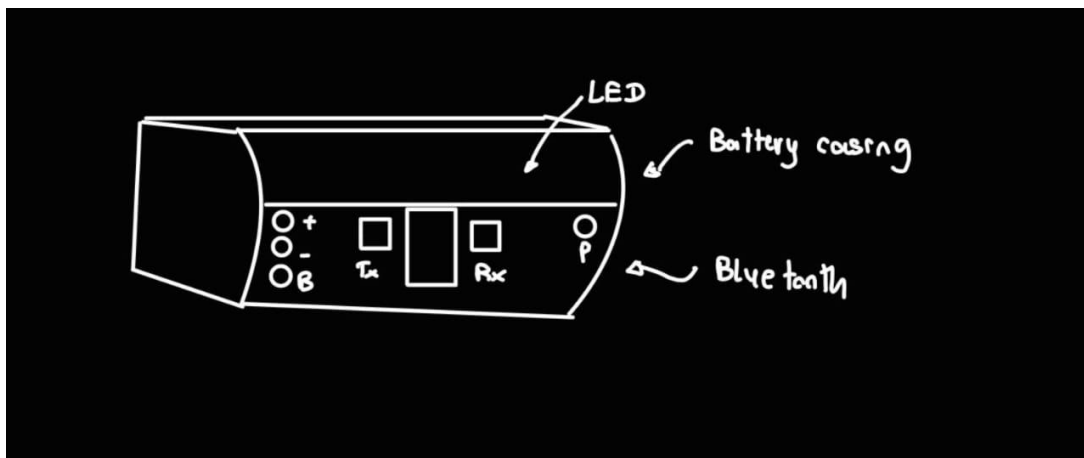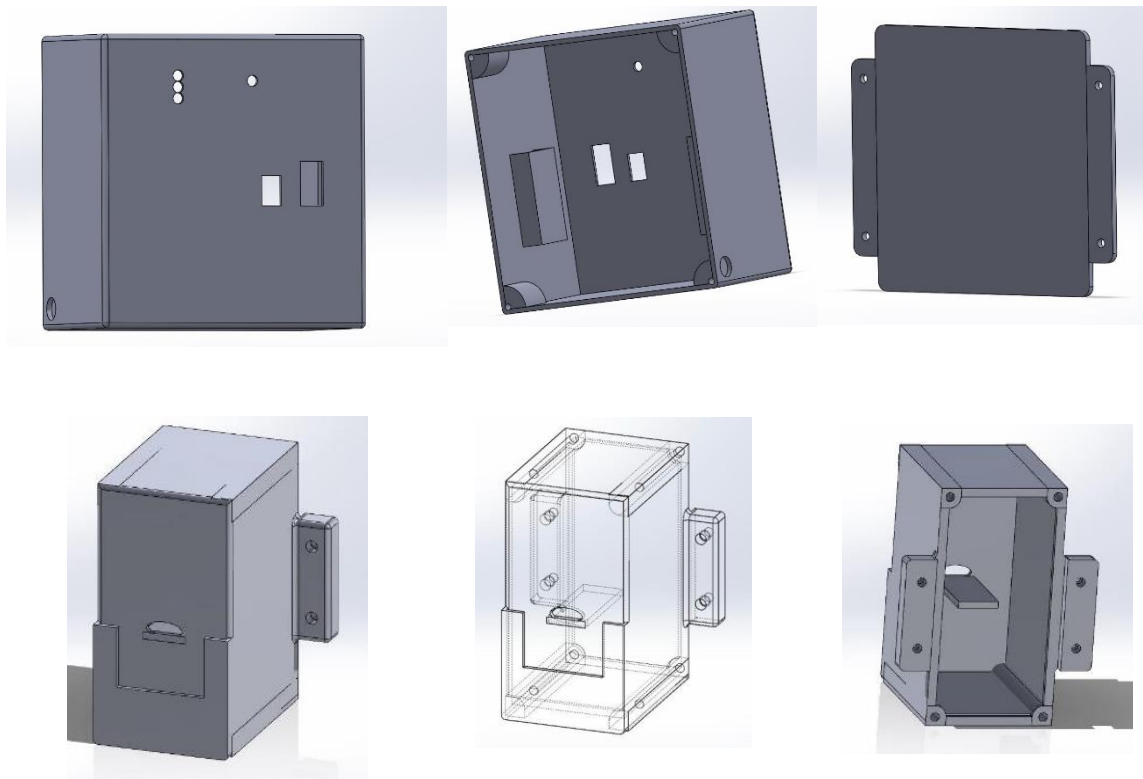que requirements of Mid-range hotels, hotel chains, and Boutique hotels. This approach ensures that ECOSYNC not only meets the current needs of luxury hotels but also adapts to the diverse demands of other hotel segments in the future.

7.2 Unique Selling Point

Normally the electricity bill of a hotel surpasses millions per month, after several meetings with some hotels, we got to know their main interest in our product is that ECOSYNC can save a significant amount on the electricity bill. We consider that as our main and unique selling point.

7.3 Marketing Strategy

To kickstart our efforts, we gathered data on hotel owners' and managers' priorities and challenges related to energy management through Surveys, field visits, and Industry reports. This research also encompassed competitor analysis to highlight ECOSYNC's unique advantages. Studies related to existing solutions, their strengths, and weaknesses were conducted to ensure ECOSYNC stands out in the market.

7.3.1 Digital Marketing Strategy

Digital marketing will play a crucial role, targeting social media campaigns on platforms like LinkedIn, Facebook, and Instagram. These campaigns will engage industry professionals. Email marketing campaigns will be tailored to hotel owners and managers, highlighting the cost-saving and comfort-enhancing benefits of ECOSYNC.

7.3.2 Sales Strategy

Direct sales will be driven by a resolute sales team, complemented by online sales through our website. We will also focus on strategic partnerships with HVAC companies and hotel suppliers to broaden our distribution network and enhance product integration.

7.3.3 Promotional Activities

- Product demonstrations
- Webinars
- Participation in hotel industry trade shows and conferences

These activities will highlight ECOSYNC's capabilities and allow us to network with potential clients and partners.

7.4 Brand Design

The brand name is "ECOSYNC," and we use that to mention our product in every single instant. We have created a logo that describes our product's functionality. We made flyers along with some stickers that simply explained the function of the product.

8 Bill of Quantities

Component / Cause	Unit Price	Quantity	Price
PCB printing	Rs. 2257.50 Rs. 200.00	1 2	Rs. 2657.50
Enclosure (3D printing)	Rs. 4580.00 Rs.480.00 Rs.815.00 Rs.4945.00 Rs. 815.00	1 1 1 1 1	Rs.11636.00
Rechargeable Battery	Rs. 840.00	2	Rs.1650.00
Atmega328P-PU microcontroller	Rs.850.00	2	Rs. 1700.00
Bluetooth Modules *(HC06, HC05)*	Rs.950.00	2	Rs.1900.00
IR Proximity Sensor	Rs.95.00	1	Rs.95.00
Buck Converter	Rs.370.00	2	Rs.740.00
16MHz Crystal Oscillator	Rs. 20.00	2	Rs.40.00
LED	Rs. 40.00	3	Rs.120.00
10K,270 resistor	Rs. 1.58	6	Rs. 9.48
22pF Ceramic capacitor	Rs. 3.00	4	Rs.12.00
0.1uF Electrolytic capacitor	Rs. 3.00	2	Rs. 6.00
Switch	Rs. 10.00	3	Rs. 30.00
Marketing Material Cost	Rs.85.00 Rs.90.00 Rs.160.00	2 1 1	Rs.520.00
TP5100 Charger Module	Rs.220.00	1	Rs.220.00
12V DC Connector Female Pin	Rs.40.00	1	Rs.40.00
Battery Case	Rs.80.00	2	Rs.160.00
Connectors, wires, and screws		Many	Rs.300.00
Total			**21835.98**

9 Revenue Streams

Subscription-Based Model: Recurring revenue from subscription fees for the use of the ECOSYNC system, including software updates and support services.

Installation Fees: One-time revenue from the first installation and integration of the system into the hotel's infrastructure.

Consulting Services: Added revenue from offering energy efficiency consulting services to help hotels maximize the benefits of the system.

Partnership Revenue: Revenue-sharing agreements with strategic partners who promote and integrate ECOSYNC's solutions into their offerings.

10 Task Delegation

Done in a manner that tasks are equally divided resulting in an evenly spread workload.

Though tasks are divided, as a team we helped each other in every other's task.

TASK	ALLOCATED MEMBER(S)
Finding a problem	ALL
Solution plan	ALL
Circuit design	Muftee MMM Aashir MRM
PCB design	Nadha MI
Programming and coding the controller	Aashir MRM
Enclosure design	Muftee MMM
Product assembly	Aashir MRM Munavvar MAA
Documentations	Munavvar MAA Nadha MI
Brand design (Logo, brochures)	Munavvar MAA

11 Functioning of the device prototype

ECOSYNC has two separate units.

- Keycard Presence Detector (KPD): *A keycard holder with a presence detector.*
- AC Controller (ACC)

KPD's IR proximity sensor detects whether the keycard is inserted or removed if it is removed,

It sends the message to the ACC using a Bluetooth signal. ACC then transmits relevant IR signals to the AC according to the selected mode to change the working temperature of the AC.

ACC has two modes,

- Eco Mode: Rises the temperature to 25 degrees Celsius; showed by green LED
- Luxury Mode: Rises the temperature to 23 degrees Celsius; showed with blue LED

The mode selection is designed to be manual and can be controlled by the hotel management.

➢ ECOSYNC works only with the implemented hotel room's air conditioner.
The calibrations for each air conditioner will be done during the implementation process.

12 Future Improvements

12.1 Development of second prototype

We are planning to upgrade our hardware components to the Xtensa LX6 microprocessor, which will significantly enhance the Wi-Fi and Bluetooth integration capabilities of our product. This upgrade will allow us to incorporate advanced IoT functionalities, providing a more connected and seamless experience for our users.

12.2 Mobile Automation

ECOSYNC will offer seamless control through an intuitive mobile app, allowing users to adjust A/C settings from anywhere. This ensures that guests can maintain their preferred comfort levels effortlessly.

12.3 Automatic scheduling

Powered by innovative AI, ECOSYNC will learn user preferences and behaviors to optimize temperature settings automatically. This feature will maintain comfort while minimizing energy usage by adjusting settings based on a personalized schedule.

12.4 Voice command functionality

As an additional luxury feature, we are also developing voice command functionality like Alexa on smart home devices. This feature will allow guests to control the air conditioning and other room settings using simple voice commands, enhancing their overall experience, and adding a modern, convenient touch to their stay.

12.5 Research and development: addressing CO_2 increase

During ECOSYNC's research phase, we are tackling the challenge of increased CO2 levels inside hotel rooms. Elevated CO2 can cause health issues such as headaches, dizziness, fatigue, and impaired cognitive performance. Poor air quality can exacerbate respiratory conditions and disrupt sleep patterns, negatively impacting guest satisfaction and overall comfort.

To mitigate these effects, we are exploring advanced ventilation systems and air purifiers integrated with CO2 sensors. These systems will monitor air quality in real-time and automatically adjust ventilation to maintain optimal levels. For AC units without built-in ventilation, ECOSYNC will provide warnings to increase ventilation. Our goal is to enhance energy efficiency and significantly improve indoor air quality, ensuring a healthier and more comfortable environment for hotel guests.