An-Najah National University Faculty of Engineering & Information Technology

Department of Computer Engineering

Graduation Project II

SmartDesk

Prepared by:

Eman Abd Alaziz
Samya Hamed

Supervised by:

Dr. Emad Natsheh

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Disclaimer

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Abstract

As technology gets better thanks to AI, we need new ways to design and make office furniture that works for people who work and study from home. Desks are important parts of daily life, both at work and at home. User activity tracking systems have shown that height-adjustable desks have helped users sit less (17% less) and be more productive and focused (65% more). This shows how smart office solutions need to be smart enough to let people move around easily to keep up with changing work and school settings. The Smart Office project brought in these systems:

* Height Adjustment System: This system keeps the desk surface at a comfortable height by using an HC-SR04 sensor to measure distance (2 cm to 4 meters, with an accuracy of up to 3 mm) and a DC motor to raise and lower the desk in both sitting and standing positions.

* Angle Desk Tilt System: This system uses a six-axis MPU6050 sensor to change the angle of the desk surface based on how the user uses it, making sure they are comfortable and in the right position.

* RGB Light Strip: Changes color based on office notifications like login, drawer storage, or environmental sensor readings (temperature, humidity, or air quality via MQ135). This gives you real-time visual feedback about the office and the area around it.

* Light Strip: An LDR controls it to check if there is enough light.

* Alarm System: Sounds alarms (sounds) when gas levels or temperatures are too high, which lets the cooling fan turn on by itself. It also makes noise when you log in and store things.

* RFID Authentication: This makes sure that only the owner or people who have permission can use the office.

* Integrated Mobile App: The owner can acquire periodic reports on desktop, tilt, and drawer garage.

With this model, we intend to set new standards for clever places of work that combine a snug painting's surroundings, automatic environmental reaction, and intelligent manipulation to make certain a healthful, secure environment.

Chapter 1

Introduction

With the developing subject for public health and the unfolding of faraway working, peak-adjustable smart desks have won popularity, specially in evolved international locations, due to their consolation and adaptability to the diverse wishes of users. However, developing modern-day desks that meet standards of consolation, safety, and productivity stays a real task, especially given the sizable reliance on conventional desks that lack flexibility and modern-day technology.

The need today is to enhance those desks with clever answers that take into account customers' different occupations, health situations, or even physical disabilities, so that everyone can use the desk effortlessly without requiring vast physical effort. This smart transformation contributes to accelerated efficiency and the provision of a cushy and secure working surroundings, enhancing productivity and lowering fitness problems on account of prolonged sitting or flawed posture.

1.1 Problem Statement

The essential trouble lies within the reliance of conventional workplace structures on guide strategies and rigid structures, mainly to negative user consolation, reduced productivity, and restricted adaptability—specifically whilst customers' physical situations or expert requirements fluctuate. As the global trend shifts towards smarter and more healthy painting environments, there is a pressing need to design and implement clever workplace structures that combine modern-day digital and technological answers. This challenge aims to address this venture by growing a clever table that complements usability, protection, and ergonomic flexibility.

1.2 Objectives

The main goal of our mission is to build a smart table that facilitates user interaction and provides a suitable and comfortable working environment. This increases the user's ability to use the desk for longer hours with greater comfort and reduces the side effects of using a traditional desk, such as physical pain and decreased efficiency.

This smart table has several of the following features:

1. A height control device via a screen on the desk or via a sensor that allows the hand to be placed at a specific height until the table reaches that height.

2. A system that changes the viewing angle of the desk, providing the user with the appropriate environment based on their use of the table. The viewing angle is determined by the display on the table.

3. A storage unit, where important papers and other tools are stored in drawers attached to the desk. The display allows the user to open the appropriate drawer or retrieve previously stored tools.

4. A lighting unit placed on the desk surface that automatically turns on in the dark and can be controlled via the display.

5. A notification widget. Notifications are displayed in multiple unique ways, such as colored lighting on the desk edges, the sound system, and the display.

6. The scheduling tool, implemented via a mobile app connected to the office, allows the user to assign tasks and generate reports.

7. It enables an air conditioning system that uses the outside temperature to operate the air conditioning for cooling or heating.

1.3 Scope of Work

1. Integrate sensors to read office data, including desk height, desk angle, ambient lighting, temperature, and harmful gas levels.

2. Develop an automated system to process readings and return them to standard values.

3. Test and validate the system to ensure reliable performance within safety standards.

4. Create an application that enables the owner to view their office information remotely and create a suitable schedule for their tasks.

1.4 Significance

The smart workplace is revolutionizing the office world. By automating basic development obligations, the gadget now not only improves operational performance but additionally ensures a higher degree of health, consolation, first-class, performance, and simplicity of use.

Recently, using offices has come to be essential for anybody, whether or not at home, at school, or at an organization. Therefore, it's far crucial to lead them to be more green, less complicated, and snug to apply.

The task also demonstrates the powerful use of modern technology, with the display screen at the table facilitating management and use through owners and users. The utility permits the proprietor to get admission to all statistics easily and seamlessly.

1.5 Organization of the report

The report starts with the introduction, including the problem statement, the objectives of the project, the scope of work, and significance.
The second chapter takes the limitations and constraints that forces us during work on the project, also the standards we use and the programs we used in coding and application, finally the earlier coursework.
The next chapter takes the literature review. In that chapter, relevant work and results are included.
Then, the chapter of methodology, which goes deeply on the project, its struc- ture, components used to build it, the electronic hardware components, and talking

specifically with details about how the system works.
The fifth chapter includes the results and analysis, then the conclusion and discussion chapter, which give the summary of the project, and the future work that can be done to the project.

Chapter 2

Constraints and Earlier Coursework

2.1 Constraints and limitations

1. The main problem was establishing the structure or basic foundation for the office to enable its ascent and descent.

2. Excessive load on the ESP, which made the system slow to respond and execute.

2.2 Standards / Codes

- We developed our software using the Arduino IDE, which enabled us to control devices via the Arduino platform.
- To store information periodically, we used Firebase to facilitate the display of information on the app.
- We built the mobile app using App Inventor, allowing users to view information and schedule tasks remotely.

2.3 Earlier Coursework

- Microprocessor and microcontroller courses, during which we gained knowledge of how to control hardware components in our project.
- Critical Thinking courses, which helped us research specific issues, as well as enhance our documentation and report writing skills.
- Electronics courses, which offer lessons on various aspects of electronic systems and technologies.
- Self-learning through Arduino courses on YouTube, courses offered by student associations such as the IEEE, and various research papers.

Chapter 3

Literature Review

A smart office is described as a combination of advanced technology to provide comfort, security, and ease of use. Therefore, this evaluation aims to explore the latest research and technologies in smart workplace structures, focusing on methodologies, sensors, Internet of Things (IoT) integration, and smart software. This evaluation will form the scientific basis for the smart workplace project, identifying gaps in current solutions that this project seeks to address.

Smart Desk Height Control Using Distance Sensors (Jamil, 2023)

Hoda Farouk Jamil and her colleagues developed a device that relies primarily on an ultrasonic distance sensor connected to an Arduino board to monitor sitting posture in real time. Upon detecting any misalignment or tilt, the device automatically issues an alert or adjusts the floor level—aimed at reducing lower back pain caused by prolonged sitting—and achieved an accuracy of approximately 97%.

"The Impact of Using a Distributed Smart Lighting System on Office Energy Consumption"

A study published in the Journal of Applied Sciences (2020) presented a smart lighting system based on computer lighting sensors and Bluetooth Low Energy (BLE) technology for automated lighting control based on user preferences and ambient light intensity, with a focus on energy savings without compromising user comfort.

"An Intelligent Sitting Posture Detection System Based on Force Sensors and a Mobile Application"

By Slawomir Matuska et al. (2022), published on arXiv. The researchers used six pressure sensors embedded in the chair connected to an Arduino board, which sends data to a mobile app. The device detects incorrect sitting posture and alerts the user via a mobile phone, using a tracking dashboard.

Chapter 4

Methodology

4.1 System Structure

4.1.1 Desk Body

The desk frame is made of 75 x 120-meter wood and a steel base for added stability and durability.

These two materials were chosen for their ability to support the weight of laptops and other items placed on them.

A wooden box is designed to store all cables, maintaining a neat and tidy appearance, as shown in the figure.

Figure 4.1: Desk body design.

4.1.2 Angle Part Body

The Angle section was constructed from a wooden plank and a 24-volt satellite motor. Two bars were added to each end of the desk, along with a door hinge to facilitate raising the desk from one side to the desired angle. A bar was mounted on the steel base to support the motor, as shown in the images below.

Figure 4.2: Angle side

4.1.3 Drawer Body

The three drawers are designed with traditional, old-fashioned rails to facilitate motor movement. Three motors and an H-shaped bridge are added to the back of the three drawers to control them. Inside, a screw drive is used to open and close each drawer.

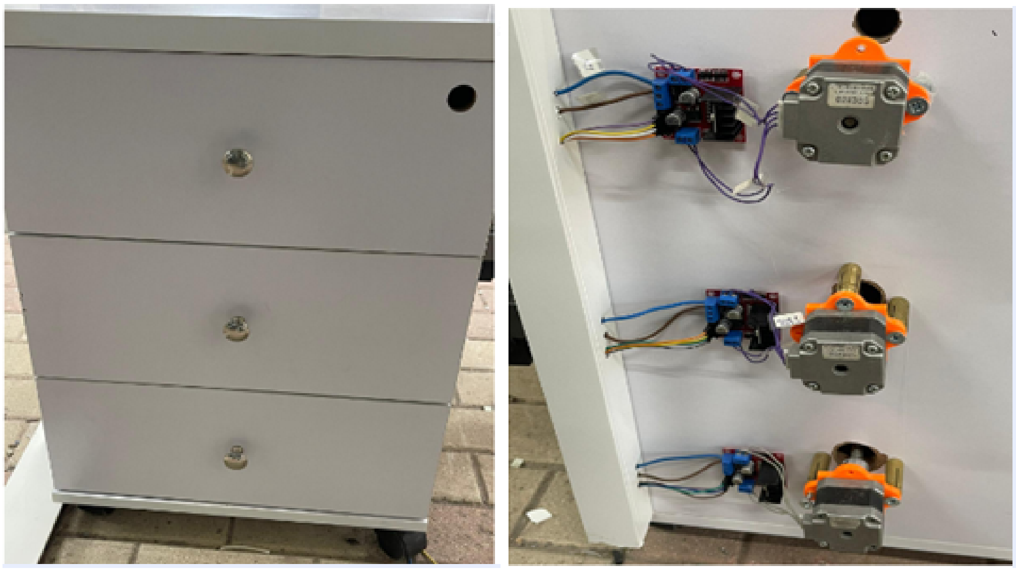

Figure 4.3: Drawer Body

4.1.4 Air Conditioning

The office air conditioner is designed with a switching fan to generate air and operates on 220 volts. The heatsell is mounted on the fan's surface to pump hot or cold air based on a temperature sensor. The fan is mounted under a wooden board, and an aluminum grille is used on the fan's surface and attached to the desk. This grille is commonly used in exhaust fans because it collects the air coming from them, increasing their power.

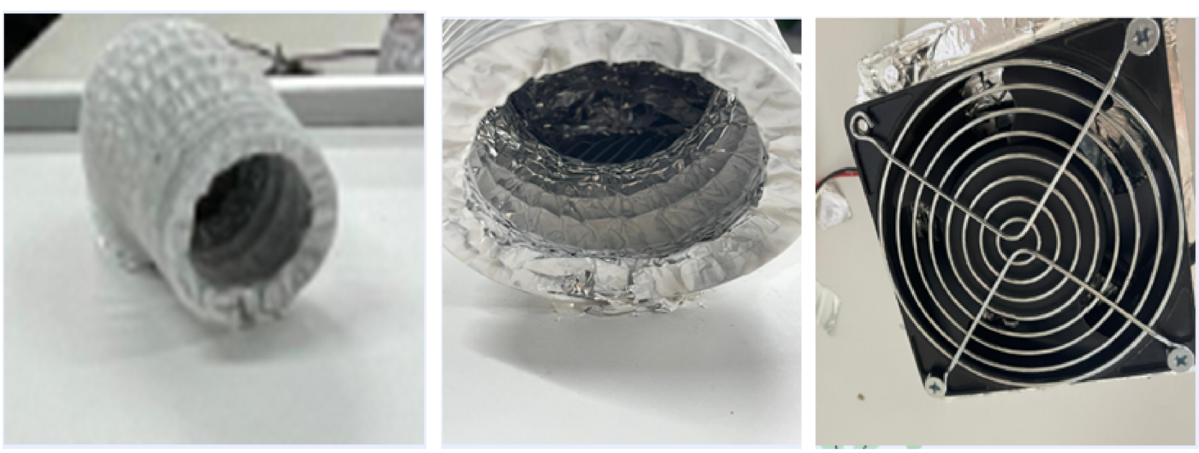

Figure 4.4: Air Conditioning Body

4.1.5 Notification Design

An RGB LED strip was used to display entry and gas detection notifications. To reduce glare, the illuminated colors were reused. To improve visibility, lighting covers used in home decor were used. Drivers and sensors change the colors, while desktop speakers play notification sounds in sync with the illuminated colors.

Figure 4.5: Notification Design

4.1.6 Control & Security System

One of the basic things about the office is that more than one user is using it. Therefore, there must be something that represents each user so that the office can distinguish between one user and the other. That's why we used FTDI with cards, and each person has his own card. Each user can use the screen on the desktop to exit the office or restore the office to the state it was in last after he creates a security check. He can also control all matters related to the office through the screen installed on the desktop. In the event of any malfunction in the system, he presses this button as a kind of emergency to stop the system.

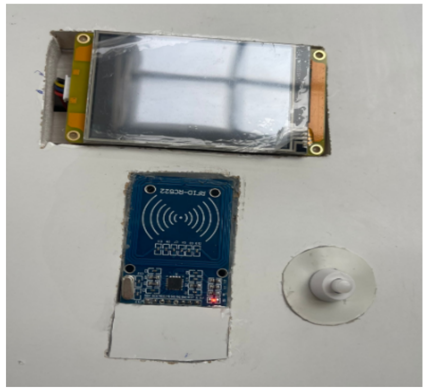

Figure 4.6: Control & Security System

4.1.6.1 Screen Interface to control Desk

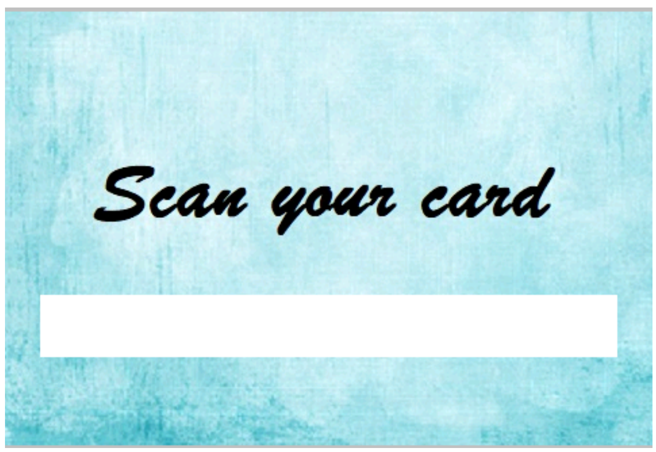

Figure 4.7: Scan Card Screen

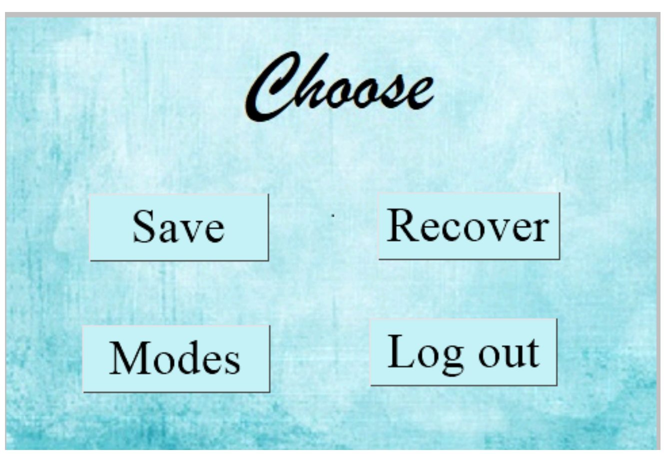

Figure 4.8: Control Desk Screen

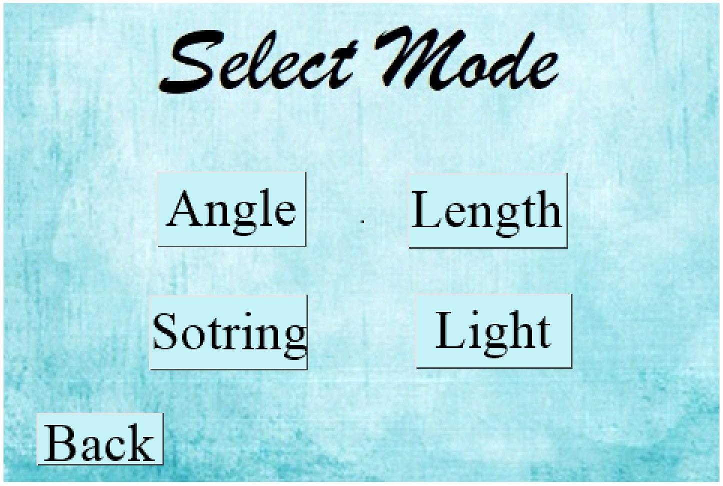

Figure 4.9: Select Mode Screen

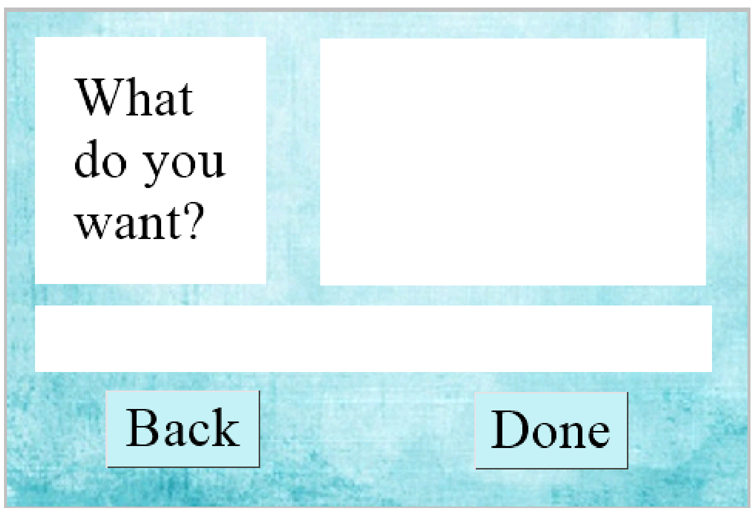

Figure 4.10: Store or Extract Screen

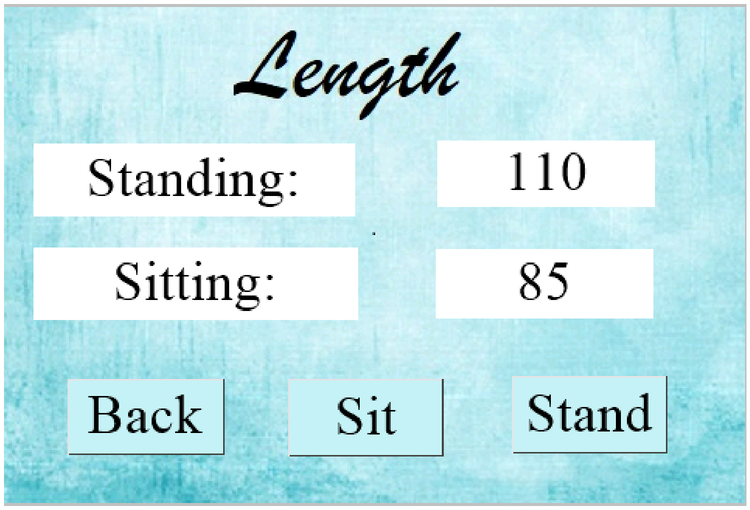

Figure 4.11: Change Length Screen

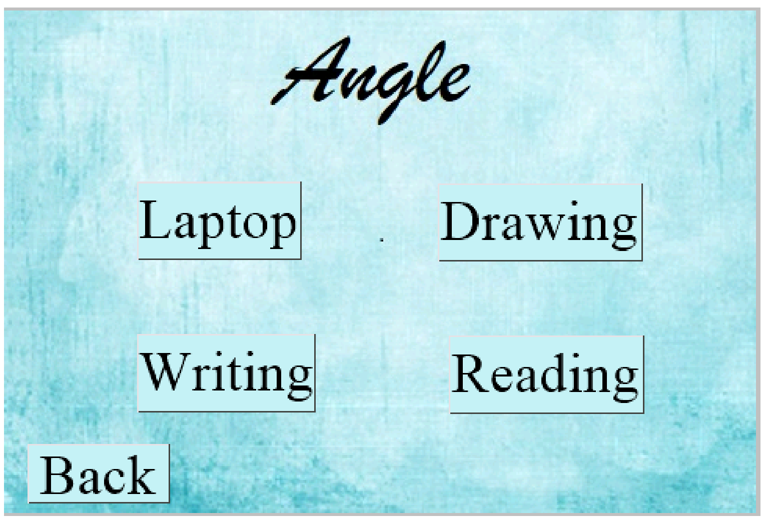

Figure 4.12: Change Angle Screen

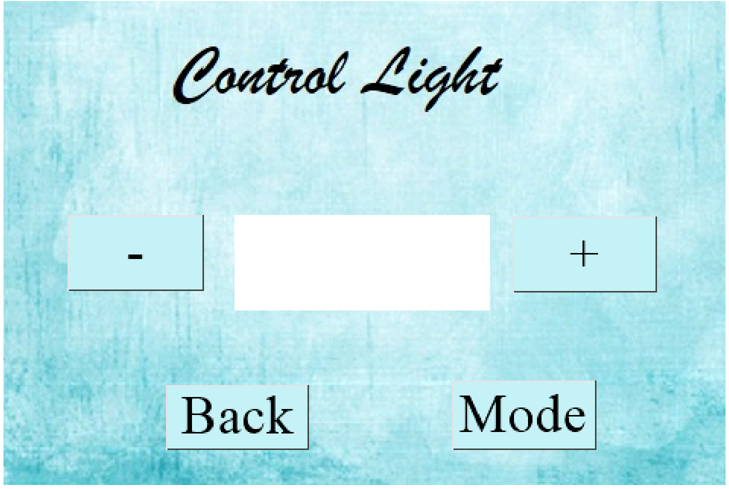

Figure 4.13: Control Light Screen

4.1.7 Light System

Desk lighting has been added to provide adequate illumination in low-light conditions or when the user needs additional lighting. A light strip with an external light cover makes it easy to install on a desk and ensures that the user is not disturbed by bright light. The lighting can be controlled via the screen or automatically activated using a light sensor. The brightness is controlled via a driver.

Figure 4.14: Light System

4.2 Hardware Components

4.2.1 Arduino MEGA

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560[1]. It has 54 digital I/O pins (15 of which can be used as PWM outputs), 16 analog input pins, 4 UART (hardware serial ports), a 16 MHz crystal oscillator, a USB port, a power jack, an ICSP connector, and a reset button. It has everything needed to support the microcontroller. We used it for the large number of I/O ports we needed for this project. We connected most of its components, such as the ESP32, all the sensors, and the DC motors. This will also include other stepper motors, RGB LEDs, a touchscreen (Nextion), an RFID card scanner, and an audio module. [Arduino, 2024a]

Figure 4.15: Arduino MEGA

4.2.2 ESP32

Powerful ESP32 is integrated with Wi-Fi and Bluetooth SOC and usually integrated with a USB-to-serial converter (e.g. CP2102 or CH340), it is ideal for compact (open source) growth and prototype board advanced IOT and built-in system.

ESP32 supports a double-core 32-bit processor, operates up to 240 MHz and includes 2.4 GHz for 802.11 B/G/N Wi-Fi as well as inherent support for Bluetooth 4.2 (classic and bl.).

It has an integrated TCP/IP stack, +20.5 dbm output power, several GPIOs, ADC, DACS, SPI, I2C and UART interface and a high performance PCB or external antenna.

The board also includes a Micro USB port, boot and reset buttons, and it can be fully programmed via Arduino Idea, Micropython or Espressif's ESP-AIDF.

In our project, we used ESP 32 to enable real-time communication with the App Inventor Mobile application on Wi-Fi, which ensures reliable wireless control and monitoring functions.

[Espressif System, 2024]

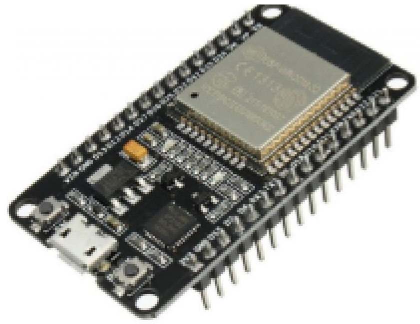

Figure 4.16: ESP32

4.2.3 Computer Power Supply

ISO-450 ATX computer power supply, 350W, 5V 32A, 12V 16A. We also needed an external 24V power supply for the desk-mounted lighting and the DC motor (satellite motor) used for the angle control, which I'll explain later.

Figure 4.17: Power Supply

4.2.4 Nextion Display

The Nextion display is a cutting-edge hybrid graphic user interface (HMI) made especially for Internet of Things (or IoT) and embedded machinery applications. With an internal memory, a resistive or capacitive touchscreen, and an onboard processor, it functions as a stand-alone graphical user interface. Microcontrollers like the ESP32 are communicated with via dependable serial UART (TTL) communication.

Our smart desk project's main user interface, the Nextion display, allows for smooth desk function control. It can display real-time desk notifications, adjust desk lighting, adjust height and tilt, and control drawer access.

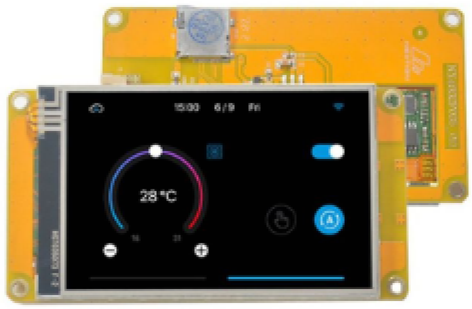

Figure 4.18: Nextion Display

4.2.5 Switch fan

In our project, we used a switched fan to accommodate the idea of having an office air conditioner that runs on 220 volts. The fan is controlled via a relay channel connected to the Arduino, which automatically turns it on based on the temperature sensor reading.

Figure 4.19: Fan Switch

4.2.6 TCE-12706

The TCE 1-12706 thermoelectric Peltier module is used to provide localized heating or cooling based totally at the course of the cutting-edge. In this undertaking, this module is incorporated with a temperature sensor and managed thru an Arduino. When the temperature exceeds a certain threshold, the system activates the module in cooling mode, the usage of a connected DC fan to dissipate the heat. Similarly, reversing the cutting-edge permits the module to behave as a heater. This setup enables smart thermal management of the workspace, supplying cool or heat airflow depending at the consumer's needs.

Figure 4.20: TEC1-12706

4.2.7 RGB LED

An RGB LED was used in the project to provide interactive lighting that changes based on system status or user notifications. Three channels (red, green, and blue) are controlled via PWM from the Arduino to produce multiple colors based on inputs or operating modes. Another type of RGB LED is used to provide lighting for the desktop.

Figure 4.21: RGB LED

4.2.8 IRF520 MOSFET Driver

It is used as a controller to control the colors of RGB LEDs, allowing the display of colors and control of their gradations, blending, and intensity.

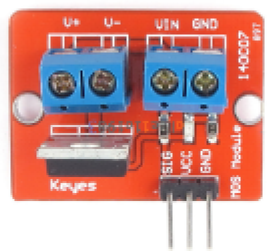

Figure 4.22: IRF520 MOSFET Driver

4.2.9 Ultrasonic Sensor

An ultrasonic sensor measures the distance to an object using ultrasonic sound waves. In this project, we used three sensors: two mounted on the base of the desk to measure height. For accuracy, two were used, and the third measured the distance when the hand was placed above the desk surface, raising the desk to hand level.

Figure 4.23: Ultrasonic Sensor

4.2.10 MPU6050 Sensor

The MPU6050 sensor was used in this project to accurately measure the desk tilt angle. It has a built-in accelerometer and gyroscope. The sensor sends motion and rotation data to the Arduino via I2C, allowing the desk angle to be automatically adjusted to the user's position.

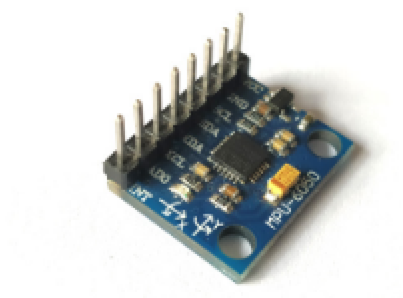

Figure 4.24: MPU6050 Sensor

4.2.11 LDR Sensor

A photoresistor (LDR), or optical resistor, is a passive electronic component that changes its electrical resistance with changing light intensity. In the presence of light, the photoresistor's resistance decreases; when it is blocked from light, its resistance increases. Harnessing its light-sensitive properties, this component has been used to sense the absence of sunlight or ambient light in an office, turning on office lights that can be controlled from a screen.

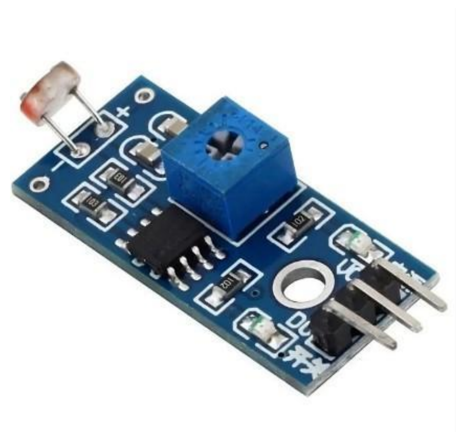

Figure 4.25: LDR Sensor

4.2.12 NEMA17 Stepper Motor

The NEMA17 stepper motor is widely popular due to its small size and high torque, making it suitable for use in a wide variety of applications. It requires 200 steps to complete a full rotation, and these steps feature a precise angle of 1.8 degrees per step. Its coils can handle a maximum current of 3.5 amps per coil and can also apply voltages ranging from 3 to 12 volts. It is used to open and close drawers. Rotating the motor moves the screw connected to the nut that secures the desk. Thus, when it rotates 360 degrees, the nut moves, allowing the drawer to open and close by reversing its direction of rotation.

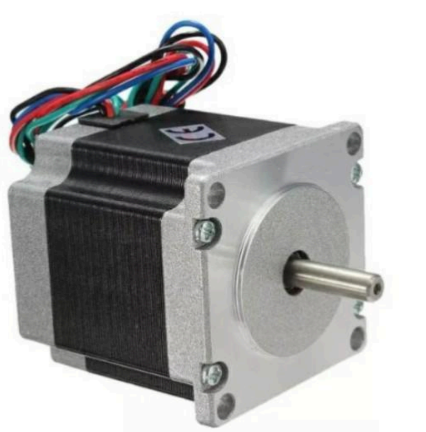

Figure 4.26: Stepper Motor

4.2.13 Satellite Actuator

A Satellite Actuator turned into used in this venture to precisely manipulate the desk floor's tilt attitude. This kind of actuator features solid linear movement and excessive drive pressure, making it appropriate for adjusting mechanical positions including table surfaces. The motor is pushed internally using a manipulated signal from the controller and moves the surface ahead or backward consistent with the preferred perspective, as determined from the Nextion display.

Figure 4.27:Satellite Actuator

4.2.14 L298N Motor Drive Controller Board Module Dual H-Bridge

The H-bridge configuration is usually utilized to reverse the polarity /direction of the motor but sometimes it’s also possible to use it for ‘braking’ the motor i.e. when its terminals are connected together, the motor abruptly stops.

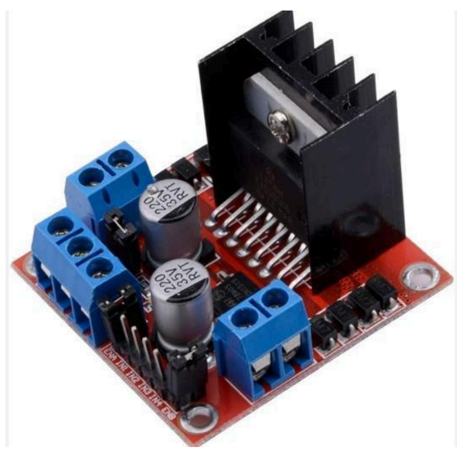

Figure 4.28: H-bridge

4.2.15 Drill Motor

A Drill Motor turned into used in this assignment to raise and decrease the desk surface due to its high power and pace, that is suitable for moving heavy loads along with the desk weight. This sort of motor is right for applications requiring high torque, and its course of rotation to elevate or lower the surface can be without difficulty managed thru a dual relay and an Arduino microcontroller. The motor operates efficiently when powered via 12V and is dependable and lengthy-lasting, making it a sensible desire for smart desk movement.

Figure 4.29: Drill Motor

4.2.16 MP3-TF-1CP With Speaker

The MP3-TF-1CP module is a small audio participant used to play MP3 audio documents from a microSD card. It has a TF card slot and a UART serial interface that lets it be managed via an Arduino microcontroller. Commands to play, pause, or alternate the quantity are sent using a simple protocol.

In our challenge, this module turned into used with a speaker to play audio signals or custom messages, which include notifications or warnings, enhancing the interplay between the person and the smart office and including an auditory size the person enjoys.

Figure 4.30: MP3-TF-1CP With Speaker

4.2.17 Relays 8 Channels

A relay is an electrically controlled device that initiates and terminates electrical connections, or turns other devices on and off within the same or another electrical network. We used low-power relays to turn the fan on and off and control both the height and angle motors.

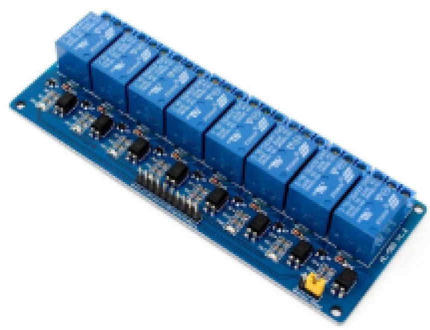

Figure 4.31: Relay 8 Channel

4.2.18 RFID

The MFRC522 RFID module is used to examine 13.Fifty six MHz RFID cards or chips. It makes use of the SPI communiqué protocol to communicate with microcontrollers which includes the Arduino or ESP32. It is green in identity verification and easy to apply to get right of entry to our security systems. In our assignment, this module was used to discover users and enable or restrict get right of entry to to sure features in the clever desk, inclusive of top manager or drawer commencing, presenting extra security and privacy for customers.

Figure 4.32: RFID

4.2.19 Intercom Wires

We used them for wiring and connecting different components together.

Figure 4.33: Intercom Wire

4.2.20 Arduino Wires

To be able to connect the components to the Arduino.

Figure 4.34: Arduino Wires

4.2.21 470 ohm & 1.2k ohm resistor

It is connected to the ESP32(to create a voltage divider).

Figure 4.35:resistor470

Figure 4.36:resistor 1.2

4.2.22 Emergency Button (ON/OFF)

It is a button that, when pressed, activates emergency mode, where the user is logged out of the system, everything is turned off, and sounds such as an alert and a red light are displayed.

Figure 4.37: Emergency Button

4.2.23 Power adapter from 220V to 9V

It was used to supply electricity to the Arduino.

Figure 4.38: Power Adapter

4.2.24 MQ-135 Air Quality Gas Sensor

The gas sensor (MQ-135) is highly sensitive to many harmful gases such as ammonia, nitrogen oxides, benzene, alcohol, smoke, and carbon dioxide. It can be connected in two ways depending on the pins, either analog or digital.

Figure 4.39:MQ-135 Air Quality Gas Sensor

4.2.23 BMP280 temperature and barometric pressure sensor

The BMP280 temperature and barometric pressure sensor measures the ambient temperature and can be connected as an I2C module. It measures both very high and very low temperatures, meaning it has a wide, good and accurate range.

Figure 4.40:BMP280 temperature and barometric pressure sensor

4.3 Mobile Application

The system is linked to an application that allows you to know all the user information from the latest information saved for the office mode. The application also allows you to add tasks and tasks that the user wants to accomplish (scheduling process). The application contains 9 interfaces as follows:

4.3.1 Start Page

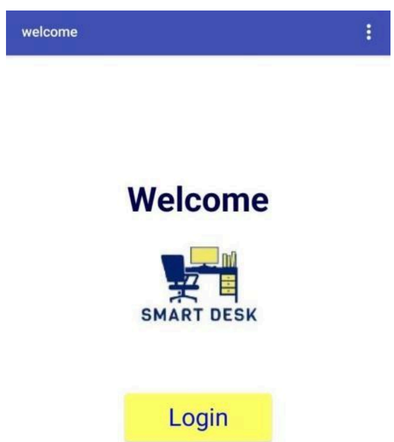

Figure 4.41: Start page of application

4.3.2 Login Page

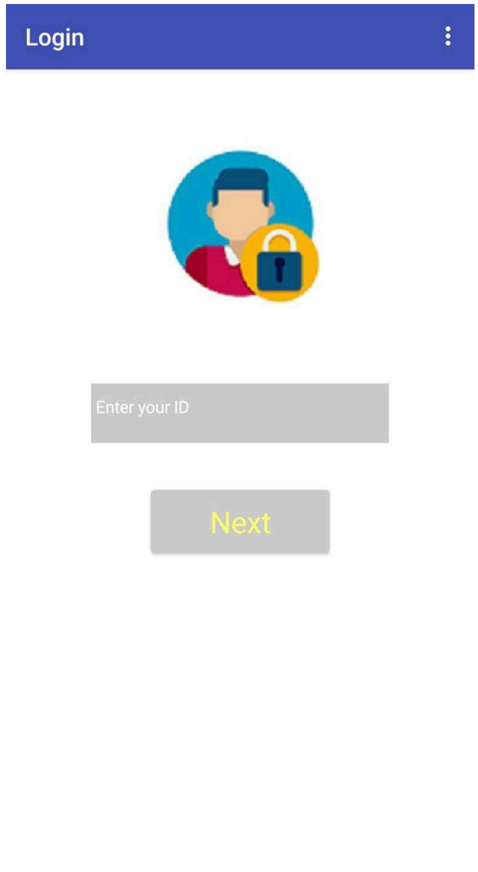

Figure 4.42: Login page of application

4.3.3 Select Mode Page

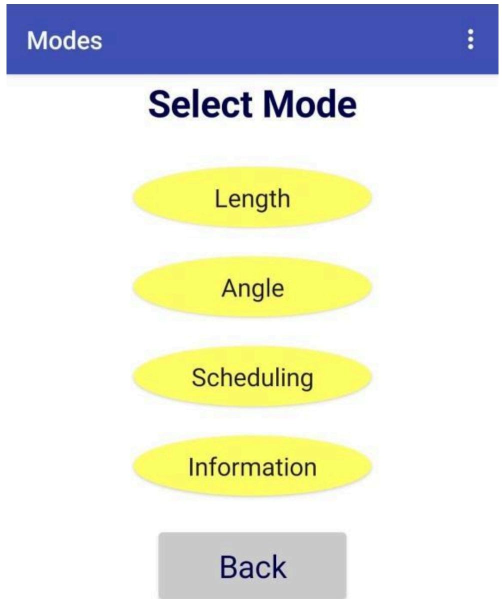

Figure 4.43: Select Mode page of application

On this page, you can choose a specific mode through which data is displayed or tasks are added.

4.3.4 Length Mode Page

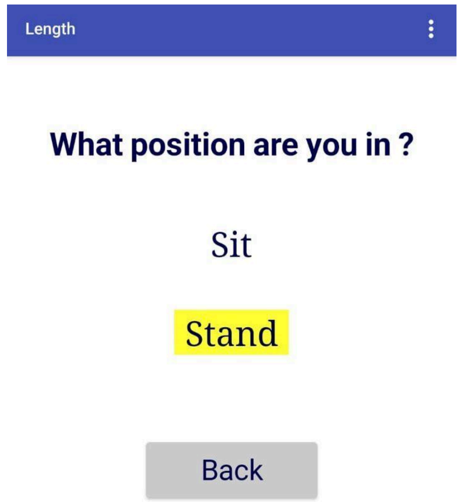

Figure 4.44: Length Mode page of application

On this page, the desk is displayed in any position by colouring the label for the desk position, whether it is a stand or a sit.

4.3.5 Angle Mode Page

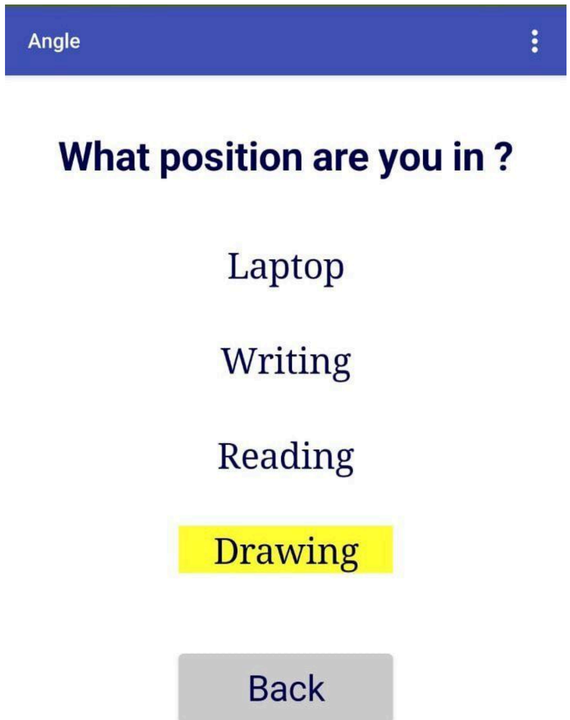

Figure 4.45: Angle Mode page of application

On this page, the desktop is displayed in any mode by coloring the label for the desktop position, whether it is in reading, writing, drawing, or laptop mode.

4.3.6 Information Page

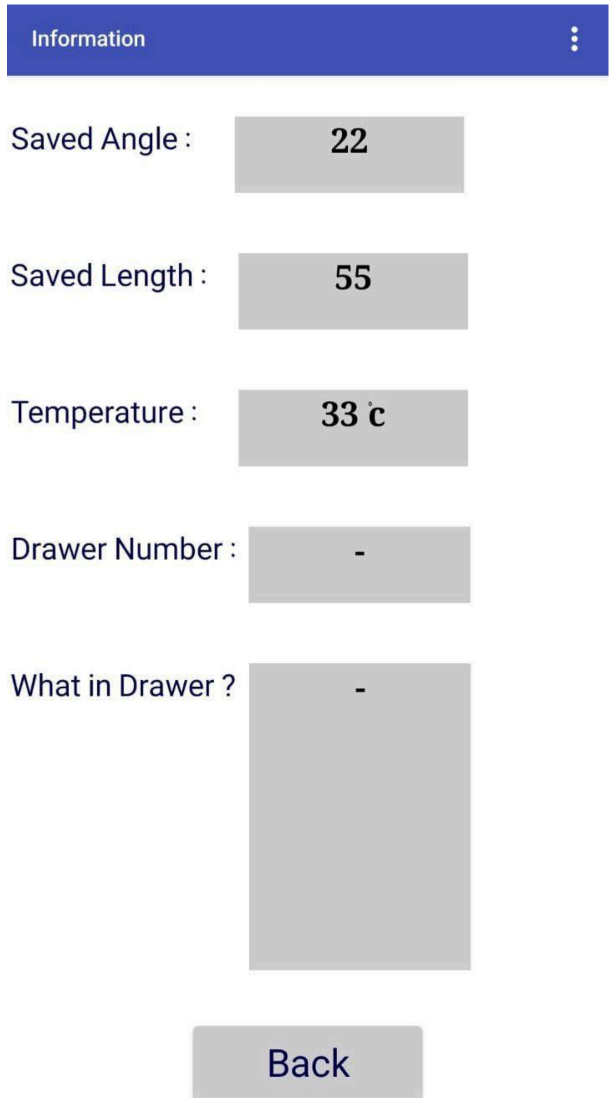

Figure 4.46: Information page of application

On this page, all information about the desk is displayed, including the height, angle in numbers, ambient temperature, user, which drawer each user belongs to, and what the drawer contains.

4.3.7 Scheduling Page

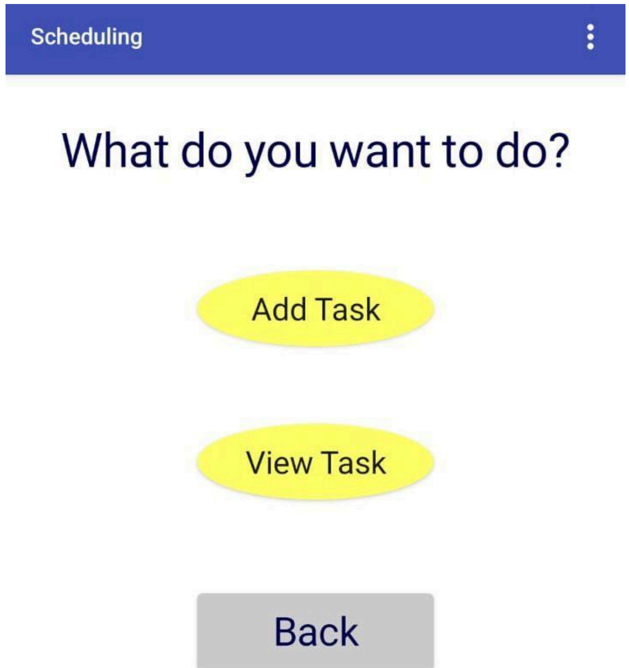

Figure 4.47: Scheduling page of application

On this page, I can add a specific task or view all the tasks I have.

4.3.8 Add Task Page

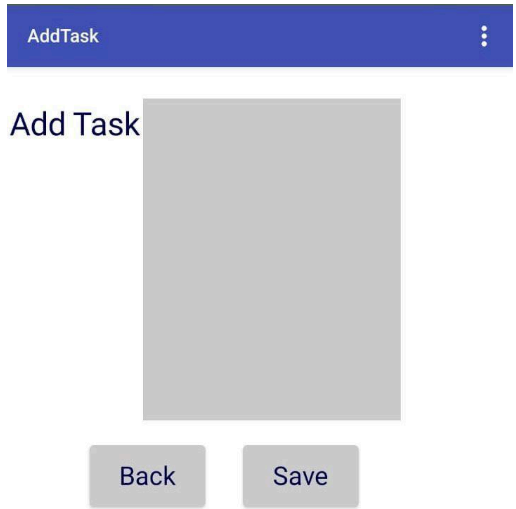

Figure 4.48: Add Task page of application

On this page, I can add tasks.

4.3.9 View & Remove Task Page

Figure 4.49: View & Remove Task page of application

On this page, I can see the tasks that have been added and I can also delete completed tasks by clicking on the task so that it turns green, which means that the task has been completed and therefore deleted.

4.4 How does the system work?

One of the project's most important ideas is to have the office serve multiple users, and to have all the information about each user available in the office to help identify them. Because the office is connected to a mobile app, we used the Firebase system, which stores each user's information and identity. When the Arduino is turned on, it connects to the ESP32 via the serial number, and the ESP connects to the Firebase.
The Firebase system is divided into two nodes, as shown in the figure:

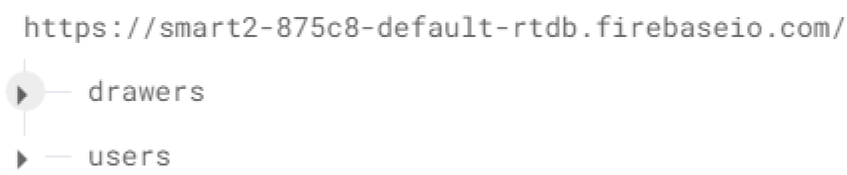

Figure 4.50: firebase node

The users contains the ID of the people who use the office, and each person has his own information, such as height, angle, temperature, gas sensor, and his own tasks that are added from the application.

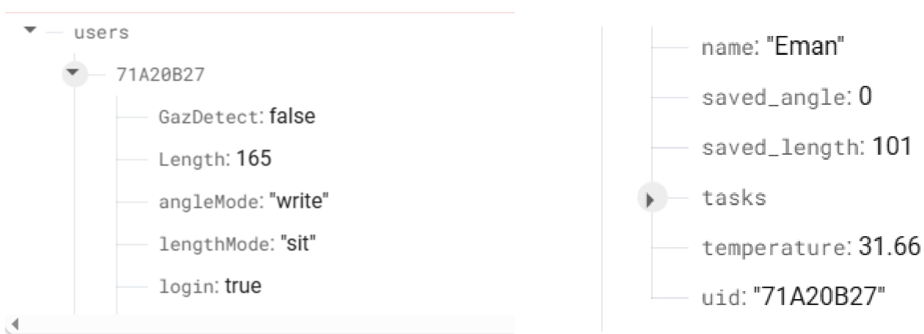

Figure 4.51: firebase users

Drawers contain the number of available drawers that users can use, as it contains each drawer, the capacity of each drawer, what it contains, and who the user is using this drawer for.

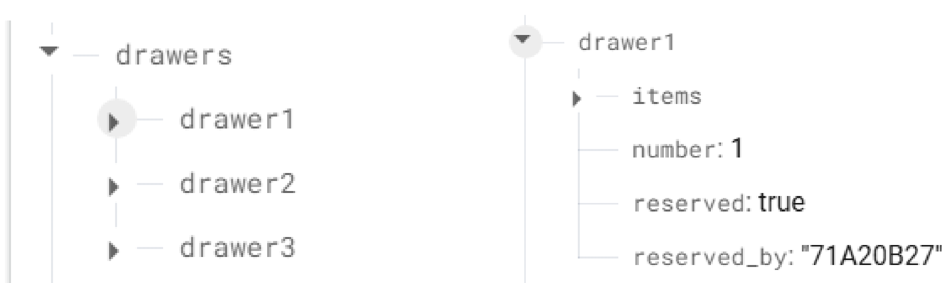

Figure 4.52: firebase drawers

4.4.1 Login

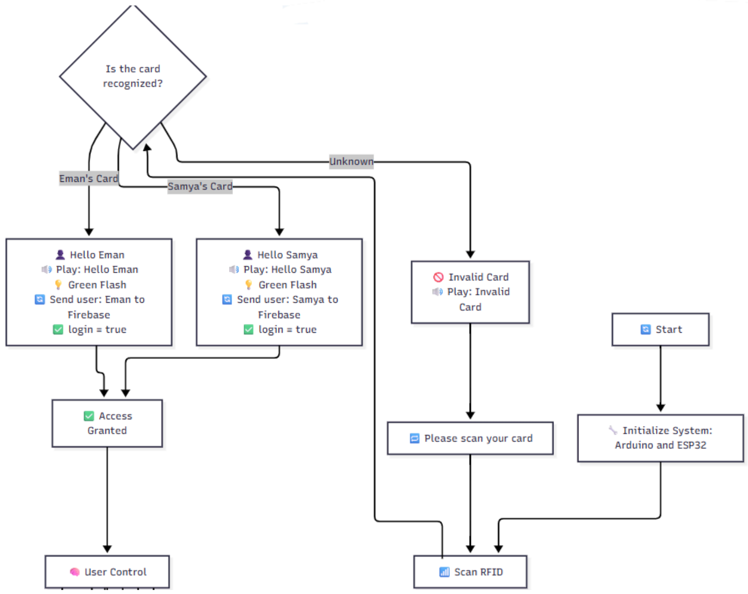

Figure 4.53: login flow chart

When the system is launched, office control is activated by scanning each user's card. For example, we have two user cards: Eman and Samya. When the card is scanned, a voice greets (username). At the same time, a green flash appears as a notification that the login was successful. If the person is not authorized to log in, the red light will flash and an invalid card will sound. Upon login, the ESP software modifies the Firebase database to ensure the login is valid.

4.4.2 Control Desk

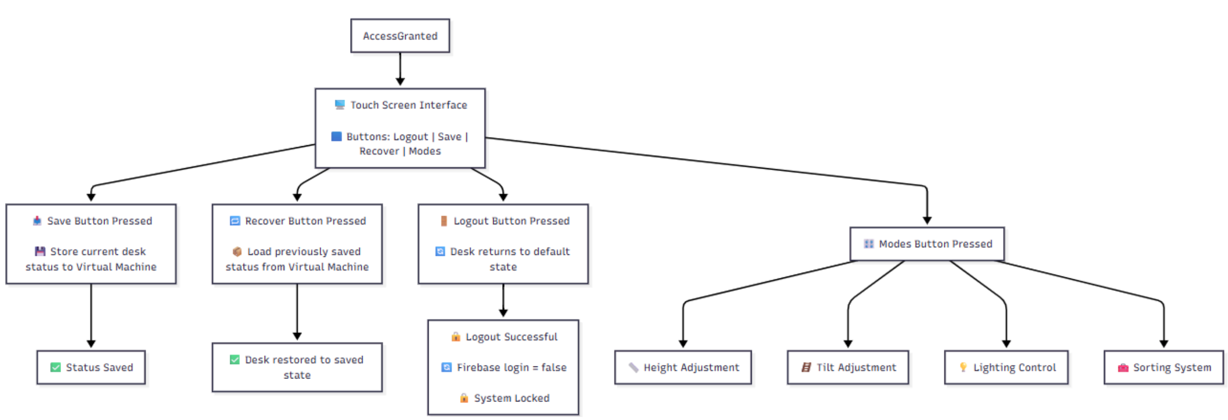

Figure 4.54: control flow chart

After scanning the card, a screen appears on the touch screen mounted on the desk with four buttons: logout, save, recover, and modes.
When you press save, the current status of the desk is saved for the user by storing the values on the virtual machine.
If you press recover after a while, the desk will be restored to the status stored in the virtual machine.
When you are finished using the desk, you must press logout to return the desk to its original state so that another user can use it.
The Modes button will be explained in detail.

4.4.3 Change Height

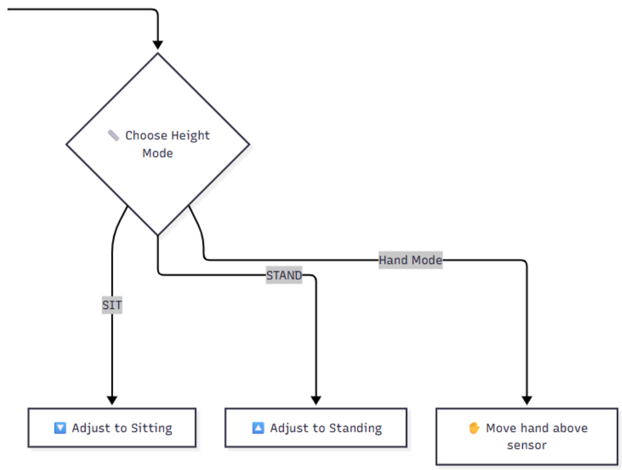

Figure 4.55: change height flow chart

The desk height can be controlled through the screen when you press the sit or stand button, as they contain fixed standard values that are suitable for most everyone. The height can be changed using a sensor installed on the desk surface. When you place your hand at a certain height above it, the desk moves upwards.

4.4.4 Choose Angle

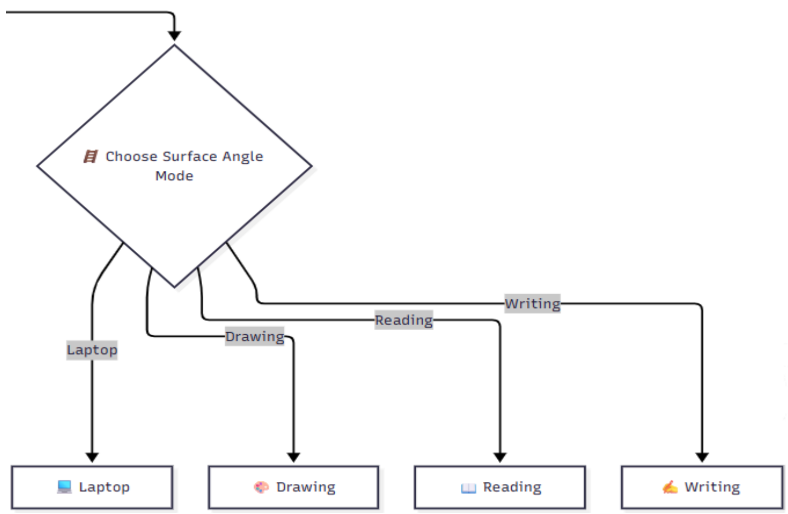

Figure 4.56: choose angle flow chart

The desktop angle can be controlled through the screen, as there are four angles, each of which has a specific use, depending on the individual, his needs, and his desires.

4.4.5 Storage and Extract

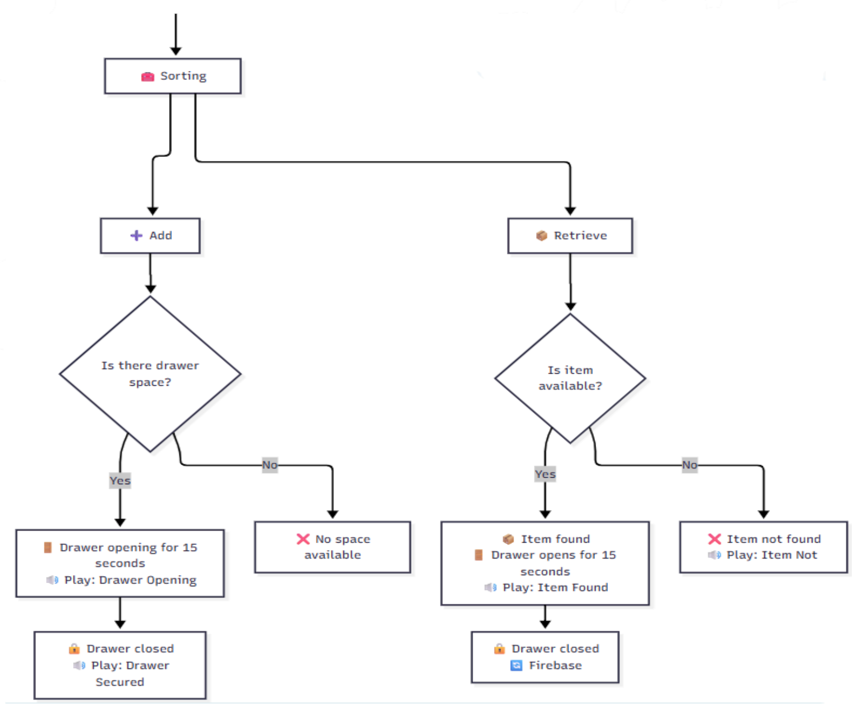

Figure 4.57: storage and extract flow chart

Each user can store items in drawers. Using the on-screen controls, any item can be added, and an empty drawer can be opened and not reserved for any other user. No one can access a drawer that is not a drawer. After opening, a fifteen-second wait is required, after which the drawer closes again. After closing, a sound indicates that the drawer is locked. No more than three items can be added. When attempting to add an item, a sound indicates that the drawer is full. This is also displayed on the screen. When a drawer is opened, a sound indicates that it has been opened for storage. Retrieving items is the same process, with the drawer being opened and closed. However, when the drawer is opened, it indicates that it was opened to retrieve a specific item. If the user attempts to retrieve a non-existent item, a sound indicating that the item is not present will be displayed on the screen. Both the storing and retrieving processes are modified in Firebase.

4.4.6 Air Conditioning

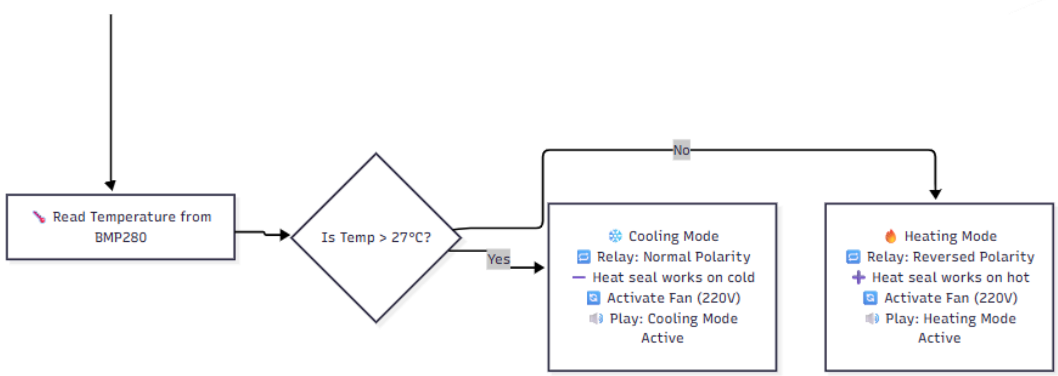

Figure 4.58: conditioning flowchart

When the system is turned on, the BMP280 temperature sensor detects the temperature. A temperature sensor sounds and the fan will switch to either cool or hot mode. This activates the heat cell via a relay, allowing it to operate on the hot or cold side by reversing the polarity of the heat cell via a two-channel relay. If the temperature is above 27°C, the heat cell operates on the cold side, with the positive wires on the positive side and the negative wires on the negative side. To operate on the hot side, the polarity is reversed. The fan always operates on 220V. The heat cell controls the fan's air temperature, whether hot or cold, so it operates as an automatic air conditioner based on the ambient temperature.

4.4.7 Gas Detect

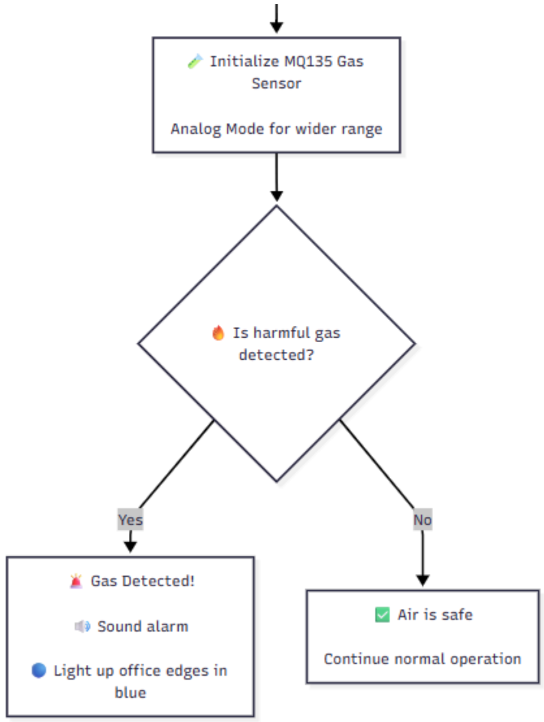

Figure 4.59: gas detect flow chart

The MQ135 gas sensor was used to detect harmful gases ambient in the office. It was connected analogously to provide the widest possible reading range. When a harmful gas is detected, a sound alert sounds, indicating the gas sensor, and the edges of the office also light up blue to indicate the alarm. The sensor is tested by placing a lighter near the sensor to detect the gas.

4.4.8 Light Control

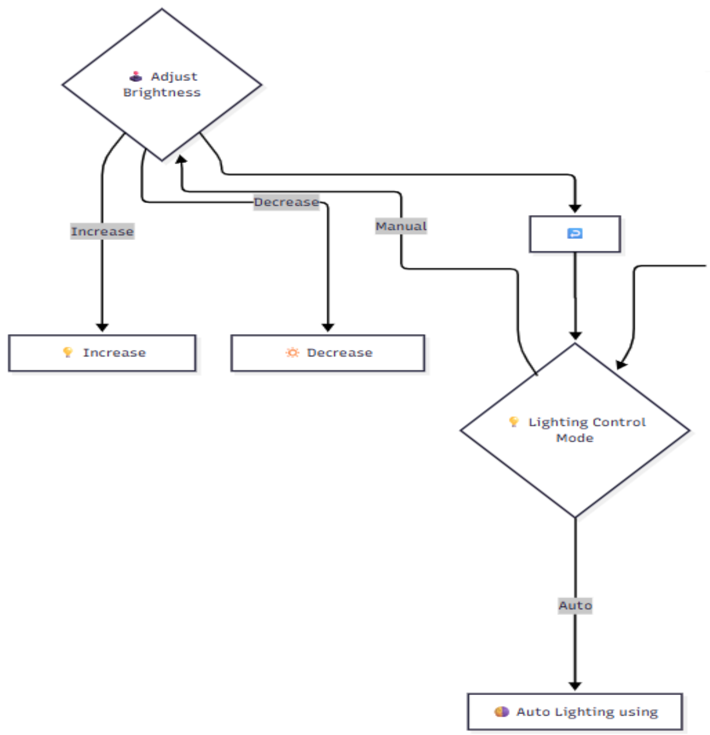

Figure 4.60: light control flow chart

The desktop has a light that can be controlled from the screen by pressing the + and - buttons. It can also be controlled automatically using an LDR sensor, which automatically turns on when the ambient light level drops.

Chapter 5

Results and Discussion

Along with numerous diverse features, the Arduino-based intelligent desk system rightfully included automation, security, customization, and greater interactive human involvement. Integrating several sensors, actuators, and modules for communication, the project evolved an interactive, consumer-focused working space.

The RFID-aided full login device upgraded to a dependable one. The gadget responded instantly with a custom voice greeting and a beginner moderate alert when a verified card was being scanned. Privilege attempts were concluded in a purple glow and an erroneous tone. Successful login occurrences were recorded instantly to Firebase to provide traceability and strong multi-character assistance.

After authentication, customers would need to personalize and manage their desk through a Nextion touch panel. The Save and Recover function facilitated all shoppers to save and respect their desired desk settings. The Logout facility was able to completely reset the table in preparation for new clients, with the Modes function allowing preset settings. Every action was cloud-synchronized, affirming system reliability and personalization accuracy.

Sit and stand buttons provided fast, constant-function height adjustments, and an ultrasonic sensor allowed the user to have a personalized top set manually by means of positioning his hand on the desired stage. Testing indicated that the device must accurately mimic hand function and alter the desktop in ±1.5 cm of the target.

For surface tilting, a satellite actuator allowed tilting to one of each four position angles. There have been smooth position changes, and the floor maintained its operational status all the time while being utilized, displaying mechanical balance and effective angular control.

The drawer mechanism, more compatible with Firebase integration, offered user-friendly and consistent storage. Products were delivered and retrieved via the touchscreen interface. The device successfully blocked access to other customers' drawers, offered sound cues in case of full drawers or incorrect access, and gave a fifteen-second timeout for drawer security. During the tryout, the device consistently succeeded in drawing access with accurate country updates on the display screen and in Firebase.

The module employed a BMP280 temperature sensor to control ambient conditions. Based on readings, a TEC1-12706 Peltier module controlled airflow to heat or cool the use of a fan and polarity-switching relay. Testing validated a particular response to temperature levels (27°C as default switching point), with continuous fan operation on 220V and heat cell delivering temperature-controlled airflow. This project designed a miniature air-conditioning system incorporated into the table to increase the user's comfort.

The MQ135 fuel sensor detected noxious gases and triggered visible and audible warnings efficiently. When exposed to assets like lighter gas, the system lit up edges of tables in blue color and triggered a buzzer. This protection feature operated round the clock and confirmed the table's capacity to trigger enviros

Lighting was both manually and robotically controlled. Manually adjusting the brightness through the touchscreen with "+" and "−" controls failed to be achieved as it should. The LDR sensor also worked well, triggering the desk light when ambient lighting was low. This double-mode capability delivered electricity, performance, and comfort, delivering the best working conditions irrespective of external light fixtures.

Conclusion

The smart office system demonstrated a high level of integration between sensors, actuators, and comprehensive cloud services. From ergonomic adjustments and fixed storage space to environmental sensing and convenient control interfaces, the system efficiently enhances the workspace experience.

Overall, tests confirmed the following:

- Accurate sensor responses (±1.5 cm for height, ±1°C for temperature control).
- Fast RFID authentication (less than 1 second per person).
- Reliable synchronization with Firebase.
- Rapid response to harmful gases via the gas sensor.
- Robust control of air conditioning operations via the temperature sensor.
- Instant communication between Arduino, ESP, and Firebase, providing robust system control.

Future Work

- Internet of Things (IoT) to control surrounding devices, such as air conditioners and other devices within the office space.
- Office chair helps the user know the time they've been sitting and provides movement alerts. Heart rate and body temperature sensors can be added to this chair so the office can monitor the body's vital signs.