



Mini Project Report

on

“SMART OFFICE AUTOMATION: Post COVID-19 Scenario”

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of T.Y B. Tech. successfully completed Mini Project in

“SMART OFFICE AUTOMATION: Post COVID-19 Scenario”

to my satisfaction and submitted the same during **Trimester VII, Academic Year 2021-22** as part of **Embedded and Internet of Things Laboratory** course.

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ABSTRACT

The smart office automation system: post COVID-19 scenarios for office environment is being implemented through his system. Internet of Things (IoT) as a new communication technology is very useful in realizing smart systems such as: smart home, smart office, smart parking and smart city, smart agriculture, etc. This study presents a prototype of the smart office automation system which is designed as a security system, environmentally friendly system, and user-friendly ergonomic systems working in congruence with each other to create an excellent environment for productivity and security.

The data can be accessed and controlled through internet network from long distance. Smart office system used Arduino microcontroller as a controller component (also feasible with Raspberry pi). In this report, Smart office automation system is able to detect unauthorized access to secured areas, automatic entrance and sanitizing, AI based smart cameras for employee detection and electricity management system containing various sensors to reduce carbon footprints because of unwanted wastage of energy by lights and cooling systems, fire detection alarm, intruders or theft and perform security monitoring outside the building by using raspberry pi cameras on autonomous robots in real time to the security guard. Various controlling subsystems are designed based on lighting, ventilating, luminance, security. Various sensors are used to extract the real time information i.e., temperature, light intensity, smoke, motion sensor is used. This data collected through these various sensors is then send to ARM 11 Controller. Further it is sent to PC where data is saved and connected with cloud servers for real time monitoring and access. Through Network switch the collected data is send to other PC's. The data collected is stored as database and can be accessed anytime later by the admin. The data is sent to the android or any internet enabled device . This system also provides need-based emergency services like Ambulance call, fire alarm. Biometric fingerprint is used for security purpose. Manual mode and automatic mode are two alternative modes designed to promote the usability system.

Chapter 1: Introduction

A world class office environment with every facility is just one touch away is dream of every employee and business leaders. IoT has changed the way we dealt with convectional problems in earlier days, completely changing the idea of automation. A smart office - a place that makes life easy for employees and customers, empowers and it increases their ability to stay connected through by making use of various advanced technology and different tools and solutions to improve the efficiency of users. The world is fatly experiencing the emergence of intelligent growth zones so smart office- has fast become the need of the hour. The COVID-19 pandemic has hit the world and IT sector is among the ones worst hit by the pandemic. Using IoT technology for a smart office means that there are many devices in an office connected to the IoT, which allows remote control of them. With smart technology, offices can be more efficient than ever before. The COVID-19 pandemic shifted businesses in ways previously unimaginable. While many employees worldwide are still working remotely, and we begin returning to work at on-site locations, office life will look quite different.

As Work from Home period is near the end for most of the employees around the world, there is an immediate need for corporate sectors to deploy smart automation systems in offices to ensure safety of each and every employee from the contractable disease. This project researched and addressed some of the most important needs of offices post-COVIS-19 pandemic by keep security, health, environment protection and user friendliness in mind A smart office is one that ensures the optimal and effective utilization of physical infrastructure and IT resources. In other words, offices in today's generation of information technology are automated. There is an urgent need for technological advancement environment which is very transparent.

Smart offices are like a smart home, which is an intelligent space that optimizes efficiency, safety, comfort and by collecting and analysing sensor data. The building sector consumes lot of energy. It is one of the main causes of the global energy consumption. Modern buildings contain sophisticated control systems, complex mechanical devices and various features to improve the safety, productivity of occupants and safety. A smart building can be considered a super system of interconnected building subsystems. The smart building will require connectivity between all the systems, equipment in a building. It helps building managers to visualize information and make fast and precise decisions.

The major aspects covered by Smart office automation system are as follows: -

1. **Health and Safety:** The Smart office automation would be able to check body temperature of anyone entering the office and maintain real-time data in cloud storage, providing swift contact tracing. Automatic sanitizer dispenser and employee's health reports are also added, with automatic coffee vending machine.
2. **Energy Consumption:** Efficient consumption of energy is most important in modern times for any organization. For improved in-depth control of energy consumption, project can put systems, computers, lightings and AC on a schedule. They turn on when people enter a certain area and turn off when they leave,
3. **Temperature control:** The automation can sense real time temperature in both environment and create optimum environment inside office premises.
4. **Lighting control:** Right use of lighting and automatic dimming in broad daylight helps employees at work. Smart lighting solutions and advanced light sensitive sensors are need of hour for every office today.
5. **Office Climate Control:** IoT technology allows the measurement and control of carbon dioxide, and humidity. This control enables the operations manager to create the optimum working environment
6. **Smart Office Security:** Employee and data security is at utmost priority of automation. Project uses voice and face recognition to tell who has entered a building, where a person is, and how many people are in the office. This allows companies making sure no unauthorized people can access high security and confidential areas like server rooms.
7. **Smart Scheduling:** Companies can automatically create schedules for IoT items needed to match employee schedules and government compliances for COVID-19 protocols.

Chapter 2: Related Work

2.1 Literature Survey /Analysis of existing methods

Emerging technologies these days are playing a vital role in making human life automated. Smart office doesn't simply mean communication with hardware devices using internet, it should also include secured linking. Some of the existing designs are briefed here: -

- 1] **Kumar Mandula** in his paper implemented home automation in two ways using Bluetooth and using Ethernet. Arduino is used for programming and controlling various devices. Bluetooth is for short range communication. So, in smart home implemented using Bluetooth, one can operate the devices from home only within the vicinity of 10-20m. This paper discussed only the control of different electronic devices in home using mobile app but it did not include any security features
- 2] **Hang Li**, In this system a comprehensive smart office system concentrated on door-access, lighting, illuminating, ventilating, heating, and reconfiguration is designed in order to save energy and promote the satisfactions of the employees
- 3] **Catalian B. Et al**, this system presents the study on how it is possible to ensure the indoor office comfort, indoor comfort is the important types of comfort (visual, acoustic, thermal, air quality, etc.) and how each of them could be analysed. This system have discussed thermal comfort
- 4] **Mitul Sheth** in his project discussed various possible devices that can be connected to Internet using Android App and different modes of using them; for measuring various parameters like temperature, moisture content, to detect levels of CO and NO₂ gases for monitoring environment in gardens and parks
- 5] **Smart Office Automation System for Energy Saving** by Kannapiran Selvaraj and Arvind Chakrapani: Concept is particularly suitable for working rooms. In this article we are using Light Dependent Resistor (LDR), Pyroelectric Infrared (PIR) sensor, Logic gates, Voltage comparator and Electromagnetic relay. Human being motion is sensed by PIR sensor and Sunlight intensity is sensed by LDR
- 6] **Smart Office Automation System** by Renuka Bhuyar and Saniya Ansari.: The smart office is designed for users comfort and leisure. It works on automatic and manual mode. In automatic mode the working of system will depend on/off conditions of various sub-systems i.e., lightning and ventilating.
- 7] **Building a Smart Office Cloud Service with Google** by Dave Smith: The following article dealt about various architecture and services provided by Google IoT cloud services to make best out of our automation system.

Chapter 3: Proposed Work

3.1 Problem Statement

Smart Office Automation with Post COVID-19 scenarios: The smart office automation IoT project is a collection of inter-related and independent sensors and actuator whose sole purpose is to bring automation and efficient environment to any office. As COVID_19 pandemic is still on its hold around the world and IT industry begins to initiate on office workforce, design and implement suitable scenarios to make office a secure, healthy and productive workplace with smart control over each machine and sensors being used.

The following are the most important scenarios to be implemented:-

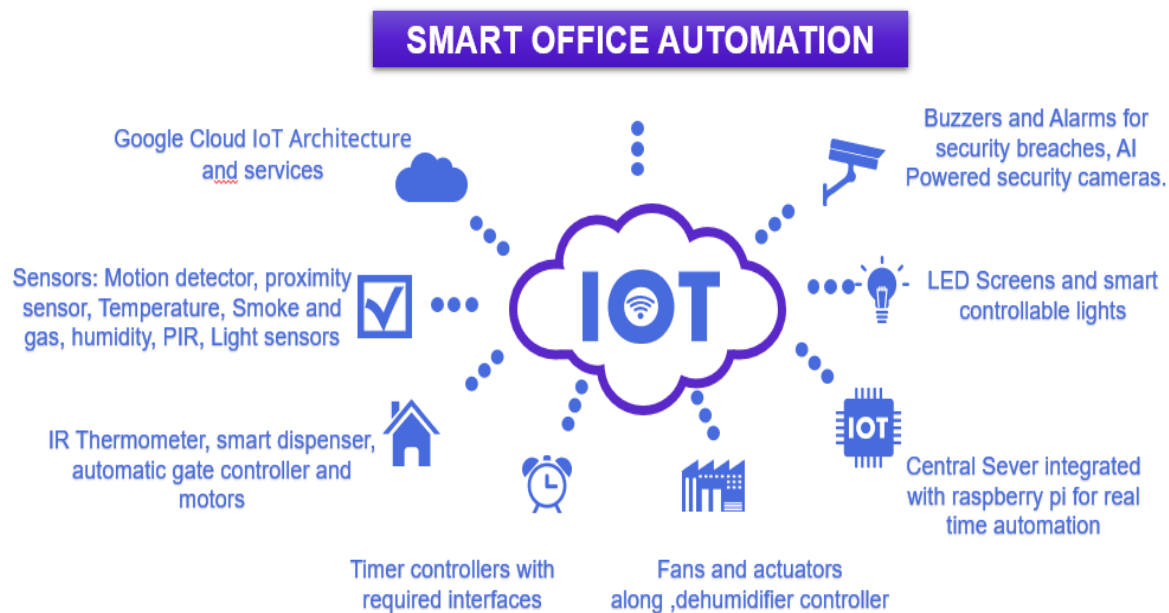
1. Safety of everyone's health: Check body temperature of anyone entering the office and maintain real-time data in cloud storage, providing swift contact tracing.
Automatic sanitizer dispenser and employee's health reports
2. Reduced energy Consumption: For improved in-depth control of energy consumption, project can put systems, computers, lightings and AC on a schedule.
3. Temperature control: The automation can sense real time temperature in both environment and create optimum environment inside office premises.
4. Lighting control: Right use of lighting and automatic dimming in broad daylight helps employees at work. Can use smart Wi-Fi based lighting solutions.
5. Office Climate Control: IoT technology allows the measurement and control of carbon dioxide, and humidity.
6. Office Security: Project uses face recognition to tell who has entered
The office and PIR sensor along with buzzers to indicate security breach

3.2 Social Relevance

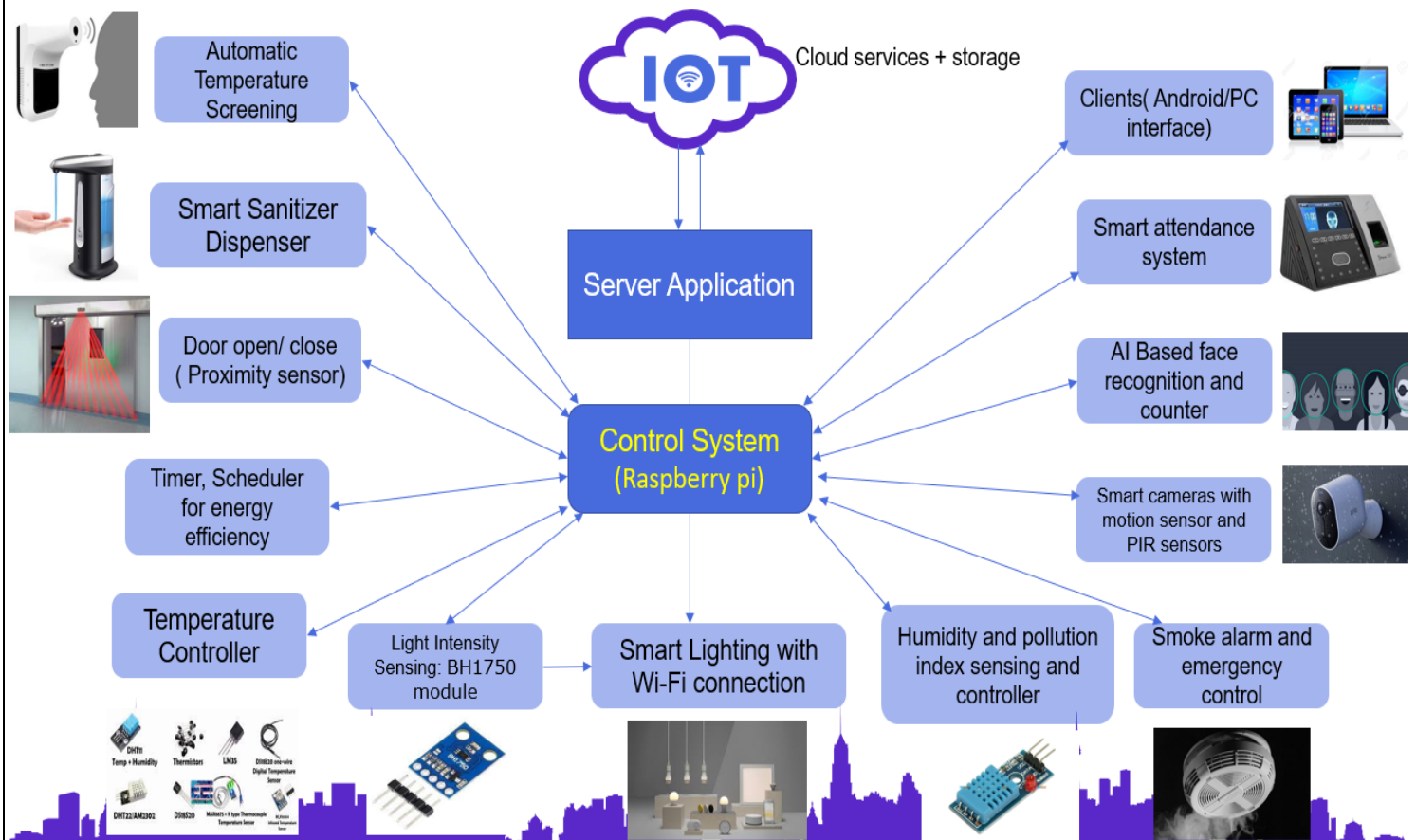
IoT devices impact society in a meaningful way. Smart offices can save energy costs by controlling the electricity or temperature when one is away from work, and they can offer better security by constant surveillance and taking proactive action in case of a security breach. As data privacy is top priority of every organization, a safe and automated system is definitely the need of hour.

As we are still going through tough times after facing more than a year with pandemic restrictions and devastation caused by contagious virus, it is everyone's responsibility nowadays to protect themselves through COVID appropriate behaviors as well as protect others by not being careless in public areas. IoT and smart automation is most effective method to check such behaviors in public areas and protecting everyone's life and making workplace safer for employees to thrive. devices will continue to evolve and impact our daily lives. These devices benefit society and make it safer and more regulation is needed to prevent hackers especially with billions and billions of connected devices.

3.3 Architecture/Model



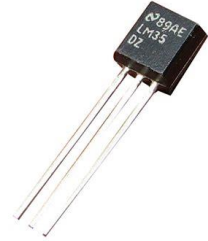
BLOCK DIAGRAM



3.4 Hardware and Software Requirement

➤ Temperature Sensor

A temperature sensor is a device, typically, a thermocouple or resistance temperature detector, that provides temperature measurement in a readable form through an electrical signal. A thermometer is the most basic form of a temperature meter that is used to measure the degree of hotness and coolness.



The working of a temperature meter depends upon the voltage across the diode. The temperature change is directly proportional to the diode's resistance. The cooler the temperature, lesser will be the resistance, and vice-versa. The resistance across the diode is measured and converted into readable units of temperature (Fahrenheit, Celsius, Centigrade, etc.) and, displayed in numeric form over readout units. In geotechnical monitoring field, these temperature sensors are used to measure the internal temperature of structures like bridges, dams, buildings, power plants, etc.

➤ Light Sensor

A light sensor is a photoelectric device that converts light energy (photons) detected to electrical energy (electrons). Seems simple? There is more to a light sensor than just its definition. Different Types of Light Sensors are:

1. Photoresistors (LDR): The most common light sensor type that's used in a light sensor circuit are photoresistors, also known as a light-dependent resistor (LDR). Photoresistors are used to simply detect whether a light is on or off and compare relative light levels throughout a day.

As its name suggests, photoresistors work similarly to your regular resistors, but instead resistance change is dependent on the amount of light it's exposed to.

- High intensity of light causes a lower resistance between the cadmium sulfide cell
- The low intensity of light results in a higher resistance between the cadmium sulfide cells

This working principle can be seen in applications such as street lamps, wherein the day, the higher light intensity results in lower resistance and no light produced.

2. Photodiodes: Photodiodes are another type of light sensor. But instead of using the change in resistance like LDR, it's more complex to light, easily changing light into a flow of electric currents. Photodiodes are mainly made from silicon and germanium materials and comprise of optical filters, built-in lenses and surface areas

Working: Photodiodes work on the working principle called the inner photoelectric effect. To simply put it, when a beam of light hits, electrons are loosened, causing electron-holes which results in electrical current to flow through.

Applications: Since current generated by photodiodes are directly proportional to the intensity of light, it makes it favorable for light sensing that requires fast light response changes. Since photodiodes are responsive to infrared light, it's applicable for more usages as well. Here are some of the applications of photodiode:

- Consumer electronics ranging from compact disc players to smoke detectors and even remote control devices
- Solar energy systems such as solar panels

3. Phototransistors: The last light sensor type we'll be exploring today is the phototransistor. The phototransistor light sensor can be described as a photodiode + amplifier. With the added amplification, light sensitivity is far better on the phototransistors.

➤ **Smoke Sensor**

Smoke detector is a necessary fire alarms device for your home safety to protect your family safe. To Know about these two types of smoke fire alarms: photoelectric and ionization smoke detectors.

1. Ionization smoke alarms:

These smoke detectors are much more responsive to fast, raging fires and flames. They contain a small amount of radioactive material that passes between two electrically charged plates, which create an ionization chamber. This configuration ionizes the air and creates a current that flows between the plates.

2. Photoelectric smoke alarms:

These types of detectors typically respond better to smoldering fires—essentially those that begin with a long period of smoldering. Photoelectric alarms work using a photoelectric sensor and a light source. As smoke enters the chamber and crosses the path of the light beam, light is scattered by the smoke particles, aiming it toward the sensor, which in turn triggers the alarm.



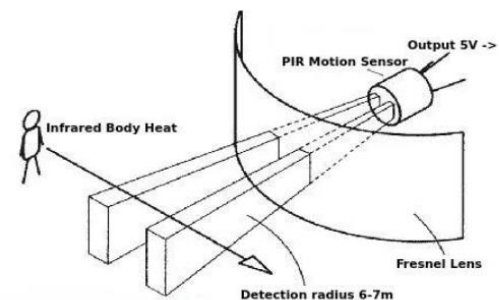
➤ Humidity Sensor

Humidity Sensor is one of the most important devices that has been widely in consumer, industrial, biomedical, and environmental etc. applications for measuring and monitoring Humidity. Humidity is defined as the amount of water present in the surrounding air. This water content in the air is a key factor in the wellness of mankind.



➤ Motion Sensor (PIR sensor)

Motion sensor consists of a fresnel lens, an infrared detector, and supporting detection circuitry. The lens on the sensor focuses any infrared radiation present around it toward the infrared detector. Our bodies generate infrared heat, and as a result, this heat is picked up by the motion sensor. The sensor outputs a 5V signal for a period of one minute as soon as it detects the presence of a person. It offers a tentative range of detection of about 6–7 meters and is highly sensitive. When the PIR motion sensor detects a person, it outputs a 5V signal to the Raspberry Pi through its GPIO and we define what the Raspberry Pi should do as it detects an intruder through the Python coding. Here we are just printing "Intruder detected".



➤ Display

This hardware is consisting of two ports such are HDMI and Composite. These are attached with HDMI cable. When using a composite video connection, audio is available from the 3.5mm jack socket. LED Screens can be used in real office scenario, but we have used 16×2 LCD screen to display various changes in state of any sensor.

➤ Atlantis Automatic Touchless Hand Sanitizer Dispenser

The Atlantis Automatic Touchless Hand Sanitizer Dispenser comes with a spray spout, thus all we have to do is place our hands under spout and sanitizer will be sprayed onto palms. A user just required to bring hands under nozzle, the machine through infrared motion sensor, and high-efficiency pump will dispense soap automatically in just 0.2 seconds.



➤ Philips smart lighting

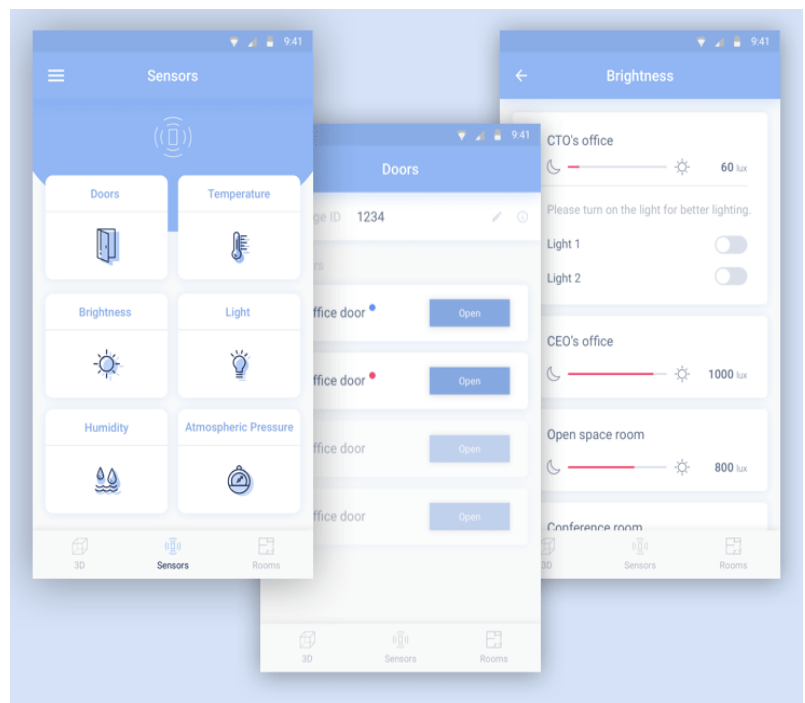
Smart lighting solutions is a necessary requirement of smart office automation. Lighting with Wi-Fi and application based control enhances the energy-saving and effective environment for any office, creating perfect work environment and improving productivity.

➤ Interfacing MCP3008 ADC with sensors:

A simple circuit is used to construct the office automation system shown in fig1. The raspberry pi GPIO pins are connected to 4 channel relay board. The relay board needs external 12V power supply. The output of relay channel connected to the electrical load of the office. The sensors will continuously sense the room conditions like (temperature, humidity, CO2, light intensity) and send that analog data into analog to digital converter (MCP3008 ADC). The ADC will convert the all-analog data into digital form and it is given to the GPIO pins of the Raspberry Pi. The GPIO pins will collect the information to the ADC and it will react the corresponding logic implemented on Raspberry Pi.

➤ User Interface

The smart office web and android application would make it much convenient and easier for the office manager and relevant stakeholders to control various sensors and monitor the efficiency of employees on their finger tips. The application would enable the user to securely login into the website or app from official devices and control various parameters such as temperature, humidity, lighting and ambience, ventilation in conjunction with automation to get best ever experience of the Smart office.

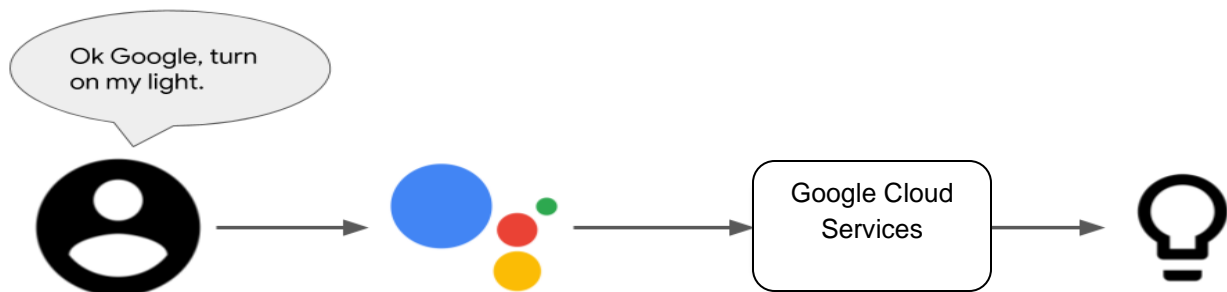


The manager would also be able to get real time employee details, body temperature calculations, and related data collected through various sensors and AI based cameras on his/her personalized dashboard and generate monthly or weekly reports automatically based on data analytics and send those reports to concerned person through mail.

➤ **Smart office Cloud Services with Google Cloud IoT Core**

IoT Core is a fully managed service that allows you to easily and securely connect, manage, and ingest data from millions of globally dispersed devices. IoT Core, in combination with other services on Google Cloud, provides a complete solution for collecting, processing, analyzing, and visualizing IoT data in real time to support improved operational efficiency.

- i. IoT Core, using Cloud Pub/Sub underneath, can aggregate dispersed device data into a single global system that integrates seamlessly with Google Cloud data analytics services. Use your IoT data stream for advanced analytics, visualizations, machine learning, and more to help improve operational efficiency, anticipate problems, and build rich models that better describe the office scenario.
- ii. Securely connect many of company's globally dispersed devices through protocol endpoints that use automatic load balancing and horizontal scaling to ensure smooth data ingestion under any condition. IoT Core supports the standard MQTT and HTTP protocols, so we can use your existing devices with minimal firmware changes. IoT Core runs on Google's serverless infrastructure, that protect the critical business data.
- iii. Centrally manage entire IoT data network from a single admin dashboard. We can easily reduce capital expenditures on our project and maintenance costs with a pay-as-you-go service.



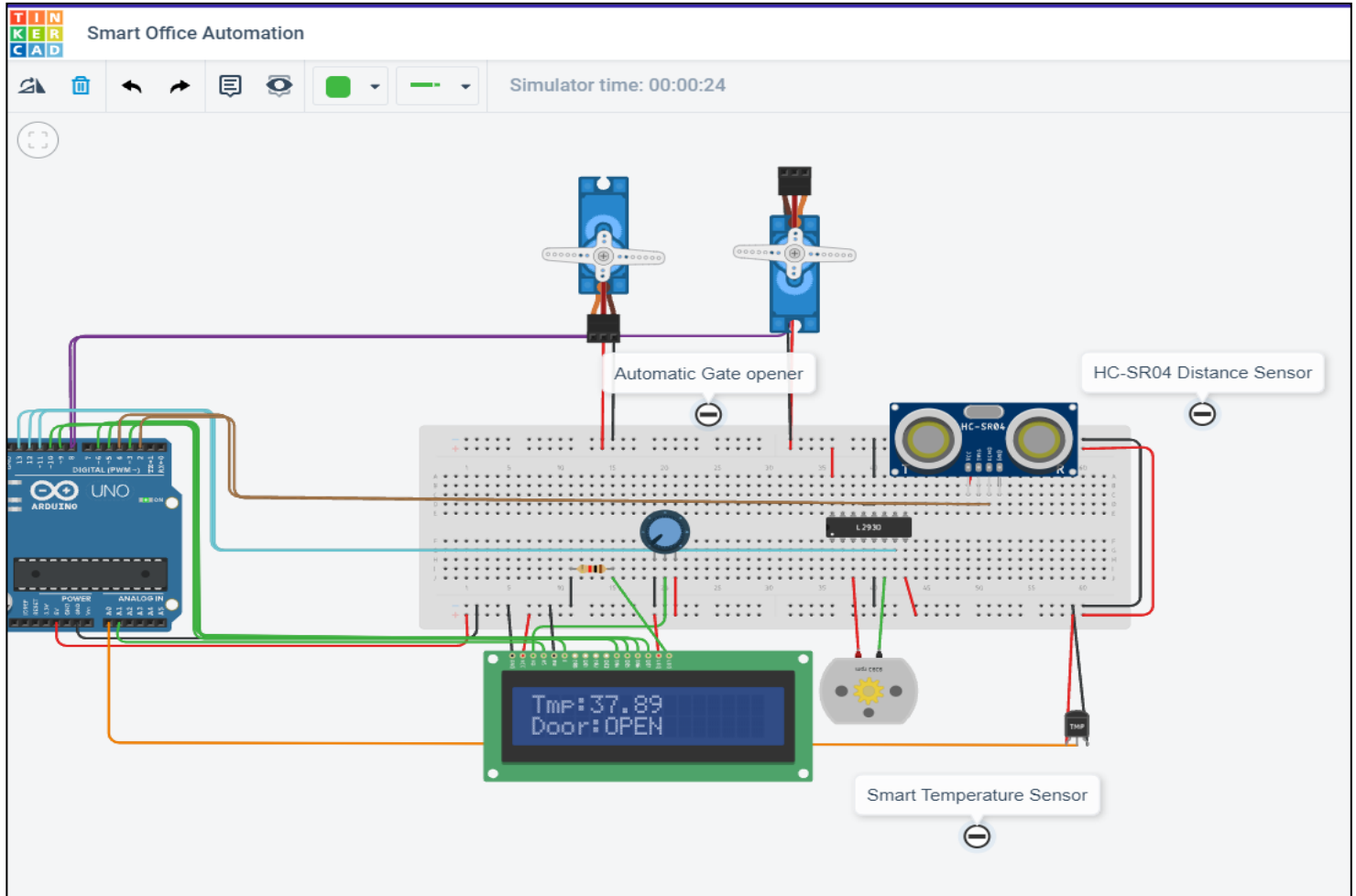
Cloud IoT Core is a fully managed service for securely connecting and managing IoT devices. Using the MQTT or HTTP bridge, IoT devices can connect to Google Cloud using per-device public/private key authentication and exchange data. Incoming device data is published to a Cloud Pub/Sub event stream.

Cloud Firestore is a flexible, scalable NoSQL cloud database to store and sync data for client- and server-side development. It keeps your data in sync across client apps through real-time listeners and offers offline support for mobile and web through their native SDKs.

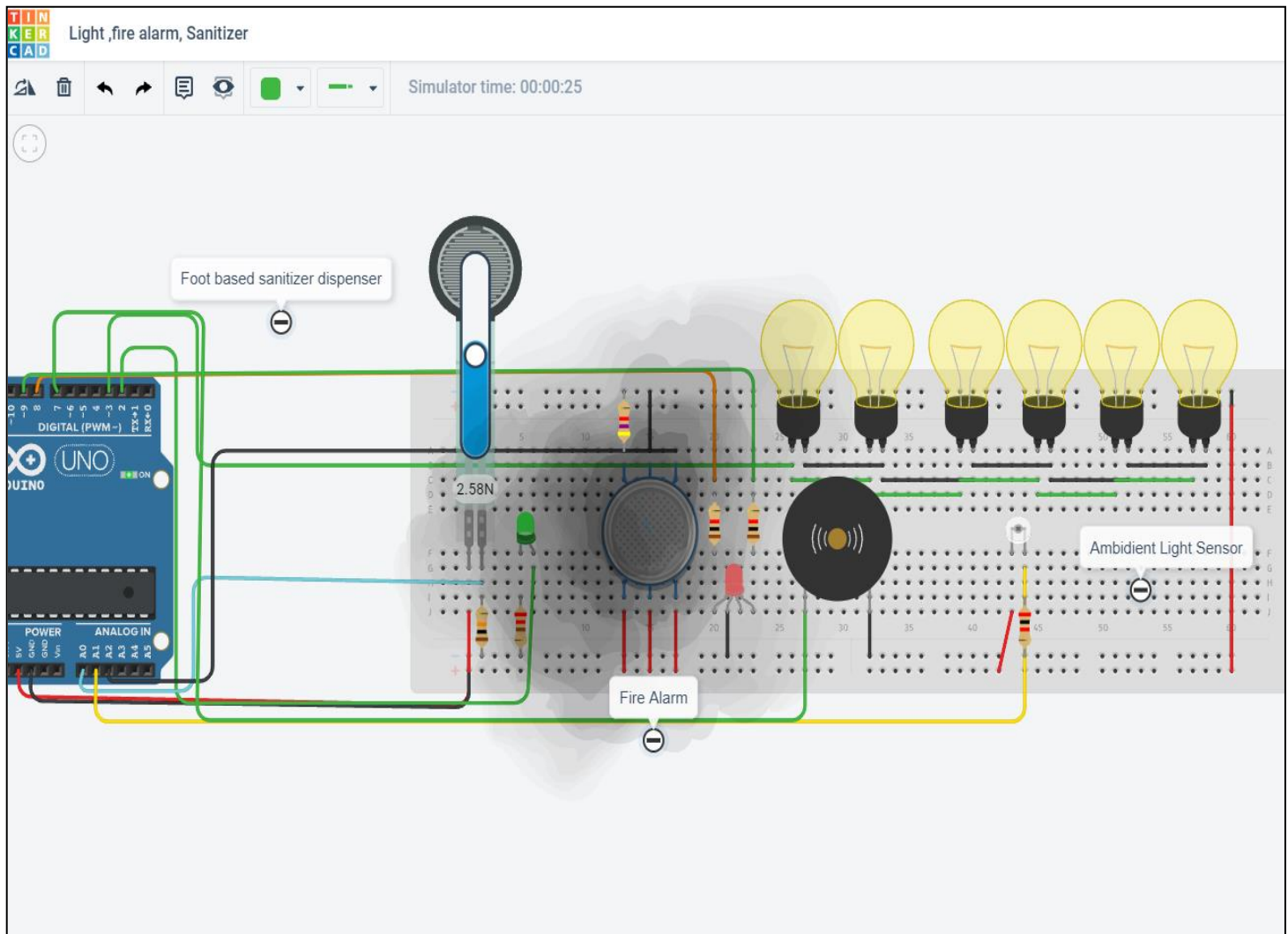
Cloud Functions enable backend code to run in response to events triggered by Firebase and Google Cloud features. We can use this to marshal device data between IoT Core and Firestore.

3.4 Results obtained (with Screen shots of Results)

We have implemented the important parts of our projects with the help of TinkerCAD with all available sensors and actuators to get the idea of how the real project would look like from operator's perspective.



- ❖ **Smart office Automation: Automatic Door opener and Smart temperature control:** Here, we have used the HC-SR04 Ultrasonic Distance Sensor and 2-stepper motors to implement automatic gate opening once any person approaches within 1 m of main gate, the gate will be closed otherwise, thus reducing chances of contacting infection through touch. Also, we have used the temperature sensor along with DC motor and L298N motor driver to regulate the office environment with optimum temperature. If the temperature goes above given threshold, then the fan will make sure to bring cool environment inside the office.

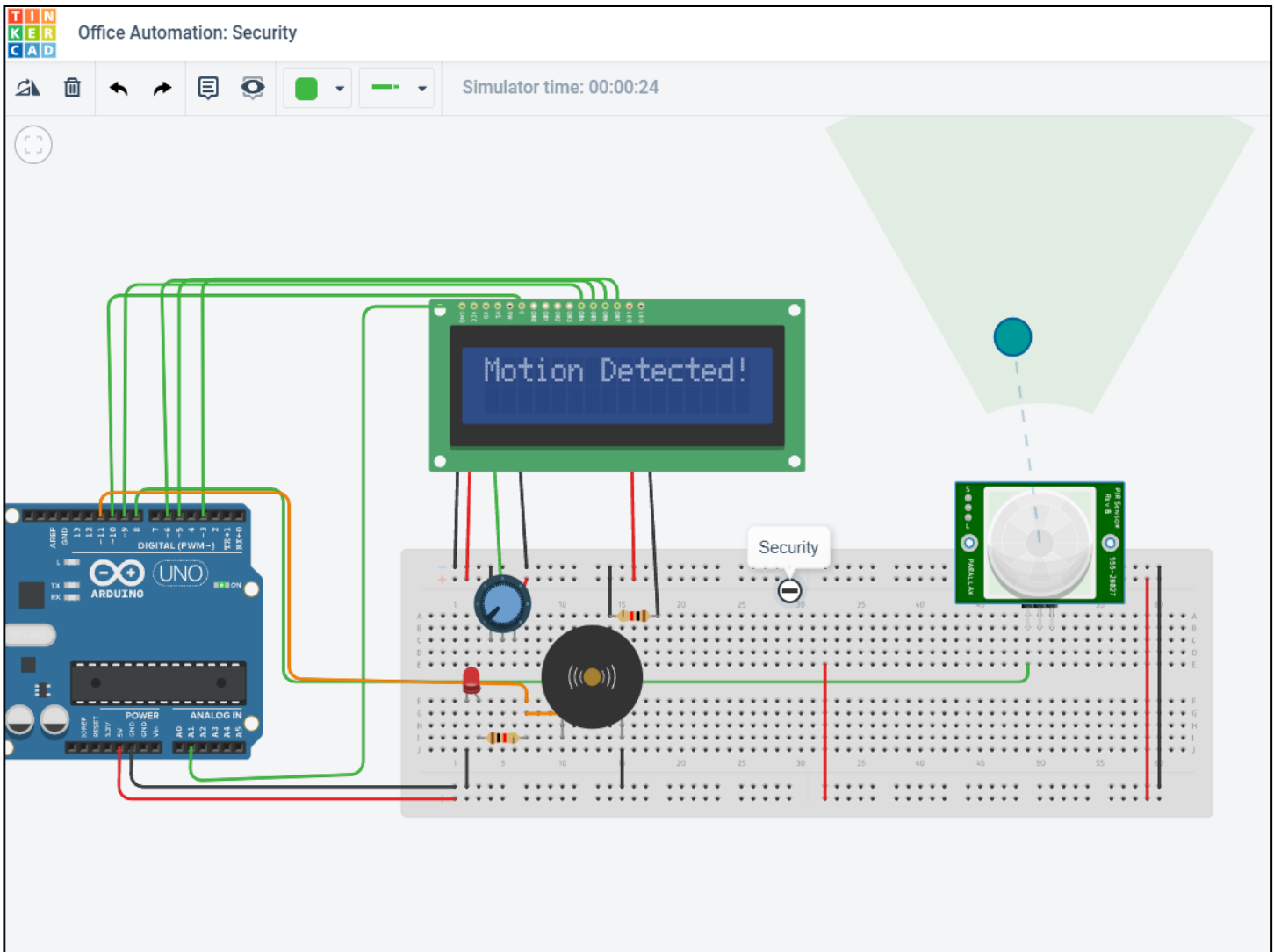


❖ **Touch-free sanitizer dispenser and smart lighting control, Fire alarm**

Here we have created suitable scenario of foot pressure-based sanitizer dispenser to demonstrate how simple sensors can make our work simple instead of using sophisticated and costly machines. We have used Force sensor connected with a LED to dispense sanitizer once the force on sensor crosses given threshold indicated by green light.

To demonstrate smart lighting, we have connected ambient light sensor and few bulbs to Arduino board and wrote suitable logic for it to dim all the lights once enough outdoor light is there inside office environment. The Ambient Light Sensor (ALS) products provide measurements of ambient light intensity which match the human eye's response to light under a variety of lighting conditions. Each device has a specific operating range of performance, from very low light up to bright sunlight.

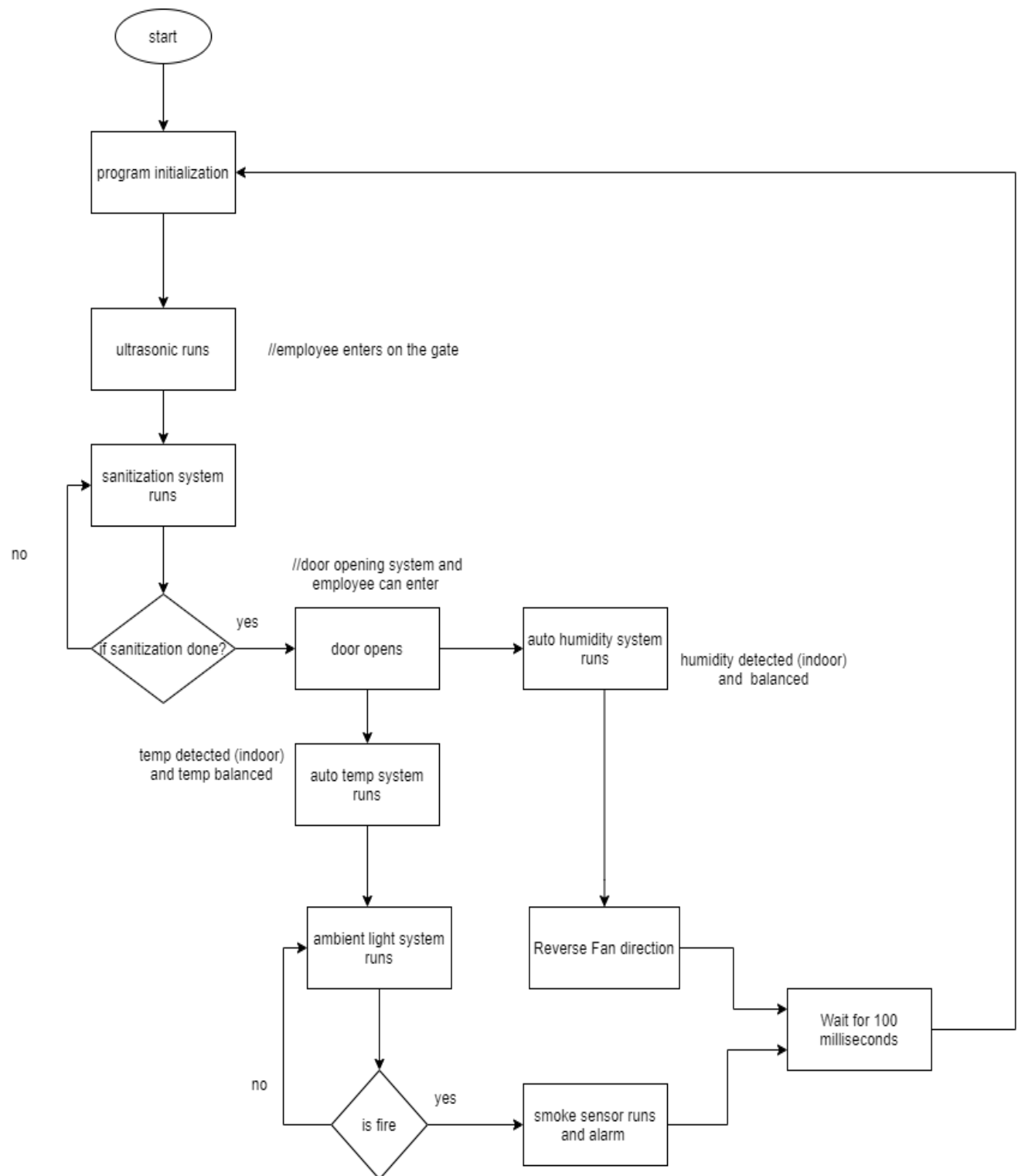
The fire alarm with smoke sensor would be able to indicate fire with buzzer and led light about any case of excess smoke inside office premises.



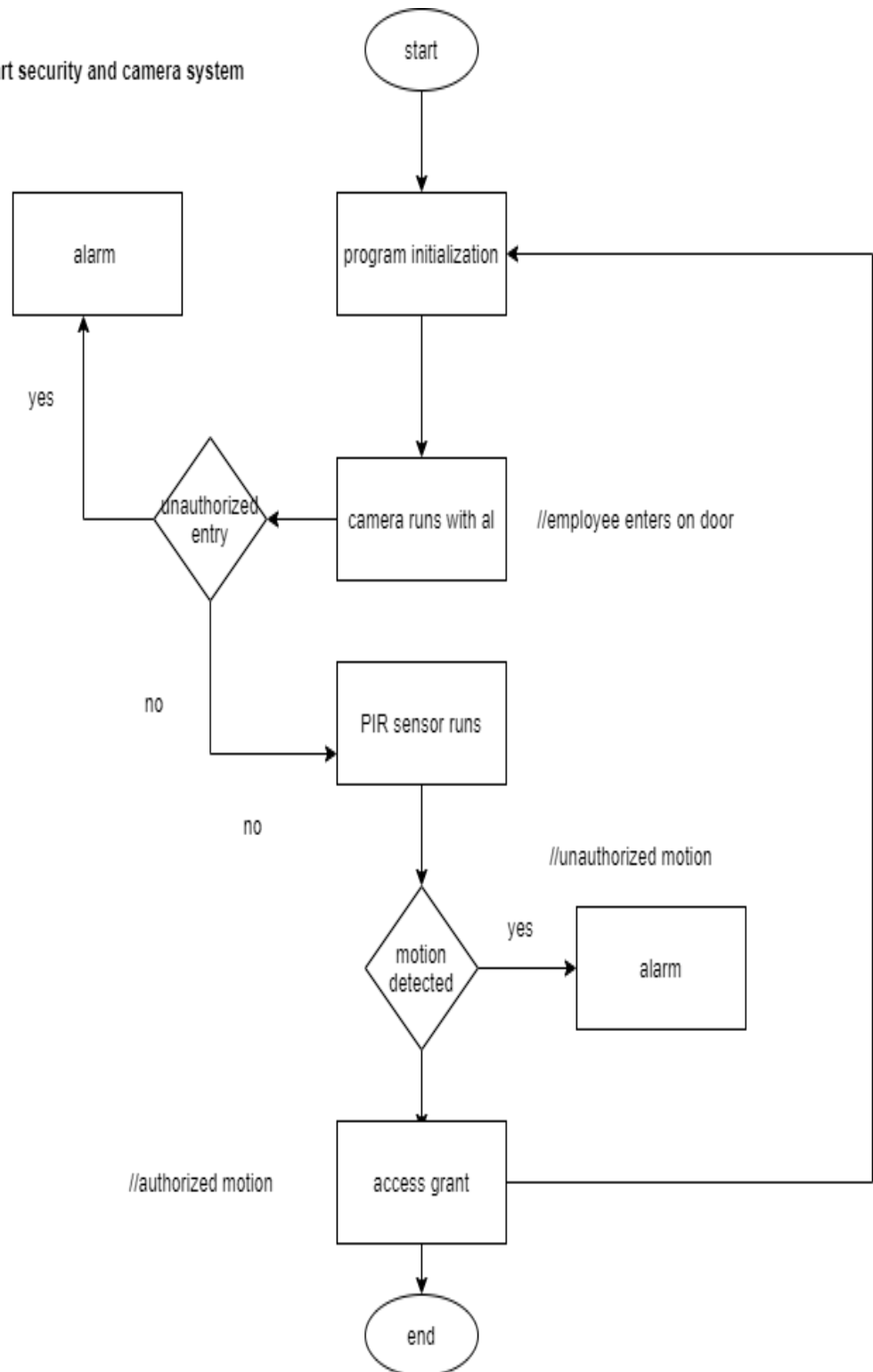
❖ Smart office Security System

The security system is especially designed to safeguard the sensitive areas on an office like server rooms, data centers, inventories, etc. We have used PIR sensor in conjunction with LCD screen, red LED, and a buzzer to alert about any security breach by unauthorized person.

We can further add smart face recognition cameras and technology to identify if the person belongs to office or not, and alert the admin as and when required. The system can also count the no. of employees at a given time inside office premises and also take attendance based on face recognition technology and store the real time data in cloud based technology.



Smart security and camera system



Chapter 4: Conclusion

Even the slightest increase in your business efficiency can become a powerful competitive advantage over the competition in today's world. The time and technology is changing at a very fast pace and correct implementation of automation tools in workspace has profound effects in overall productivity of offices. While most people spend around 8-10 hours a day at work, it is only natural that office automation using IoT is gaining momentum. According to the a report, the size of the smart office market is steadily growing and it is amounted to \$22.21 billion in 2017 and is forecasted to double by 2023, reaching \$46.11 billion.

Despite its steady growth and the huge potential, the smart office market is still in its early stages of development. The IoT office application is being outpaced by the other industries benefiting from the use of IoT solutions, including home automation, health, and fitness, as well as retail and inventory management. Thus, we have researched and implemented some necessary and important scenarios a smart office must have in today's unpredictable and ever-changing time to cope up with the change and adopt to sustainable development growth and in sync with future technologies et to be discovered.

As we have already learned and implemented some commonly used sensors and actuators in TinkerCAD for demonstration purpose, it becomes much easier and viable to go for actual working demonstration of same project on larger scale than the scope of given project. Thus, the benefit any organization can avail from the smart office automation project are as follows: -

- Improved accuracy and ease of use of resources
- Reduced costs and maintenance
- Reduced time and increased productivity
- Data storage and management
- Data insights and more informed decisions
- Business process improvement and participation in sustainable environment goals

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