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HOME FIREFIGHTING SYSTEM BASED ON MACHINE LEARNING AND INTERNET OF THINGS

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Abstract

The smart home is now of interest to many researchers. The network of things has enabled homes to become interactive away from the traditional homes that have lasted for a long time. The Web is an important part of the various exchanges of current life. The Web of Things has expanded rapidly to include many aspects of life today, including home appliances, alarm systems, and distributed storage systems for information created by home appliances. The various innovations and parts make up a smart home, and they all produce valuable information that can be used to guess home conditions and outdoor traffic. A wonderful and comprehensive smart home fire suppression system based on IoT and machine learning is presented with plan and framework for optimization. The frame controls and directs the security of the house and its current conditions through the use of a group of sensors, where there is a unit that controls and examines electrical tools and natural variables, and to obtain a protected and accurate frame, the idea of artificial intelligence was used to determine the state of the flame. This work shows that AI computations can advance the usefulness of a home computing framework and improve home security.

Keywords: Internet of Things (IoT), Smart Home, Fire system, Machine Learning.

1. INTRODUCTION

An essential part of new data innovation and an extension of web applications is Internet of Things (IoT). The main ideas of the IoT include the automation of tasks and the connection of ordinary objects to the Web [1]. Accessory tools obtain information about the actual world, which is then manipulated, analyzed, and used to carry out tasks. The IoT applications in a wide number of companies, including boardroom establishment, smart homes, cool transportation, and medical services [2].

Monitoring home security and climate is essential due to the high rate of electrical accidents, individual hazards to home occupants, and damage to property. The security of people's lives and property is of paramount importance and should be the primary concern. Then the home should include a smart framework for checking from a distance, entitlement and illuminating the occupant regarding exercises. A great home automation framework is expected to bring home security, luxury, comfort and control. A savvy house is a (IoT) application that permits its occupants to just screen, control, and manage their home tasks from anyplace. The IoT, as per [3], is an organized framework that empowers electronic items to talk with each other and trade information.

By checking and dealing with the home climate, savvy home mechanization frameworks are essential to guaranteeing a decent personal satisfaction. The primary objectives of a

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savvy home mechanization framework are energy and water investment funds, wellbeing (like the recognition of risky gases, fires, or house intruders), and comfort (through remote observing and the board of machines and the actual climate).

The IoT home equipment advances of sensors and actuators for correspondence and mechanization are connected with machines and contraptions, giving restricted or remote home control [3], making the home smart by offering types of assistance that require minimal human info or association. One has some control over a home, for example, through the Web from any area, utilizing particular programming or a portable application that sudden spikes in demand for a PC, tablet, PC, or cell phone [4].

Through the arranged IoT home equipment innovations of sensors and actuators for correspondence and computerization, offering confined or remote home control [5], machines and gadgets are associated with offer types of assistance that expect practically zero human information or collaboration. This makes the home smart by offering these types of assistance. For example, utilizing the Web, an individual could deal with their home from anyplace, with the control component being given by particular programming or a portable application that sudden spikes in demand for a PC, tablet, PC, or cell phone [5].

The utilization of AI calculations in brilliant home computerization has the advantage of dissecting and evaluating information to conjecture ecological activities and conditions and further develop robotization [6]. A shrewd home robotization framework performs staggeringly well when AI is coordinated with IoT advances in the plan and improvement process. This article will focus on the smart home, which gives knowledge, control and network to the average home. It is a component of the IoT annotation era in general [7]. This post will analyze security and protection concerns despite the advent of the Internet of Things and great homes.

2. RELATED WORKS

The improvement of ecological control, energy the board, home security, and different areas of savvy home robotization frameworks is a shared objective of examination articles and contemporary writing. In the space of the IoT, AI calculations have additionally been utilized for arrangement, expectation, and examination. The region remembers articles for the Web of Things that cover computerized brilliant homes and the utilization of AI to canny frameworks.

Utilizing IoT innovation, Govindraj et al. [8] introduced a savvy home mechanization framework to play the job of the conventional home robotization framework. A satellite station and a radio recurrence handset are utilized in the proposed framework to oversee and screen machines, temperature, movement, and gases in the home climate.

Rani et al. [9] proposed a characteristic language handling (NLP) and computerized reasoning (man-made intelligence)- based voice-controlled home computerization framework. Voice orders are sent over a cell phone and interpreted utilizing a preset normal language handling medium to control domestic devices. The framework was not

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extended to incorporate different areas of home mechanization, like the control, observing, and recognition of natural circumstances, gatecrashers, developments, and so forth. The framework was exclusively used to work home devices.

A client-server-based strategy for savvy home mechanization was proposed by Gladence et al. [10]. The proposed framework lays out association between the frameworks and individuals utilizing AI methods and NLP thoughts. The client guides to play out specific errands, like working entryways and home apparatuses and tuning in for vocal bed development.

Mehmood et al. [11] .'s improvement of an item ID instrument for the control of savvy home machines used a model view regulator engineering, haze of things, and item recognition calculation as the establishment for the robotization framework. Through the message lining telemetry transport (MQTT) mode, the Web of Things gadgets connected with home apparatuses. This study showed how joining object distinguishing proof strategies with profound learning calculations further develops object identification in a brilliant home setting.

Khan et al. [12] introduced a strategy for controlling domestic devices in light of examination and canny direction, utilizing support vector machines for security of IoT gadgets and blockchain innovation for smart navigation. Machines may now be worked remotely on account of an Android application. While going with choices on home devices and their situations with, creators utilized a straight part.

A system for overseeing home machines like lights, fans, radiators, and outlets was advanced by Taiwo et al. [3]. With the assistance of Bluetooth and Zigbee advancements for correspondence and an Android versatile application for sending orders, the proposed system empowers on-and off-site home control. The proposed Bluetooth innovation, notwithstanding, restricted the +e correspondence range.

A home computerization framework was depicted by Garg et al. [13] for detecting and keeping up with appropriate encompassing house conditions, as well as to give security from robbery or peril utilizing sensors and home apparatus the executives. It recovers orders that work the house through the Web utilizing a cloud data set. Time sensitive boundaries from different home sensors are likewise put away in the cloud data set.

3. SMART HOME BASED ON IoT

The smart home (SH) is a vital IoT application that helps control and monitor homes [14]. Figure (1) shows the popularity patterns of the expression “cool home” and “network of things” starting from 2013. According to Figure (1), it is clear that smart home and network of things are on the rise. Cool Homes uses a few IoT-based innovations to offer a range of utility instances that include controlling lights, home appliances, phone remote control, and more [15].

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Figure 1: Functions of a smart house [16]

Rather than traditional abodes, the shrewd home consolidates standard private elements as well as abilities for home development, organizing, brilliant apparatuses, and hardware computerization. Furthermore, broad commitment prospects are offered, and, surprisingly, related uses for different energy admissions are diminished [17].

Table 1: Features of Smart Home [16]

Smart home Devices	Control of draperies, sound and video hardware, lighting frameworks, computerized theater frameworks, network machines, cooling, and so on.
Features of Smart Homes	Control of domestic devices, lighting, phones, indoor and outside controllers, thief cautions, natural observing, infrared sending, and customized time controls, in addition to other things.

Concerning Table (1), the idea of SH has a couple of key parts, some of which are momentarily depicted here. One is the SH's fundamental framework for home robotization. It alludes to coordinating or overseeing electronic home machines, like lighting, security, sound and video, PC equipment, warming, and cooling frameworks [18].

A focal handling unit is customized to gather information from electrical and electronic gear and afterward, in the wake of following different methodology, convey specific data to different gadgets. Cell phones, controllers, PCs, and different points of interaction can be generally used to control the gadgets. One more fundamental part of the SH is the home organization. A stage for family data associates laptops, home electrical machines, security frameworks, lighting frameworks, and WAN in shrewd homes, performs hardware the board, and offers information and mixed media [19].

4. MACHINE LEARNING ALGORITHMS

Artificial intelligence has gotten new improvement chances alongside the speedy progression of science and innovation. The practical characteristics of man-made brainpower are reinforced by the joining of multidisciplinary hypothetical information into machine innovation that depends on PC innovation, like measurements and calculation intricacy. It is feasible to work on the materialness of AI calculations and give more

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comfort for the monetary improvement of the business by leading a reasonable investigation of AI calculations and giving guidance reference for later AI improvement [20].

4.1 Random Forest (RF)

Leo Breiman made the Random Forest [21], which is an assortment of unpruned grouping or relapse trees made from an arbitrary example of preparing information. The elements picked during the acceptance system are aimlessly. The expectations of the gathering are consolidated (greater part vote in favor of grouping, normal for relapse). Each tree is developed as per [22]:

- On the off chance that the preparation set contains N cases, yet with substitution, by haphazardly choosing N cases. The preparation set for developing the tree will be this example.
- The variable m is picked with the end goal that for M info factors, m<<M is provided at every hub, m factors are picked aimlessly from the M, and the best parted on these m is utilized to part the hub. The amount m is held consistent during the development of the RF.
- Each tree is developed to its full potential. Pruning is not done.

Generally speaking, Random Forest performs significantly better than single tree classifiers like C4.5. Its generalisation error rate compares favourably to Adaboost's, although it is more noise-resistant [22].

4.2 Light Gradient Boosting Classifier

In 2016, Microsoft MSRA fostered the Light gradient boosting machine (LightGBM), a speedy and viable inclination helped choice tree (GBDT) strategy with an open-source work reason. This approach upholds viable equal preparation and is used for arranging, order, relapse, and numerous other AI strategy tasks. The LightGBM strategy, rather than Xtream Inclination Supported (XGBoost), utilizes a histogram to stimulate preparing, save memory, and apply a reasonable development plan with profundity limits [23].

The crucial idea of LightGBM is to discretize the congruity of drifting point eigenvalues into k canisters and produce a histogram with a width of k. LigthGBM can store 8-bit whole numbers, decreasing memory utilization to 1/8 of the first, and doesn't need an enormous measure of pre-arranged results capacity. This uncertain segment no affects the exactness of the LightGBM mode [24].

4.3 Hist Gradient Boosting Classifier

Inclination supporting purposes a method called hist slope helping relapse to prepare choice trees all the more rapidly. Preparing trees that are added to a group can be added substantially more rapidly by binning or discretizing. Subsequently, the information factors are utilized to carry out the hist angle helping technique's calculation. Each tree that is added to a troupe really tries to redress the anticipated missteps utilizing the gathering's prior models [25].

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Alongside different methodologies, the hGBR strategy is utilized. For example, the scikit-learn AI bundle, which gives a trial variant of the inclination helping procedure that upholds the histogram approach, may be utilized to make it. It offers the Hist Gradient Boosting Classifier and Hist Gradient Boosting Regressor classes specifically. The default GBR execution given by the library is significant degrees more slow than the hGBR execution, as indicated by the scikit-learn documentation [26].

5. SMART HOME SIMULATION

The smart home system was simulated based on the Cisco Payment Tracer program, where a virtual server was set up to be used as an Internet service provider, and as it is known, these servers are connected to main routers and then distributed to homes so that the Internet is used inside the house as shown in the Figure (2).

With regard to the devices of the supposed house, the house contained a system of solar cells for energy supply, and among them the house contained a number of devices and electrical controls, including that the doors were programmed with RFID keys, as well as lighting systems, air conditioning and cooling systems, garden watering system, and finally the fire safety system.

This work deepened in controlling the fire system to increase the security of the residents inside the house, as artificial intelligence and machine learning techniques were used to control and control that system. The mechanism of the system's work revolved around several axes, as these axes were linked to the environmental conditions inside the house, as it relied on the internal external temperature for one of the rooms, for example, as the internal temperature exceeded the external one by a large difference, which means that there is an abnormal thermal glow in the room, which indicates By burning, in addition to that, the amount of lighting indicates the glow, and your lie is the decrease in the amount of moisture, all of which are factors indicating the presence of fires.

The framework of the fire system is related to all of the above, in addition to that, a sensor has been placed to measure the level of carbon dioxide inside the room, as it is known that combustion generates carbon dioxide gas, and from here it can be said that in the event of a meeting of all these factors It is certain that a fire will occur inside a particular room. With regard to machine learning and control of the system, a condition has been set that if the amount of all of the factors mentioned changes in a certain direction, which is the direction that indicates the presence of fire, the fire system will open its sprinklers automatically for the purpose of extinguishing that fire.

On the other hand, only the rain sensor was placed to measure the level of the amount of spraying of the system and whether it is working well or not, and in the event that the system is working, the amount of humidity, temperature, and glow is continued to be read, as the decrease in heat and the excess of humidity gives an indication that the fire is extinguished, and this in turn instructs the system to close its sprinklers.

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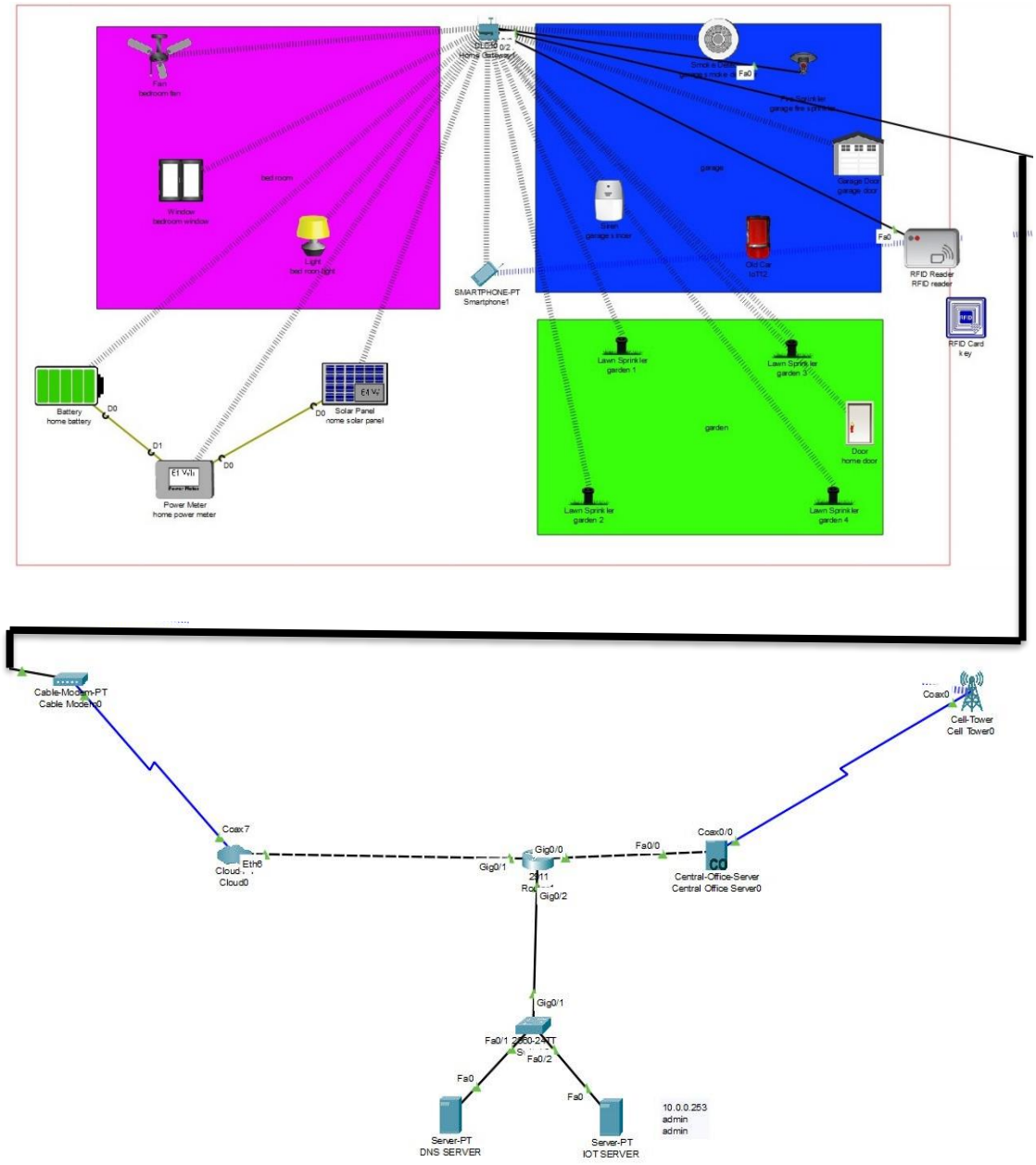

Figure 2. IoT Home system simulation

6. HARDWARE DESCRIPTION AND DATASET COLLECTION

The Hardware description of the data collection circuit consist of the elements shown in figure (3).

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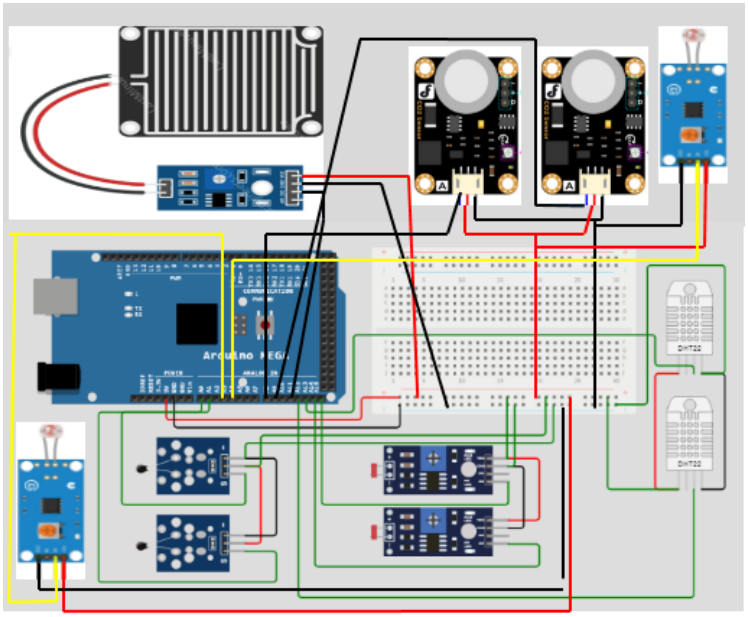

Figure 3: Dataset collection circuit

- **LM35 Sensor:** Two pieces of this sensor were connected to read the temperature inside and outside the room in which the fire system was activated.
- **DHT11 Sensor:** Two pieces of this sensor were connected to read the humidity level inside and outside the room in which the fire system was activated.
- **SPG30 Sensor:** This sensor was used to measure the level of carbon dioxide in the internal and external environment, as carbon dioxide increases in the atmosphere when there are fires.
- **Rain Sensor:** With regard to the rain sensor, it has been employed to see if the fire system is working well or not, in other words, it gives an indication of opening the fire system in the event of a fire.
- **LDR:** The photo resistance sensor, which is a variable resistance whose value decreases when the light increases, which gives an indication of the presence of a fire, as the light resulting from the fires reduces the value of that sensor

The sample of data set collected shown in Table (1), It contained eight characteristics (internal temperature, external temperature, the amount of light intensity inside the room, the amount of light intensity outside the room, the amount of internal humidity, the amount of external humidity, the amount of dioxide inside the room, the amount of carbon dioxide outside the room) and then the target Who decides whether the fire system will operate or not.

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Table 2: Dataset sample

In Temp	In Humidity	Out Temp	Out Humidity	In Light	Out Light	In Co2	Out Co2	Open Fire
21.9	94	20.8	66	22	21	0.85	0.77	1
21.9	95	20.7	69	23	20	0.87	0.75	1
21.9	94	20.8	66	24	21	0.76	0.69	1
22	93	21.0	67	25	19	0.82	0.59	1
22	94	21.5	64	26	20	0.86	0.65	1
21.7	95	20.0	74	27	20	0.76	0.65	1
21.7	96	20.1	68	25	21	0.81	0.66	1

7. RESULTS AND DISCUSSION

As mentioned and illustrated in Figure 4, performance is evaluated using the Confusion Matrix (CM), or the matrix used to describe characteristic outcomes in classification problems. In binary classification tasks, the incorrect choice receives a category 0 rating, while the correct one receives a category 1 rating [27].

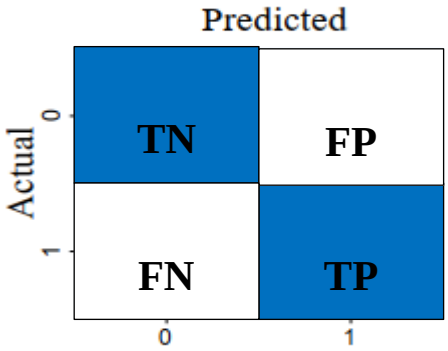

Figure 4: Confusion Matrix

The TP (1, 1) and TN (0, 0) scores in this case indicate that normal and pathological consumption patterns can be accurately distinguished. Similar to the FP (0, 1) and FN (1, 0) scores, these indicate an incorrect classification of the instances with normal and abnormal circumstances. And although FN observations comprise dishonest spending patterns that were accurately predicted, FP accounts for those observations in CM that were honest but unfairly forecasted. The model's performance is evaluated using CM in terms of a number of parameters, including precision, accuracy, recall, and F1 score.

$$Accuracy = \frac{TP+TN}{TP+TN+FP+FN} \quad (1)$$

$$Precision = \frac{TP}{TP+FP} \quad (2)$$

$$Recall = \frac{TP}{TP+FN} \quad (3)$$

$$F1 - Score = 2 \times \frac{Precision \times Recall}{Precision+Recall} \quad (4)$$

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The Confusion Matrix Results get from the used algorithm shown in Figures (5, 6, 7) respectively, when the measured values of the metrics shown in Table (3, 4, 5) respectively.

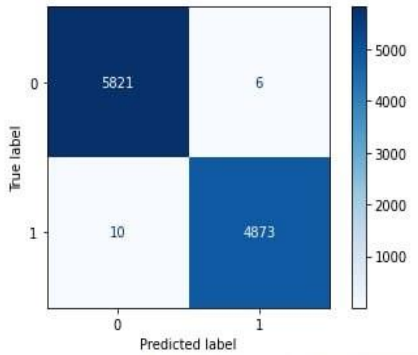

Figure (5) Light gradient boosting CM

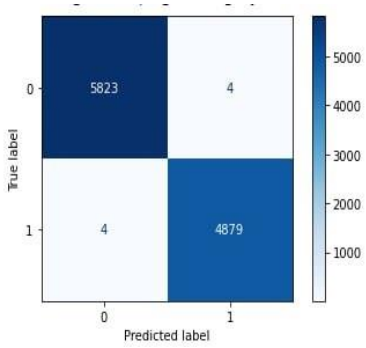

Figure (6) Random Forest CM

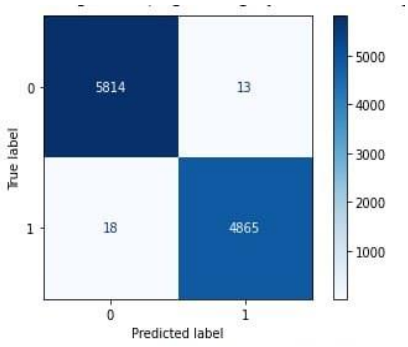

Figure (7) Hist Gradient Boosting Classifier CM

Table 3: Light Gradient Boosting Results

Precision	Recall	F1-Score	Support	Accuracy
1.00	1.00	1.00	5827	99.85
1.00	1.00	1.00	4883	

Table 4: Random Forest Results

Precision	Recall	F1-Score	Support	Accuracy
1.00	1.00	1.00	5827	99.93
1.00	1.00	1.00	4883	

Table 5: Hist Gradient Boosting Classifier Results

Precision	Recall	F1-Score	Support	Accuracy
1.00	1.00	1.00	5827	99.71
1.00	1.00	1.00	4883	

As shown in Tables above the maximum accuracy geted when the Random Forest algorithm used that equal to (99.93%).

8. CONCLUSION

In smart homes, enhancing home security is a top difficulty, and solving this issue requires constant technical advancement. A brand-new technology was put forth that would allow the fire system to be managed according to the standards of heat, humidity, light intensity, and carbon dioxide gas in the immediate vicinity. The IoT-based engineering upholds constant observing of an individual's home condition as well as controller of domestic devices across an organization. It additionally incorporates security caution, controller,

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distant natural observing, and different elements. The sensors and microcontroller have been effectively associated with the cloud server. The data set effectively stores the information. The aftereffects of all testing settings and perceptions exhibit the fulfillment of this savvy home framework. The client can screen the state and circumstance at home and approach information from mechanical devices. The establishment of this framework will increase living expectations by improving security. The sensors and microcontroller have been effectively associated with the cloud server. The data set effectively stores the information. The aftereffects of all testing settings and perceptions exhibit the fulfillment of this savvy home framework. The client can screen the state and circumstance at home and approach information from mechanical devices. The establishment of this framework will increase living expectations by improving security.

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