International Journal of Innovative Research in Engineering
Volume 3, Issue 2 (March-April 2022), PP: 174-180.
www.theijire.com **ISSN No: 2582-8746**

Smart Home Systems Based on Internet of Things

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How to cite this paper:
PRASANTH.G[1], MADESHWARAN.N[2], "Smart Home Systems Based on Internet of Things", IJIRE-V3I02-174-180.

Abstract: *IoT home automation is the ability to control domestic appliances by electronically controlled, internet-connected systems. It may include setting complex heating and lighting systems in advance and setting alarms and home security controls, all connected by a central hub and remote-controlled by a mobile app.*

Key Word*: smart home, IoT, cloud computing, event processing, home appliances, rule-based event processing.*

I. INTRODUCTION

Classic smart home, internet of things, cloud computing and rule-based event processing, are the building blocks of our proposed advanced smart home integrated compound. Each component contributes its core attributes and technologies to the proposed composition. IoT contributes the internet connection and remote management of mobile appliances, incorporated with a variety of sensors. Sensors may be attached to home related appliances, such as air-conditioning, lights and other environmental devices. And so, it embeds computer intelligence into home devices to provide ways to measure home conditions and monitor home appliances' functionality. Cloud computing provides scalable computing power, storage space and applications, for developing, maintaining, running home services, and accessing home devices anywhere at anytime. The rule-based event processing system provides the control and orchestration of the entire advanced smart home composition.

Combining technologies in order to generate a best of breed product, already appear in recent literature in various ways. Christos Stergioua et al. merge cloud computing and IoT to show how the cloud computing technology improves the functionality of the IoT. Majid Al-Kuwari on embedded IoT for using analyzed data to remotely execute commands of home appliances in a smart home. Trisha Datta et al. [3] propose a privacy-preserving library to embed traffic shaping in home appliances. Jian Mao et al. [4] enhance machine learning algorithms to play a role in the security in a smart home ecosystem. Faisal Saeed et al. [5] propose using sensors to sense and provide in real-time, fire detection with high accuracy.

In this chapter we explain the integration of classic smart home, IoT and cloud computing. Starting by analyzing the basics of smart home, IoT, cloud computing and event processing systems. We discuss their complementarity and synergy, detailing what is currently driving to their integration. We also discuss what is already available in terms of platforms, and projects implementing the smart home, cloud and IoT paradigm. From the connectivity perspective, the added IoT appliances and the cloud, are connected to the internet and in this context also to the home local area network. These connections complement the overall setup to a complete unified and interconnected composition with extended processing power, powerful 3rd party tools, comprehensive applications and an extensive storage space.

II. CLASSIC SMART HOME OVERVIEW

Smart home is the residential extension of building automation and involves the control and automation of all its embedded technology. It defines a residence that has appliances, lighting, heating, air conditioning, TVs, computers, entertainment systems, big home appliances such as washers/dryers and refrigerators/freezers, security and camera systems capable of communicating with each other and being controlled remotely by a time schedule, phone, mobile or internet. These systems consist of switches and sensors connected to a central hub controlled by the home resident using wall-mounted terminal or mobile unit connected to internet cloud services.Smart home provides, security, energy efficiency, low operating costs and convenience. Installation of smart products provide convenience and savings of time, money and energy. Such systems are adaptive and adjustable to meet the ongoing changing needs of the home residents. In most cases its infrastructure is flexible enough to integrate with a wide range of devices from different providers and standards.

The basic architecture enables measuring home conditions, process instrumented data, utilizing microcontroller-enabled sensors for measuring home conditions and actuators for monitoring home embedded devices.

The popularity and penetration of the smart home concept is growing in a good pace, as it became part of the modernization and reduction of cost trends. This is achieved by embedding the capability to maintain a centralized event log, execute machine learning processes to provide main cost elements, saving recommendations and other useful reports.

III. SMART HOME SERVICES

3.1 Measuring home conditions

Creates the cloud service for managing home appliances which will be hosted on a cloud infrastructure. The managing service allows the user, controlling the outputs of smart actuators associated with home appliances, such as such as lamps and fans. Smart actuators are devices, such as valves and switches, which perform actions such as turning things on or off or adjusting an operational system. Actuators provides a variety of functionalities, such as on/off valve service, positioning to percentage open, modulating to control changes on flow conditions, emergency shutdown (ESD). To activate an actuator, a digital write command is issued to the actuator.

3.1.1 Controlling home access

Home access technologies are commonly used for public access doors. A common system uses a database with the identification attributes of authorized people. When a person is approaching the access control system, the person's identification attributes are collected instantly and compared to the database. If it matches the database data, the access is allowed, otherwise, the access is denied. For a wide distributed institute, we may employ cloud services for centrally collecting persons' data and processing it. Some use magnetic or proximity identification cards, other use face recognition systems, finger print and RFID.

In an example implementation, an RFID card and an RFID reader have been used. Every authorized person has an RFID card. The person scanned the card via RFID reader located near the door. The scanned ID has been sent via the internet to the cloud system. The system posted the ID to the controlling service which compares the scanned ID against the authorized IDs in the database.

IV. THE MAIN COMPONENTS

To enable all of the above described activities and data management, the system is composed of the following components, as described.

a. Sensors to collect internal and external home data and measure home conditions. These sensors are connected to the home itself and to the attachedto-home devices. These sensors are not internet of things sensors, which are attached to home appliances. The sensors' data is collected and continually transferred via the local network, to the smart home server.

b. Processors for performing local and integrated actions. It may also be connected to the cloud for applications requiring extended resources. The sensors' data is then processed by the local server processes.

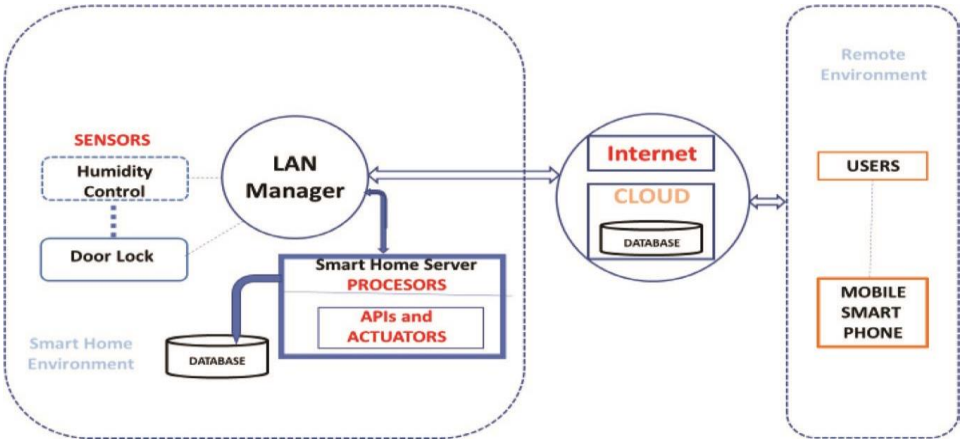
c. A collection of software components wrapped as APIs, allowing external applications execute it, given it follows the pre-defined parameters format. Such an API can process sensors data or manage necessary actions.

Actuators to provision and execute commands in the server or other control devices. It translates the required activity to the command syntax; the device can execute. During processing the received sensors' data, the task checks if any rule became true. In such case the system may launch 3. Internet of things [IoT] overview

The internet of things (IoT) paradigm refers to devices connected to the internet. Devices are objects such as sensors and actuators, equipped with a telecommunication interface, a processing unit, limited storage and software applications. It enables the integration of objects into the internet, establishing the interaction between people and devices among devices. The key technology of IoT includes radio frequency identification (RFID), sensor technology and intelligence technology. RFID is the foundation and networking core of the construction of IoT. Its processing and communication capabilities along with unique algorithms allows the integration of a variety of elements to operate as an integrated unit but at the same time allow easy addition and removal of components with minimum impact, making IoT robust but flexible to absorb changes in the environment and user preferences. To minimize bandwidth usage, it is using JSON, a lightweight version of XML, for inter components and external messaging.

V.INTERNET OF THINGS [IOT] OVERVIEW

The net of things (IoT) paradigm refers to gadgets related to the net. Devices are items including sensors and actuators, ready with a telecommunication interface, a processing unit, restricted garage and software program applications. It allows the mixing of items into the net, organising the interplay among humans and gadgets amongst gadgets. The key generation of IoT consists of radio frequency identification (RFID), sensor generation and intelligence generation. RFID is the muse and networking middle of the development of IoT. Its processing and communique competencies in conjunction with precise algorithms lets in the mixing of a whole lot of factors to perform as an included unit however on the equal time permit clean addition and elimination of additives with minimal impact, making IoT strong however bendy to take in adjustments withinside the surroundings and person preferences. To reduce bandwidth usage, it's miles the usage of JSON, a light-weight model of XML, for inter additives and outside messaging.



VI. CLOUD COMPUTING AND ITS CONTRIBUTION TO IOT AND SMART HOME

Key Attributes	Service Models	Deployment Models
Broadband Access	Software	Public
Rapid Elasticity	Platform	Private
Measured services	Storage	Hybrid
On Demand Self Service	Infrastructure	Community

Cloud computing is a shared pool of computing assets equipped to offer plenty of computing offerings in distinctive levels, from primary infrastructure to maximum state-of-the-art software offerings, without problems allotted and launched with minimum efforts or provider company interaction [6, 7]. In practice, it manages computing, storage, and verbal exchange assets which are shared with the aid of using a couple of customers in a virtualized and remoted environment. depicts the general cloud paradigm.

IoT and clever domestic can enjoy the huge assets and functionalities of cloud to compensate its drawback in storage, processing, communication, help in select out call for, backup and recovery. For example, cloud can help IoT provider control and achievement and execute complementary programs the usage of the facts produced through it. Smart domestic may be condensed and cognizance simply at the simple and essential capabilities and so reduce the nearby domestic assets and rely upon the cloud abilities and assets. Smart domestic and IoT will cognizance on facts collection, simple processing, and transmission to the cloud for in addition processing. To address safety challenges, cloud can be personal for pretty secured facts and public for the rest.

IoT, clever domestic and cloud computing aren't only a merge of technologies. But rather, a stability among nearby and principal computing along side optimization of assets consumption. A computing challenge may be both completed at the IoT and clever domestic gadgets or outsourced to the cloud. Where to compute relies upon at the overhead tradeoffs, facts availability, facts dependency, quantity of facts transportation, communications dependency and safety considerations. On the only hand, the triple computing version regarding the cloud, IoT and clever domestic, must reduce the whole device cost, typically with greater cognizance on lowering aid consumptions at domestic. On the hand, the triple computing version regarding the cloud, IoT and clever domestic, must reduce the whole device cost, typically with greater cognizance on lowering aid consumptions at domestic. On the alternative hand, an IoT and clever domestic computing provider version, must enhance IoT customers to satisfy their call for while the usage of cloud programs and deal with complicated troubles bobbing up from the brand new IoT, clever domestic and cloud provider version.

Some examples of healthcare offerings furnished through cloud and IoT integration: well handling information, sharing digital healthcare information allow highquality scientific offerings, handling healthcare sensor facts, makes cell gadgets desirable for fitness facts delivery, safety, privacy, and reliability, through improving scientific facts safety and provider availability and redundancy and assisted-dwelling offerings in real-time, and cloud execution of multimedia-primarily based totally fitness offerings.

VII. CENTRALIZED EVENT PROCESSING, A RULE-BASED SYSTEM

Smart domestic and IoT are wealthy with sensors, which generate large information flows withinside the shape of messages or occasions. Processing this information is above the ability of a human being's capabilities [8–10]. Hence, occasion processing structures were evolved and used to reply quicker to categorized occasions. In this section, we cognizance on rule control structures that can experience and examine occasions to reply to modifications in values or interrupts. The consumer can outline occasion-induced rule and to manipulate the right transport of offerings. A rule consists

of occasion situations, occasion sample and correlation-associated facts which may be mixed for modeling complicated conditions. It became carried out in an ordinary clever domestic and proved its suitability for a carrier-orientated gadget.

The gadget can procedure big quantities of occasions, execute features to monitor, navigate and optimize strategies in real-time. It discovers and analyzes anomalies or exceptions and creates reactive/proactive responses, which include warnings and stopping harm moves. Situations are modeled with the aid of using a consumer-pleasant modeling interface for occasion-induced guidelines. When required, it breaks them down into easy, comprehensible elements. The proposed version may be seamlessly incorporated into the allotted and carrier-orientated occasion processing platform.

The assessment procedure is induced with the aid of using occasions turning in the maximum latest country and facts from the applicable environment. The final results is a selection graph representing the guideline of thumb. It can spoil down complicated conditions to easy situations, and integrate them with every different, composing complicated situations. The output is a reaction occasion raised while a rule fires. The fired occasions can be used as enter for different guidelines for similarly assessment. Event styles are found while more than one occasions arise and suit a pre-described sample. Due to the graphical version and modular technique for building guidelines, guidelines may be without difficulty tailored to area modifications. New occasion situations or occasion styles may be delivered or eliminated from the guideline of thumb version. Rules are accomplished with the aid of using occasion offerings, which deliver the guideline of thumb engine with occasions and procedure the assessment result. To make sure the supply of appropriate processing assets, the gadget can run in a allotted mode, on more than one machines and facilitate the combination with outside structures, as well. The definition of relationships and dependencies amongst occasions which might be applicable for the guideline of thumb processing, are achieved the usage of collection sets, generated with the aid of using the guideline of thumb engine. The rule engine constructs sequences of occasions applicable to a selected rule situation to permit associating occasions with the aid of using their context information. Rules robotically carry out moves in reaction while said situations hold. Actions generate reaction occasions, which cause reaction sports. Event styles can suit temporal occasion sequences, permitting the outline of domestic conditions in which the occurrences of occasions are applicable. For example, while the door is saved open too long.

The following demanding situations are regarded with this version: shape for the processed occasions and information, configuration of offerings and adapters for processing steps, together with their enter and output parameters, interfaces to outside structures for sensing information and for responding with the aid of using executing transactions, shape for the processed occasions and information, information transformations, information evaluation and persistence. It permits to version which occasions must be processed with the aid of using the guideline of thumb carrier and the way the reaction occasions must be forwarded to different occasion offerings. The procedure is easy: information is accumulated and acquired from adapters which ahead occasions to occasion offerings that devour them. Initially the occasions are enriched to put together the occasion information for the guideline of thumb processing. For example, the reaction occasions are despatched to a carrier for sending notifications to a name agent, or to offerings which transmit occasion put off notifications and occasion updates returned to the occasion control gadget.

Different hand, an IoT and clever domestic computing carrier version, must enhance IoT customers to meet their call for while the usage of cloud programs and cope with complicated troubles springing up from the brand new IoT, clever domestic and cloud carrier version.

Some examples of healthcare offerings supplied with the aid of using cloud and IoT integration: nicely coping with facts, sharing digital healthcare information allow highquality clinical offerings, coping with healthcare sensor information, makes cellular gadgets suitable for fitness information transport, protection, privacy, and reliability, with the aid of using improving clinical information protection and carrier availability and redundancy and assisted-residing offerings in real-time, and cloud execution of multimedia-primarily based totally fitness offerings. 5.1 Event processing languages

Event processing is involved with real-time shooting and coping with predefined occasions. It begins offevolved from coping with the receptors of occasions proper from the occasion occurrence, even identification, information collection, procedure affiliation and activation of the reaction action. To permit speedy and bendy occasion handling, an occasion processing language is used, which permits rapid configuration of the assets required to address the predicted collection of sports in keeping with occasion type. It consists of modules, ESP and CEP. ESP effectively handles the occasion, analyzes it and selects the correct occurrence. CEP handles aggregated occasions. Event languages describe complicated occasion-kinds carried out over the occasion log.

7.1 Rediscovering workflow from events

In a few cases, regulations relate to discrepancies in a series of activities in a workflow. In such cases, it's far obligatory to exactly apprehend the workflow and its related activities. To triumph over this, we recommend a opposite engineering method to robotically rediscover the workflows from the activities log amassed over time, assuming those activities are ordered, and every occasion refers to 1 undertaking being accomplished for a unmarried case. The rediscovering method may be used to validate workflow sequences through measuring the discrepancies among prescriptive fashions and real method executions. The rediscovery method includes the subsequent 3 steps: (1) production of the dependency/frequency table. (2) Induction of dependency/ frequency graphs. (3) Generating WF-nets from D/F-graphs.

VIII. ADVANCED SMART HOME

In this section, we awareness on the mixing of clever domestic, IoT and cloud computing to outline a brand new computing paradigm. We can discover withinside the literature section [11–14] surveys and studies paintings on clever domestic, IoT and cloud computing separately, emphasizing their specific properties, features, technologies, and drawbacks. However, our method is the contrary. We are searching on the synergy amongst those 3 ideas and trying to find approaches to combine them into a brand new complete paradigm, utilising its not unusualplace underlying ideas in addition to its specific

attributes, to permit the execution of latest processes, which couldn't be processed otherwise.
depicts the superior clever-domestic major additives and their interconnectivity. On the left block, the clever domestic environment, we will see the typical gadgets linked to a neighborhood place network [LAN]. This permits the communique most of the gadgets and outdoor of it. Connected to the LAN is a server and its database. The server controls the gadgets, logs its activities, presents reports, solutions queries and executes the best commands. For greater complete or not unusualplace duties, the clever domestic server, transfers records to the cloud and remotely prompt duties in it the usage of APIs, software programming interface processes. In addition, IoT domestic home equipment are linked to the net and to the LAN, and so expands clever domestic to consist of IoT. The connection to the net permits the quit user, resident, to talk with the clever domestic to get contemporary facts and remotely prompt duties.

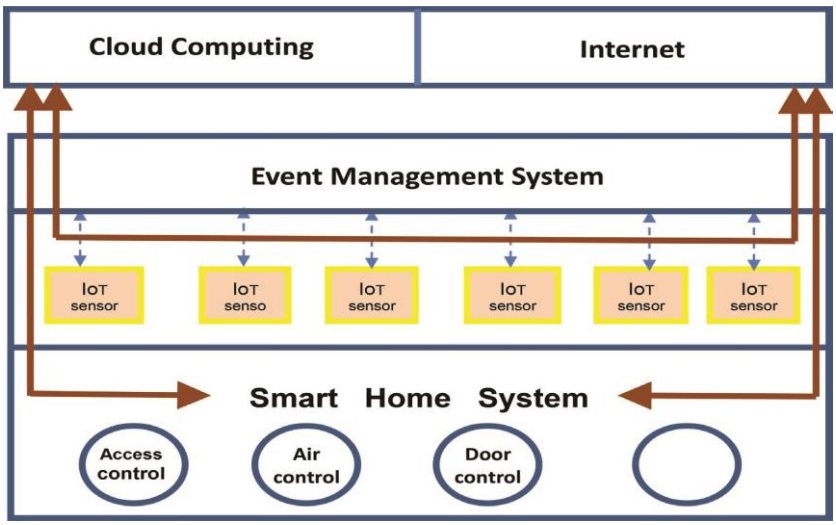
To reveal the advantages of the superior clever domestic, we use RSA, a sturdy uneven cryptography algorithm, which generates a public and personal key and encrypts/decrypts messages. Using the general public key, anyone can encrypt a message, however best those who maintain the non-public key can decrypt the despatched message. Generating the keys and encrypting/decrypting messages, includes big calculations, which require enormous reminiscence area and processing strength. Therefore, it's also processed on effective computer systems constructed to deal with the specified resources. However, because of its constrained resources, walking RSA in an IoT tool is nearly impossible, and so, it opens a protection hole withinside the Internet, wherein attackers might also additionally without difficulty utilize. To deal with it, we integrate the strength of the neighborhood clever domestic processors to compute a few RSA calculations and ahead greater complex computing duties to be processed withinside the cloud. The effects will then be transferred returned to the IoT sensor to be compiled and assembled together, to generate the RSA encryption/decryption code, and so near the cited IoT protection hole. This instance demonstrates the records go with the drift most of the superior clever domestic additives. Where, every factor plays its personal stack of operations to generate its specific output. However, in case of complex and lengthy duties it's going to break up the assignment to sub duties to be achieved with the aid of using greater effective additives. Referring to the RSA instance, the IoT tool initiates the want to generate an encryption key and so, sends a request message to the RSA software, walking withinside the clever domestic laptop. The clever domestic laptop then asks the “high numbers generation” software walking on cloud, to offer p and q high numbers. Once p and q are accepted, the encryption code is generated. In a later stage, an IoT tool troubles a request to the clever domestic laptop to encrypt a message, the usage of the current generated RSA encryption key. The encrypted message is then transferred returned to the IoT tool for in addition execution. A comparable state of affairs can be withinside the contrary direction, while an IoT tool receives a message it can request the clever domestic to decrypt it.
To summarize, the RSA situations depict the usage of the electricity of the cloud computing strength, the clever domestic secured computing competencies and on the quit the constrained strength of the IoT tool. It proves that with out this computerized cooperation, RSA could now no longer be capable of be achieved on the IoT level.

IX. PRACTICAL ASPECTS AND IMPLEMENTATION CONSIDERATIONS FOR IOT AND SMART HOME

Smart home has three components: hardware, software and communication protocols. It has a wide variety of applications for the digital consumer. Some of the areas of home automation led IoT enabled connectivity, such as: lighting control, gardening, safety and security, air quality, water-quality monitoring, voice assistants, switches, locks, energy and water meters.

Advanced smart home components include: IoT sensors, gateways, protocols, firmware, cloud computing, databases, middleware and gateways. IoT cloud can be divided into a platform-as-a-service (PaaS) and infrastructure-as-a-service (IaaS). demonstrates the main components of the proposed advanced smart home and the connection and data flow among its components.

The smart home application updates the home database in the cloud to allow remote people access it and get the latest status of the home. A typical IoT platform contains: device security and authentication, message brokers and message queuing, device administration, protocols, data collection, visualization, analysis capabilities, integration with other web services, scalability, APIs for real-time information flow and open source libraries. IoT sensors for home automation are known by their sensing capabilities, such as: temperature, lux, water level, air composition, surveillance video cameras, voice/sound, pressure, humidity, accelerometers, infrared, vibrations and ultrasonic. Some of the most commonly used smart home sensors are temperature sensors, most are digital sensors, but some are analog and can be extremely accurate. Lux sensors measure the luminosity. Water level ultrasonic sensors.
Float level sensors offer a more precise measurement capability to IoT developers. Air composition sensors are used by developers to measure specific components in the air: CO monitoring, hydrogen gas levels measuring, nitrogen oxide measure, hazardous gas levels. Most of them have a heating time, which means that it requires a certain time before presenting accurate values. It relies on detecting gas components on a surface only after the surface is heated enough, values start to show up. Video cameras for surveillance and analytics. A range of cameras, with a high-speed connection. Using



Raspberry Pi processor is recommended as its camera module is very efficient due to its flex connector, connected directly to the board.

Sound detectors are widely used for monitoring purposes, detecting sounds and acting accordingly. Some can even detect ultra-low levels of noise, and fine tune among various noise levels.

Humidity sensors sense the humidity levels in the air for smart homes. Its accuracy and precision depend on the sensor design and placement. Certain sensors like the DHT22, built for rapid prototyping, will always perform poorly when compared to high-quality sensors like HIH6100. For open spaces, the distribution around the sensor is expected to be uniform requiring fewer corrective actions for the right calibration.

Smart home communication protocols: bluetooth, Wi-Fi, or GSM. Bluetooth smart or low energy wireless protocols with mesh capabilities and data encryption algorithms. Zigbee is mesh networked, low power radio frequency-based protocol for IoT. X10 protocol that utilizes powerline wiring for signaling and control. Insteon, wireless and wireline communication. Z-wave specializes in secured home automation. UPB, uses existing power lines. Thread, a royalty-free protocol for smart home automation. ANT, an ultra-low-power protocol for building lowpowered sensors with a mesh distribution capability. The preferred protocols are bluetooth low energy, Z-wave, Zigbee, and thread. Considerations for incorporating a gateway may include: cloud connectivity, supported protocols, customization complexity and prototyping support. Home control is composed of the following: state machine, event bus, service log and timer.

Modularity: enables the bundle concept, runtime dynamics, software components can be managed at runtime, service orientation, manage dependencies.

X. CONCLUSIONS AND SUMMARY

In this bankruptcy we defined the mixing of 3 loosely coupled additives, clever home, Iot, and cloud computing. To orchestrate and well timed control the giant facts go with the drift in an green and balanced way, using the strengths of every aspect we recommend a centralized actual time occasion processing application. We describe the benefits and advantages of every standalone aspect and its viable complements, which can be carried out through integrating it with the opposite additives presenting new advantages raised from the entire compound system. Since those additives are nevertheless at its improvement stage, the mixing amongst them might also additionally alternate and offer a strong paradigm that generates a brand new era of infrastructure and applications. As we follow-up at the development of every aspect and its corresponding effect at the included compound, we can continuously bear in mind extra additives to be added, ensuing with new carrier fashions and applications

XI.DISCUSSION

Driving The Next Generation of More Efficient, Resilient, and Sudtainabe Industries. Software & Uniqu solutions That's bring Tomorrow's Inustries To life today .Energy Efficiency. Industry of the Future.

XII. SUMMARY

Start the IoT starter app in the device, and it starts to collect sensor data. From the device, it goes over the colleting data to the IoT cloud and there you can access an home appliance. The data collected are accelerometer data from the device.

XIII.CONCLUSION

In this bankruptcy we defined the mixing of 3 loosely coupled additives, clever home, Iot, and cloud computing. To orchestrate and well timed control the giant facts go with the drift in an green and balanced way, using the strengths of every aspect we recommend a centralized actual time occasion processing application. We describe the benefits and advantages of every standalone aspect and its viable complements, which can be carried out through integrating it with the opposite additives presenting new advantages raised from the entire compound system. Since those additives are nevertheless at its improvement stage, the mixing amongst them might also additionally alternate and offer a strong paradigm that generates a brand new era

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XIV.ACKNOWLEDGEMENT

This paper was submitted as a part of the Assignment for the subject of Biology for Mechatronics Engineering.

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