Web Based Architecture of SMART Home networking using IOT

S.Nithish Kumar, Dr. Annamalai Solayappan, A. Kalai Selvan, Dr. R. Sivaraman, Dr.N.Shanmugasundaram, Dr.E.N.Ganesh

[1]UG Student,Department of Information Technology,
Sri Sairam Engineering College, Chennai, Tamil Nadu, India -600044
[2]Assistant Professor,Department of Business Administration,
(On Deputation from Annamalai University)
SriSubramaniyaSwamy Government Arts College, Tiruttani,Tamilnadu, India-631209.
[3] Assistant Professor of Business Administration,
Shanmuga Industries Arts and Science College, Thiruvannamalai, Tamilnadu,India
[4] Associate Professor, Post Graduate and Research Department of Mathematics
Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, Tamilnadu, India,
[5]Professor and Head Department of Electrical and Electronics Engineering
Vels Institute of Science, Technology & Advanced Studies, Chennai,
[6]Dean School of Engineering, Vels Institute of Science, Technology & Advanced Studies, Chennai
Email.Id:shannithish2990@gmail.com,an.solayappan@gmail.com,kalaiselvanvijay78@gmail.com,rsivaraman1729@yahoo.co.in,shanmugam71.se@velsuniv.ac.in,enganesh50@gmail.com

Abstract. As an ever-increasing number of gadgets are getting associated with the Internet, the following consistent advance is to involve the World Wide Web and its related innovations as a stage for brilliant things. This paper proposes a web-based engineering model for the execution of Internet of Things. An execution situation for home systems administration is likewise talked about. The concept of smart home with the integration of networking using IoT enabled cloud computing to it, by embedding intelligence into sensors and actuators, networking of smart things using the equivalent technology, facilitating interactions with smart things using cloud computing for easy access in different locations, increasing computation power, storage space and improving data exchange efficiency.

Keywords:- Smart Home, Cloud Computing, Event Processing, Home Appliances, Sensor Layer and Vehicle Layer.

1 Introduction & Related Work

In the ongoing situation, there is a need to lay out an associated snare of savvy protests, the great explanation being the enormous populace of items. Because of the advances in innovation and expanding requests for shifted administrations, it is anticipated that the quantity of items/things would be multiple times the human populace toward the finish of 2015. Such an enormous climate would require a productive and exceptionally secure method for controlling and observing them. Web of Things targets fulfilling this specific need as well as giving a large group of different offices. The expression "things" in Internet of Things alludes to any recognizable actual item, autonomous of innovation, used to furnish data with environmental elements. The excellent goal of Internet of Things is the joining of this present reality objects with the virtual universe of data innovation. This present reality along these lines turns out to be more open through PCs and organized gadgets in regular situations. The new advances of scaling down and the falling expenses for RFID, sensor organizations, NFC,

ITSPWC 2022, May 14-15, Karur, India

DOI 10.4108/eai.14-5-2022.2318899

remote correspondence, innovations and applications, has prompted the Internet of Things become important for industry and end-clients. Discovery of the actual status of things through sensors, along with assortment and handling of definite information, permits prompt reaction to changes in reality. This completely intelligent and responsive organization yields gigantic potential for residents, purchasers and business. RFID is progressively being conveyed in applications across supply chains with pursuers that are circulated across processing plants, distribution centers, and retail locations. Sensor innovation is likewise being embraced in assembling and coordinated operations to control processes and the nature of products. On the organization level, steps are being taken to foster a unique engineering which would uphold both human-endlessly machine connection. Different design plans have been proposed for different application situations. The development of next age correspondence frameworks like LTE and WiMax infers that continuous observing of information and high velocity information access are no longer restrictions except for benefits. Up to this point Internet of Things has been applied in different fields like climate checking, transport, shrewd lattice and medical services however almost no examination work has been centered on the use of Internet of Things in home systems administration. In a common home situation the principle use for Internet of Things is made an organization which would empower the client to remotely screen and control his family gadgets/things. Shen Bin et al. [1] proposed four information digging models for the Internet of Things, which are multi-facet information mining model, conveyed information mining model, Grid based information mining model and information mining model from multi-innovation combination viewpoint. The information models are pointed taking care of issues, for example, saving information at various locales and to acknowledge elements of information mining. Mia Wu et al. [2] proposed a five layer engineering model subsequent to breaking down the specialized system of the Internet. It is a blend of the standard 3 layered design and the legitimate layered engineering utilized in broadcast communications organization. The subsequent stage zeroed on different application situations utilized the above engineering models and their general benefits and bad marks. JingranLuo et al [3] proposed a remote checking data framework that procures definite physiological information of the patients at remote spot utilizing human-checking sensor chips and the Internet of Things to consequently produce electronic clinical records. This is saved into the data set. The framework depends on a Zigbee Wireless Sensor Network innovation to accomplish constant transmission of actual data. Angelo P. Castellani et al [4] proposed a reasonable acknowledgment of an Internet-of-Things (loT) engineering at the University of Padova, Italy. The organization traverses the floors of various structures inside the Department of Information Engineering, and is intended to give admittance to fundamental administrations like ecological observing and confinement to University clients, as well as to oversee administration access in light of client jobs and approvals. Che-Yuan Tu et al [5] proposed a minimal expense shrewd metering framework for cloud design in light of open equipment Arduino board. From [1] to [5] it is discussed about tracking and control aspects of IOT. In paper [6] to [9] briefs application and design aspects of IOT implementation are dealt in detail. Paper [10] to [15] explains a design and application detail of IOT is explained in detail. Finally from [16] to [20] impact and analysis aspects of IOT dealt in detail.

2 Proposed Architecture Model

The engineering model proposed here is a 4 layer model. The four layers are the Sensor

Layer, the Vehicle Layer, the Web Layer and the Application Layer. The Web alludes to a capacity and correspondence foundation which may either be the Internet or a solitary little local area of PCs. The design model is imagined with the goal of giving the right data in the perfect amount at the ideal time perfectly located [7]. The right data connects with precise and proper data about a remarkably recognizable actual article as well as its structure, fit and capacity. This is accomplished through the use of Auto-ID and proper sensor data or some other sort of connected data to the article that can be received through the Web of Things. The right amount can be accomplished through high granularity of data joined with separating and keen handling. Right amount alludes to the precision and protection of the data. This is to be in specific with the approved information received. The ideal opportunity doesn't guarantee the mean ongoing information access, however alludes to giving information when required which is different for various application conditions. In certain applications it is adequate to give the information if there arise an occurrence of a status change while in others "constant" access is required.

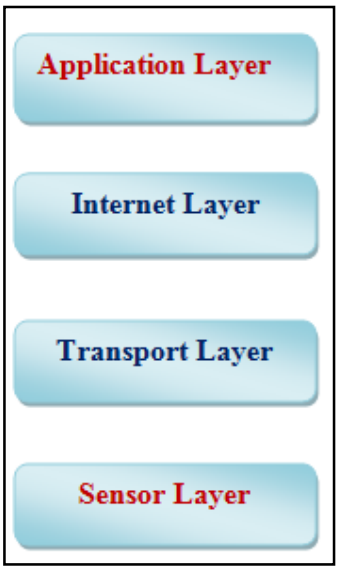

Figure 1: Four layer model

1. Sensor Layer:

The sensor layer is similar to the discernment layer of the business case model and the information assortment layer of the information mining model. The different sensors are utilized to see different actual properties of items. The superb elements of the sensor layer are ID and detecting

2. Transport Layer

The vehicle layer is worried about the vehicle of sensor information to the web layer through different organizations like Remote LAN, Bluetooth, and Zigbee and so forth. The vehicle layer is additionally worried about the security and interoperability between two distinct organizations as Web of Things. The Web of Things being a tremendous organization, interfaces billions of things, yet additionally includes immense measures of different

organizations. Along these lines, the correspondence between various organizations and elements is exceptionally vital. The fundamental perspectives managed by the vehicle layer are heterogeneity and interoperability. Interoperability doesn't allude to simply specialized interoperability as in two unique organizations attempting to trade information yet in addition semantic interoperability.

3. Internet Layer

The Web Layer is concerned about the handling of sensor information to empower the improvement of client driven applications. The Vehicle Layer and the Web Layer speak with one another through REST conventions. REST alludes to Illustrative State Move which is a product design created for applications like the Internet. REST was created close by HTTP1.0 by Roy Handling in view of the design of HTTP 1.0. The quintessence of REST is to zero on making inexactly coupled administrations Online, with the goal that they can be handily reused. REST is the design style of the Internet (executed by URIs, HTTP, and normalized media types, like HTML and Extensible Markup Language (XML) and involves URIs for recognizing assets Online. It abstracts administrations in a uniform connection point (HTTP‟s techniques) from their application-explicit semantics and gives components to clients to choose the most ideal portrayals for co-operations. This makes it an optimal contender to assemble an "all inclusive" design and Application Programming Connection point (Programming interface) for shrewd things. The administrations that brilliant things uncover Online for the most part appear as an organized XML archive or a JavaScript Item Documentation (JSON) object, which are straightforwardly machine-discernible. These configurations can be perceived by machines, but on the other hand are sensibly open to individuals; gave significant markup components and variable names are utilized and documentation is made accessible. The Web Layer comprises of the accompanying three sub-layers. An Information Catch sub-Layer which is principally worried about the assortment of the information given by the sensor layer. The information consequently gathered is then handled by the Information Handling sub-Layer. The third sub-Layer, the Information Stockpiling sub-Layer is worried about the capacity of client inclinations, preset reactions and so forth. The upside of involving Web as it is that to cycle layer "substantial client communication" and "peculiarity" recognizable proof turns out to be somewhat more straightforward. Substantial client association indicates getting to computerized data through actual world climate. The expression "peculiarities of the Web of Things" alludes to distinguishing proof of examples. The Web Layer gives elevated degree of reflections regarding client setting mindfulness, distinguishing proof of indistinguishable examples. The peculiarities of the Web of Things are an applicant empowering idea; it manages recognizable proof of examples and deciding the different reactions, relegating needs to each example distinguished. Peculiarity identification is conceivable through the accompanying advances:

1. Monstrous information assortment: Different Web 2.0 destinations like pachube.com and noisetube.com empower the sensor information to be handled into comprehensible or machine intelligible information. The web layer upholds both dynamic and static information. Static information alludes to RFID and different gadgets that simply recognize objects. Dynamic information alludes to the sensor gadgets which connect with the articles in regard to a particular boundary or substance (for example sensors that action pressure, temperature and so on.).

2.User Review and input: The client can assess, control and limit the information regardless of

whether information is given deliberately - for example by utilizing a sensor unequivocally, to gauge something in a particular setting, or by physically entering such estimations or unwittingly for example by giving agree to follow geological position.

3. Improvement on data catch with cycle: The peculiarities go about as a shut circle in this way empowering assurance of what information and information designs are applicable overall or specifically cases.
Fuelling client created applications.

4. Application Layer
The application layer utilizes the information given by the web layer to foster different utilizations of Web of Things. The fundamental targets of the application layer are to empower Human-to-Endlessly machine to-Machine collaboration. The principle advantage here is that since the results of the web layer are different in nature, the application layer generally is equipped for meeting the ideal prerequisites. As the design model is client driven, the application layer has the accompanying key central suspicions or guidelines:

1. The information given by the web layer is thought to be private, for example the information can't be received by different clients or things except if indicated.
2. The client ought to have the choice of picking what and with whom to share the information. The client can impart a section or whole information to either a solitary part or a local area.
3. Use of enhanced information triggers the applications and make empowered.
4. The handled information is addressed principally utilizing a visual organization (for example A chart). The translation of the information is passed on to the circumspection of the client.
5. The application layer can either take care of a particular individual client or a gathering of clients.

Aside from client driven applications, the application layer likewise empowers decision making through mix of programming specialists. The product specialist stage comprises of a question point of interaction and dynamic point of interaction. The question interface connects with the information stockpiling point of interaction of the web layer. The choice point of interaction decides the reaction relying upon the reaction. M2M correspondence is empowered through an actuator interface. The actuator interface sets off an incitation order which then initiates the objective gadget. The processed data is represented primarily using a visual format (e.g. A graph). The interpretation of the data is left to the discretion of the user.
In the accompanying subsection, as additional representations to the idea, an application space for the previously mentioned design model is talked about.

3 Home Applications: Checking of Cooking Gas Utilization

A Homegrown Gas utilization oversight framework would assist with expanding energy productivity, diminish wastage and further develop energy utilization. A brilliant meter is intended to screen the pace of utilization.

A. Sensor Design

The utilization of cooking is still up in the air by observing the heaviness of the gas chamber utilizing a heap cell. The boundaries that should be considered are Entrance Assurance (IP) rating, hysteresis, evaluated burden and creep. IP rating orders the levels of assurance given against the interruption of strong articles (counting body parts like hands and fingers), dust, coincidental contact, and water in electrical fenced areas. Hysteresis characterize the most extreme distinction between load cell yield readings for a similar applied load; a bunch of readings is acquired by expanding the heap from nothing and the other by diminishing the heap from evaluated yield. The hysteresis for an ideal burden cell is zero which is basically unimaginable thus low hysteresis esteem is liked. Appraised Burden is the greatest pivotal burden and the heap cell is intended to gauge inside its determinations. An appraised heap of 30-40 Kg is viewed as great for the situation viable. Creep is the adjustment of burden cell yield happening with time while under load and with every single natural condition and different factors staying consistent. For an ideal burden cell creep is zero though basically it ought to be less. CZL601, a solitary point, high accuracy load cell is picked for the reason.The sensor information is simple in nature; the sensor point of interaction is A/D converter which changes over the simple information into exceptionally exact advanced yield. The advanced result is then enhanced utilizing a straightforward functional speaker

B. Transport Layer

The excellent capacity of the vehicle layer is to move the sensor information to the Web layer. The vehicle layer has two sections, a microcontroller (Arduino) and an Ethernet safeguard. Arduino is an open-source gadget prototyping stage in view of adaptable, simple to-utilize equipment and programming [8]. In view of open source equipment, it opens all equipment plan and related data to everybody, so that clients can uninhibitedly plan and carry out their thoughts. Arduino is made out of a solitary board microcontroller and various I/O backing, and it can detect the climate by getting input from an assortment of sensors and can influence its environmental factors by controlling lights, engines, and different actuators. Moreover, clients can move information to any arrange upheld gadgets through correspondence instruments, for example, RJ-45, IEEE 802.11 and IEEE 802.15.4-consistent remote organizations. Arduino is made out of a solitary board microcontroller and different I/O backing, and it can detect the climate by getting input from an assortment of sensors.

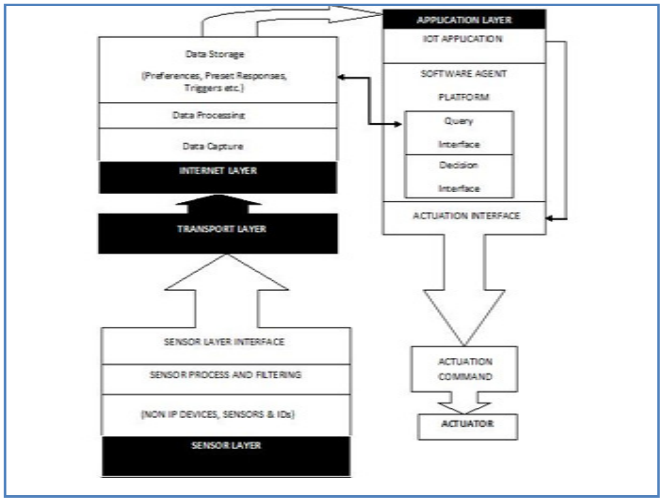

Figure 2: Enhanced 4 Layer Architecture Model

The vital attributes of Arduino are:

- Versatility: Clients can get checking information through numerous transmission convention, similar to Ethernet, RS232 and Zigbee by deciding to utilize various sensors or modules.
- Extensibility: There are bunches of electrical parts and modules that help Arduino. Clients can plan various types of gadgets that meet their necessity with different I/O support.
- Cost: The Arduino improvement board and related parts are modest, so clients can foster such a gadget with lower cost than purchasing a completed item independently.

The information is moved to the Web by means of an Ethernet safeguard. The Ethernet Safeguard is intended to permit the Arduino base module to interface with the web effectively as an independent unit. The module conveys a locally available WIZnet W5100 Ethernet chip, which gives an organization (IP) stack equipped for TCP and UDP, as well as a standard RJ45 Ethernet jack. It upholds up to four synchronous attachment associations. An Ethernet library composes draws that associate with the web utilizing the safeguard. The Ethernet safeguard associates with an Arduino board utilizing long wire-wrap headers which reach out through the safeguard. This safeguards the pin format and permits one more safeguard to be stacked on top.

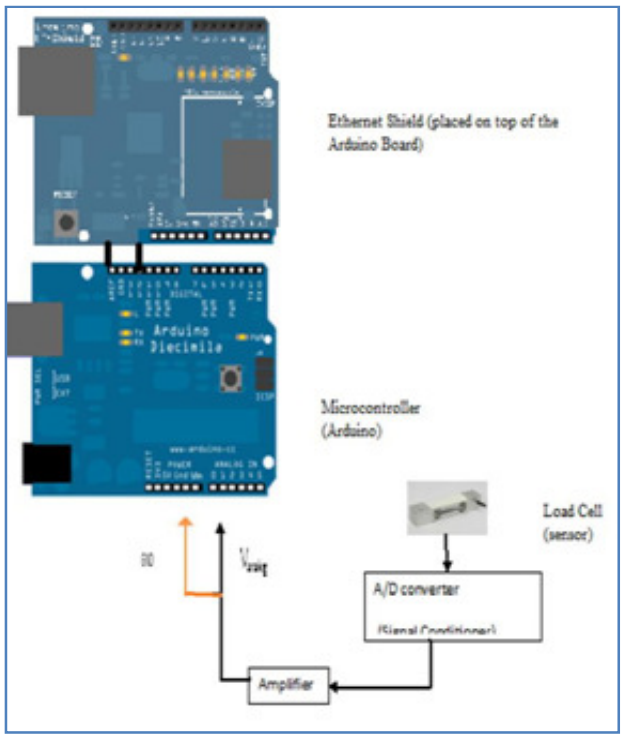

Figure 3. Smart Meter Architecture

C. Data The executives utilizing the Web Layer

The sensor information is transferred to pachube.com, a web administration that empowers putting away, sharing and finding continuous sensor, energy and climate information from items, gadgets and structures all over the planet. It is a safe and versatile stage for the advancement of Web of Things. Pachube gives the majority of its usefulness by means of its Application Programming Connection point (Programming interface), as opposed to through the actual site. The Programming interface hurries up and simple to make items that associate with the Web of Things by offering complex real time information, history and client the board apparatuses for sensors, gadgets and conditions all over the planet.

As displayed in the upgraded design model the Web layer has three significant capacities to be specific information catch, handling and stockpiling.

1. Data Catch

An order of information types is utilized to catch information in the Pachube framework. The three information types are climate, datastream and datapoint. Climate (or a feed) is a unique situation - explicit assortment of estimated information of a similar area. The area might allude to an actual substance like a room or a virtual element, for example, a Subsequent Life model.

A Pachube 'feed' is the information portrayal of a climate and its datastreams.

Alternatively, the feed information can determine whether it is physical or virtual, fixed or versatile, indoor or open air, and so on. Datastream addresses a singular sensor or estimating gadget/script inside a climate. Each datastream should have a novel (inside the climate) alphanumeric ID. It can likewise indicate 'units' (for example 'watts') as well as client characterized 'labels' (for example 'fridge‟ or „energy'). Datapoint addresses a solitary worth of a datastream at a particular moment. It is just a key worth sets of a timestamp and the worth around then. The feeds can be either manual or programmed. Manual feeds signify those where the climate or gadget 'pushes' refreshes, typically through a PUT demand. Manual feeds are utilized to refresh esteems consistently, or on esteem change or at another huge second. As referenced before, the superb goal is to give the information brilliantly and not during constant. Programmed takes care of, and then again, are those where the climate or gadget can serve information on demand. Pachube consequently 'pulls' information from them either like clockwork or at whatever point another client demands it The situation with a feed can be either live or frozen which mean marginally various things relying upon the feed type. Live feed implies that the far off climate or gadget has physically update. Pachube or that Pachube has effectively recovered information from the far off climate. A frozen feed then again signifies that the feed was last refreshed over 15 minutes prior.

2. Data Handling and Stockpiling:

The Pachube Programming interface upholds three information designs specifically JSON, CSV and XML. Every one of these arrangements is the most ideal to a specific reason. For the Programming interface, on the off chance that no arrangement is indicated, the JSON design is utilized. This implies that the information moved will be parsed as JSON.

JSON

The JSON information design is especially fit to electronic applications as it tends to be effectively parsed involving JavaScript in the program. Anyway it additionally makes a superb nonexclusive information serialization design since it has a lot of lower handling overheads than XML and utilizes less data transmission to communicate. A JSON yield contains the accompanying boundaries

1. Web subtleties: The subtleties like the host website, feed status, last update time, title of the feed are recorded in this part.
2. Feed subtleties: The feed subtleties like nature of feed, greatest and least result esteem, the ongoing worth of the feed, the openness of the feed are recorded in this part. Aside from this area subtleties like scope, longitude, height, and feed demeanor are likewise recorded here.

XML

The Pachube Programming interface utilizes a particular organization of XML called EEML. It is appropriate to coordinate with existing frameworks like structure the executive's frameworks despite the fact that it contains a similar data as JSON. A XML yield contains the accompanying label subtleties:

1. Environment subtleties: The different subtleties, for example, the area subtleties like spot, scope, longitude, rise, openness, area space, area demeanor (whether fixed or moving) are made sense in this part. The climate subtleties are of specific use when natural circumstances are being checked like the temperature of a specific spot, the stickiness conditions and so on. The Xml yield empowers the client to screen the surrounding conditions around his fringe layer and in this manner make sufficient strides if vital.

2. Feed subtleties: The different feed subtleties like feed availability (whether public or private), nature of the feed (whether live or frozen) are recorded here. Aside from this the

different boundaries like encoding, client id, feed id, number of data-streams (the quantity of sensor yields), the most extreme and least upsides of the feed are likewise recorded beneath.

CSV

CSV is intended for use by extremely basic implanted gadgets, like an Arduino or other low fueled microcontroller. It contains none of the metadata that the XML and JSON designs contain (however this can be added independently utilizing the Programming interface or the web interface). The CSV yield comprises of three sections. The initial segment demonstrates the DataStream id (for a considerable length of time). The subsequent part shows the last date and time the sensor had checked. The third part is the information part where current worth is put away.

4 Implementation

In the initial step, the sensor (load cell) is adjusted by stacking the loads in rising and slipping request. The adjustment is done to guarantee repeatability. The simple result is then changed over completely to computerized yield for working on the accuracy and precision.The heap cell has a result in the scope of a couple of millivolts. Subsequently the adjusted result is intensified utilizing an enhancer. The enhancer utilized for this situation is a basic rearranging intensifier. The addition of the enhancer is changed so the heap cell yield is inside the satisfactory info scope of the microcontroller. Arduino has a simple info scope of 6-12 V henceforth the addition is resolved in this manner. The Arduino gives six simple sources of info, and goal of the Arduino simple to-advanced converter (ADC) is 10-bit. In this manner, the ADC can encode a simple contribution to one out of 1024 distinct levels as indicated by estimated voltage, since 210 = 1024. The subsequent advance is to change over the worth of Simple contribution at the reach from 0 to 5(V) into computerized inside the reaches from 0 to1023.

Along these lines, the subsequent advance can be communicated as the accompanying condition:

In sync three, the result is step by step changed over completely to its identical in weight. Each heap put on the heap cell creates a comparing special. The change can be made sense of as follows.

The most extreme result under full burden conditions indicates and signifies the result delivered by the ongoing burden. Contingent upon the increase of the intensifier the progression size might shift, for an addition of 1000 the progression size is determined to be 0.5 for example the progressions fundamentally for each 0.5 Kg decline in weight. As referenced before the design model depends on the REST conventions. Relaxing access utilizes the HTTP action words to figure out which activity to make on a specific information object:

GET: Recovers the present status of the item PUT: Sets the present status of the article POST: Makes another article

Erase: Erases the article

The qualities are then transferred to the Web layer which for this situation is pachube.com utilizing Arduino coupled along with the Ethernet safeguard. The transfer is not entirely settled by the client. The sensor information is put away in CSV, JSON and XML designs. The sensor information is then handled and delivered in both comprehensible diagrams and machine decipherable .xml and.JSON scripts. The engineering model accentuates on client cooperation at the application layer. The client can foster a particular application to suit his/her own requirements or the client can utilize the handled information to

set off an actuator. The client can likewise decide to set explicit trigger qualities and decide the idea of reaction for the trigger

Figure 4: Representation of the implemented system

.

5 Conclusion & Future Work

The current three-layer structure presents an extremely huge instrument to figure out the specialized parts of the Web of Things. Anyway its functional execution is restricted past a specific starting stage. Thus a design model has been proposed with an expectation to grasp the importance and engineering of Web of Things in a superior way. Further examination and review should be embraced for giving a business case arrangement utilizing the proposed model and furthermore in testing the vigor of the model in different application situations.

References

[1].Dr.E.N.Ganesh (2022). Fuzzy Logic and Fuzzy Logic Sun Tracking Control. Research & Reviews: Discrete Mathematical Structures, 8(3), 9–19.DOI:10.6084/m9.figshare.19513849

[2]..Betty Jane, J., &Dr.E.N.Ganesh (2019). Big data and internet of things for smart data analytics using machine learning techniques. In International conference on computer networks, big data and IoT (pp. 213–223).DOI:10.1007/978-3-030-43192-1_24

[3].Jane, J., &Dr.E.N.Ganesh (2019). A Review On Big Data With Machine Learning And Fuzzy Logic For Better Decision Making INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH 8(10) 1120-25. DOI: 10.6084/m9.figshare.19608081

[4].Shanmugasundaram, N., Sushita, K., Kumar, S., &Dr.E.N.Ganesh (2019). Genetic algorithm-based road network design for optimising the vehicle travel distance. International

Journal of Vehicle Information and Communication Systems, 4(4), 344–354.DOI:10.1504/IJVICS.2019.103931
[5].Sankarasubramanian, P., &Dr.E.N.Ganesh(2019) IoT Based Prediction for Industrial Ecosystem. International Journal of Engineering and Advanced Technology (IJEAT)", ISSN, 2249–8958.DOI:10.6084/m9.figshare.19453712
[6].Dr.E.N.Ganesh (2019). Implementation of digital notice board using raspberry pi and iot. Oriental journal of computer science and technology, 12(1), 14–20.DOI:10.13005/ojcst12.01.04
[7].Dr.E.N.Ganesh. (2017). Development of SMART CITY Using IOT and BIG Data. International Journal of Computer Techniques, 4(1), 49–54.DOI: 10.6084/m9.figshare.19608099
[8].Dr.E.N.Ganesh. (2017). IOT Based Environment Monitoring using Wireless Sensor Network.international journal of advanced research, 5(2), 964–970.DOI:10.21474/IJAR01/3241
[9].Ragul, R., Shanmugasundaram, N., Krishnakumar, R. "PV System with Zeta Converter using ANFIS Controller based GWO Optimization"Proceedings of the International Conference on Electronics and Renewable Systems, ICEARS 2022, 2022, pp. 366–370
[10].NithaiyanShanmugasundaram*, S. Pradeep Kumar and E.N. Ganesh "Modelling and analysis of space vector pulse width modulated inverter drives system using MatLab/Simulink" Int. J. Advanced Intelligence Paradigms, Vol. 22, Nos. 1/2, 2022
[11].Shanmugasundaram, N., Thangavel, S."High frequency power cable modeling for screen voltage calculation of different cable length with induction motor drive system (VFD)"ARPN Journal of Engineering and Applied Sciences, 2015, 10(20), pp. 9150–9158
[12].Rubini, B., Shanmugasundaram, N., Pradeepkumar, S."Smart grids investigation and analysis in terms of cost benefits"International Journal of Engineering and Technology(UAE), 2018, 7(2), pp. 185–189
[13].Pradeep Kumar, S., Shanmugasundaram, N., Ganesh, E.N."Measurement of thermometer using automated system"International Journal of Engineering and Technology(UAE), 2018, 7(2.8 Special Issue 8), pp. 307–310