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Intelligent Smart Automation and Intelligent Edge Systems Made Possible by Deep Learning in Embedded Systems

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ABSTRACT

The lightning-fast advancement of technology such as digital transmission, electronics, and miniature technologies has made it possible for our society to make significant strides forward. As a consequence of this, the prices of producing electronic devices have reduced, the utility of these devices has increased, and the digital world has displaced the physical world. As a direct result of this, the ways in which we interact with one another and the environment have developed. We make use of sophisticated equipment improve our understanding of the world around us. In today's world, scientific institutions and technology advancements are continually working to produce more complex living environments. It is now possible for any system to gain intelligence as a result of technological breakthroughs in fields such as energy, communication, embedded systems, the internet of things, and wireless sensor networks. These technical breakthroughs have made it possible for systems to become more native, robust, autonomous, and limited compared to their previous state. In real time, these systems are able to maintain their concentration on the tasks at hand, even while operating in the most difficult conditions.

As a result of the fact that we are now living in a digital age, the norms and systems that we depend on continue to function reliably and make our lives easier. As an illustration of this kind of application, consider the integration of embedded systems with power and energy networks. All of the gear that was used in this transformation has been updated and converted into digital form. This includes anything from enormous transportation hubs to everyday home products. The local customers need to anticipate a system that is both more secure and more intelligent as a whole. Automation and improvements in information and communication technology (ICT) have made it possible for any energy system to have far less space for mistake or loss than it did in the past. The Internet of Things (IoT), wide area networks (WSN), and artificial intelligence (AI) are examples of trustworthy technologies that have made it possible for businesses and households to make more efficient use of energy and save money on it. a new design line

Keywords: Information Communication (ICT),Internet Of Things(IOT),Wide Area Networks(WSN) And AI.

INTRODUCTION

The passage of time and the pace of change are both speeding at an increasing rate. Things that were previously considered desirable now have a significant influence on things that people do on a daily basis. In the year 2000, for instance, just 14% of homes had access to the internet, although 26% of businesses made use of robots and many other forms of automation. In the years that followed, developments in technology made it impossible to expand in the domains of communication and information technology.

People had reached the critical milestone of automating both their homes and their office buildings, and within a span of just 15 years, 86 percent of businesses had automated their work units. At the present day, it is present in the majority of families as well as in practically every business. The cumulative effect of all of these improvements teaches us more about the hidden benefits of technology and its ability to save energy in real time across the board, from power plants to the distribution network. In spite of the fact that automation may be more user-friendly than control and maintenance, it nevertheless raises the necessity of running a whole unit, regardless of whether it is a corporate or residential establishment.

Both big information technology companies and energy grids have seen an increased focus on the automation of controls and processes achieve energy savings. This is due to the fact that embedded agents have made it possible for automation to take place in just about any environment. For the time being, the holy grail of robots is to reduce costs without compromising efficiency. This is the reason why they devote a significant amount of resources to the research

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and development of energy collecting systems, as well as energy-aware technologies that may be used in commercial and HAN settings. Because of its immediate and prospective societal effect, energy conservation and resource management is just as vital as automation. It changes people's economic circumstances and way of life.

By implementing automated controls in your home, you may be able to reduce the amount of money you spend on your monthly energy bills. It has the potential to assist you in increasing your revenue. Additionally, it gives the user the ability to multitask and is speedier than it was previously. As a result of developments in sensors and integrated agents, the HAN is now able to easily include any communication channel and protocol into its system for conserving energy. By connecting to consumer electronics such as laptops, tablets, and mobile phones using technology such as Bluetooth and Wi-Fi, as well as by utilizing Internet Protocol (IP) to control things, they are able to continuously monitor energy use and conserve resources. Currently, cables are not always required for the purpose of regulating utilities and monitoring energy use. The purpose of this chapter is to examine a literature review of several studies that have the potential to shed light on the ways in which technology assists in the management and control of energy for utilities and waste.

Building design, connection construction, and networking protocols are some of the issues that are being researched. Topology analysis for wide coverage is also being researched. Several different methods and their source codes were put through their paces in real-world circumstances, which included homes and other business enterprises, to see how successful they were.

A.HOME AREA NETWORK AND AUTOMATION

Users and feeders are able to access, monitor, and control the integrated equipment and electronics in their homes from any mobile device that is linked to the internet, regardless of where they are located. This is made possible by the use of automation.

To be more exact, the term "Grid connected-Home Area Networking" refers to homes in which practically all of the appliances are connected to a networking environment that is easily accessible, can be controlled remotely, and is continuously monitored. Electricity, tools, plugs, and heating, ventilation, and air conditioning systems are all included in this category.

It is the Advanced Metering Infrastructure (AMI), which is a component of networking standards and protocols, that is responsible for handling significant tasks that must be finished by a certain time or independently. It is possible for people and businesses to monitor the operation of integrated devices and smart products in the workplace by using high-quality networking protocols and standards in combination with a topological design that is standardized.It's possible that the electronic device used by an organization has a wireless network connection built right in; for instance, it may be moved into a residential area. It is possible to perform continuous monitoring of the machine by connecting it to the home computer of the enterprise via the use of the internet. Modern home networks are able to establish connections with gadgets that are considered to be state-of-the-art. In respect to the same activity of self-driving vehicles, people and organizations alike are experiencing concerns over safety and security.

For the purpose of establishing a controlled environment, it is absolutely necessary to maintain precise records of power transfers, uses, and disposals. In the past, major organizations and a select few very rich houses were the only ones who had access to control and automation of equipment that functioned across the whole building. Building automation was only able to control mechanical systems in the past, such as heating, ventilation, and air conditioning (HVAC), lighting, and other mechanical systems. A limited number of access points were available, and the system offered only the most fundamental capabilities in terms of scheduling, monitoring, and control.

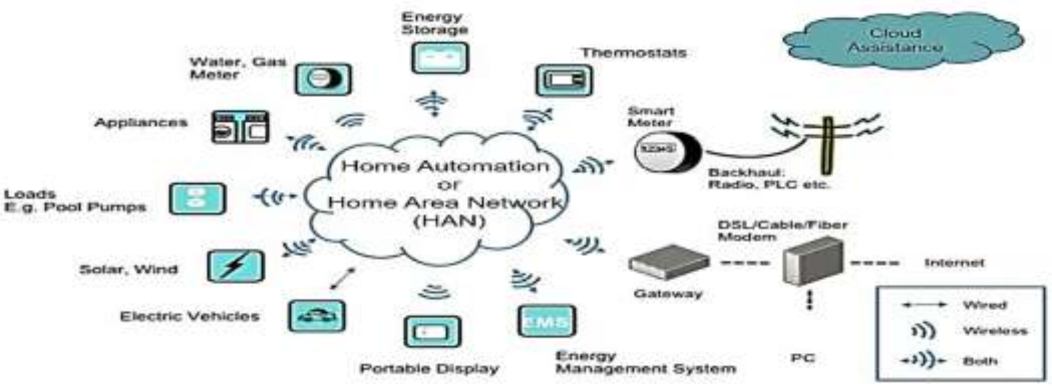

Figure 1.1 Elements involved in Home Area Network (HAN) Automation

LITERTURE SURVEY

When it comes to the two most important aspects of energy supply and demand side regulation, it is absolutely necessary tofunction independently. Additionally, these key areas need to be subjected to continuous surveillance monitoring. There are a number of factors that contribute considerably to the creation of energy, including but not limited to large-scale industrial facilities, dispersed public services, and private dwellings. "Energy can neither be created nor destroyed; it can only be transferred or used as such." By making this assertion, the actual nature of energy is brought to light.

The result of this is that the equilibrium between the amount of energy that a nation produces and the amount that it consumes will always be unstable. Because of this, a significant amount of research may be focused on energy and power, including matters such as the incorporation of intelligent products and the automation of energy systems, either in their whole or in part.

Reduce the amount of energy that is wasted, the most effective technique would be to manage the amount of power that is used during both production and consumption. It is the Distributed Control System (DCS) and the Supervisory Control and Data Acquisition (SCADA) that are responsible for keeping track of the present condition of the distribution units and residential lines that make up the power grid. Specifically, they do this by carefully monitoring and regulating every component. Innovative developments in the field of communication are contributing to the enhancement of the energy grid. As a result of these improvements, rigid systems are changed into sensing units that are fully automated and trustworthy. Within the scope of their study, João Figueiredo and Martins (2009) investigated the concepts of distributed power management and demand-side energy management. Within the home market, there is a constant competition for both the production of energy and the use of energy. The degree of complexity that can be achieved in real time production and distribution is not constrained in any way. Consequently, cut down on the amount of energy that was used, they came up with a method that could be engaged automatically from any utility setting.

Illustrate that the design may include renewable energy sources, the authors have incorporated three components of the power system: Demand-Side Management (DSM), Building Automation System (BAS), and Energy Production System Management (EPSM). Utilizing a Programmable Logic Controller (PLC) for testing purposes, the newly designed method is then put into action with the help of a Supervisory Control and Data Acquisition (SCADA) system. In addition to this, they have proposed a transmission design that simplifies the process of connecting several integrated devices to the existing grid. For them to be able to change into a smart grid, they need the infrastructure that is provided by the ideas and plans that have been suggested.

According to the findings of Vangelis Marinakis et al. (2012), a complicated electrical system calls for a complicated infrastructure. Detailed information is provided on the difficulties that arise when attempting to combine the specialized software with the integrated components in a way that enables accurate operation and control. The authors illustrate, with the use of scientific data, how two important aspects—energy and the environment—can be combined with electricity get rid of wasteful energy usage and improve management and automation. Because of the live tools that are included in the control system, all of the components of the system are able to interact with one another. The authors went to significant efforts to lower the operational expenditures of an automated grid-connected home and to compute the overall power consumption of a totally automated house. Both of these endeavors were accomplished simultaneously.

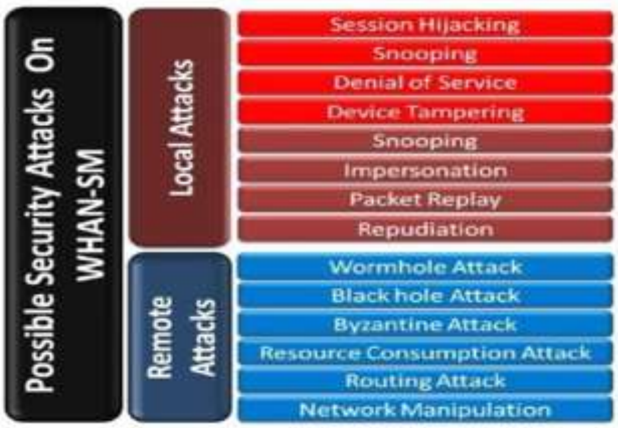

Figure 1.3 List of attacks on Wireless HAN Scenario

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As seen in Figure 1.3, the authors highlighted a wide variety of possible vulnerabilities that may exist inside the WSN-HAN system. This makes it possible for AMI to execute service demand-side management and restrict machine capabilities during certain time periods.

Jiazhen Zhou and colleagues (2012) conducted research on the Meter Data Management System (MDMS) and designed a scalable distributed communication architecture make it possible for AMI in smart grids. The smart grid system that the authors have developed for transmission that is entirely dispersed may be shown in Figure 1.4.

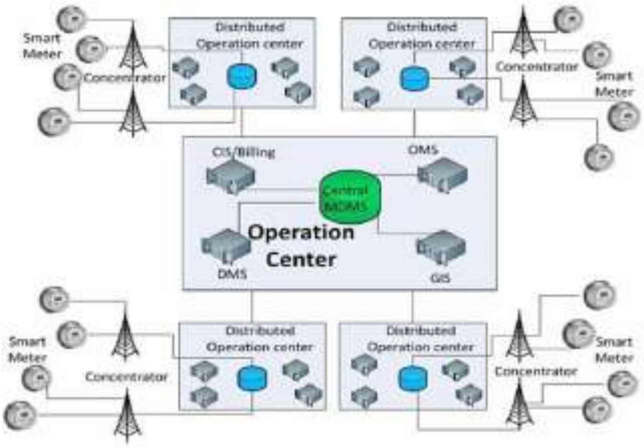

Figure 1.4 A Fully Distributed Communication Architecture in Smart Grid

Hasen Nicanfar et al. (2014) and Yang Liu et al. (2016) published articles in which they examined smart grid communication key management and identification systems, as well as hack detection that takes into consideration frequency loss and power overloading. Through the implementation of two fundamental ideas, namely improved identity-based cryptography (EIBC) and secure remote password (SRP), the smart grid system has become a dependable place for the distribution of electricity distribution. The use of internet access and smart identification are both examples of cybersecurity measurements.

The findings and assessments show that the security framework's protocol has to be more robust and complex to withstand assaults like malware and other cyber threats.

3.FRAMEWORK ANALYSIS, CONTROL AND SIMULATION

An investigation of the feedback responses and channel capacities of the network cells was carried out by Bradford Campbell et al. (2016). This investigation focused on the existing structure and design of the components of the network. Using the stated area coverage and spontaneous signals, the channel capacity and execution time are calculated at each design junction and crossing point. This is done ensure appropriate operation.

It is common practice to put the concentrator and gateway sensors through multi-nodal order processing testing. This is because of the great interoperability that they possess. When analyzing the performance of the framework, one of the most essential aspects to take into consideration is the flow of data, which plays a role in defining the channel capacity, multi-node link, and signal analysis.

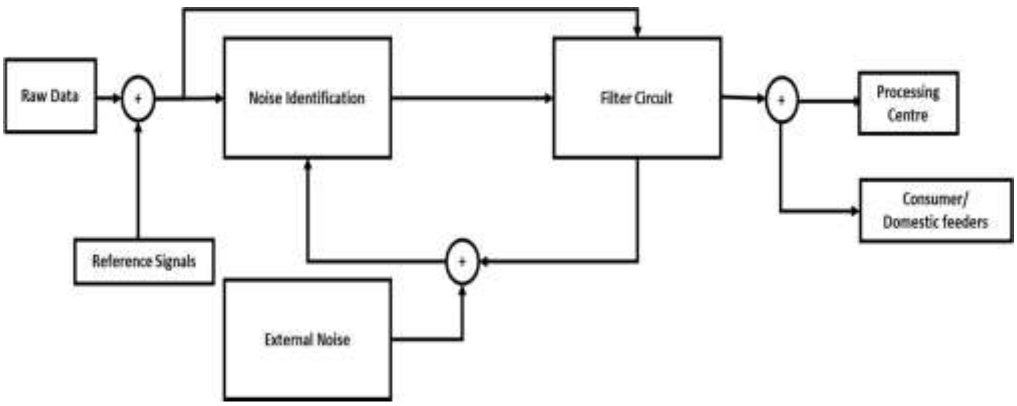

Figure 3.6 Signal Correction and Noise Cancellation Workflow

The elimination of noise makes it easier to see and comprehend the manner in which certain nodes and concentrators carry random signals. It's possible that the total number of nodes will change depending on the port and the CPU. As a result, a novel approach to the positioning of sensors is created accommodate differences in the loads present in households. As can be observed in Equations (3.1) and (3.2), the QoS-GPSR protocol is used ascertain the number of regional hops (H) that are included in the chosen quickest route.

At the perimeter of each data center, data flow is monitored in real time, and any problems that occur in the open network are fixed as soon as they are discovered. It was determined that traffic that came directly from nodes was given priority, and the number of hops that were necessary to clear traffic varied within the same frequency range.

Finding G (L) requires you to fill in the gaps. The probability distribution function fv(v), which determines the remaining distance to the destination, is used to determine the order of priority for the closest friend while a packet is being sent. R represents the communication range, and v, which is a random integer, represents the remaining distance to our target. Both of these numbers are interconnected. Consequently, the forward velocity per hop is equal to L minus v. This is the outcome.

It is possible to use the G(L) function determine the typical amount of progress that is made toward the goal with each hop. Examining the different places that are in close proximity to the center allows one to determine the average number of cell flows that are capable of connecting to it with m hops between them. This experimental filtering arrangement is based on the premise that the data comes from a large number of wireless networks that, on average, have the same hop count.

Performance Evaluation
It is possible for us to validate the functioning of the system by collecting data from a single HAN and conducting tests with all of the appliances that are linked with, respectively. When a large number of devices broadcast data at the same time, the results of the experiment show that the signals may be recovered in a variety of different ways owing to even a minute inaccuracy in the model.

When the model mistake manifests itself as a persistent spike, the data bits can only be partly retrieved by the use of filtering and smoothing distributions. As a consequence of this, aliasing and congestion are both possibilities that may arise during the processing of the data bits by the control center. Three metrics are used to assess the proposed network design in both datasets. These metrics are the packet loss ratio, the average end-to-end packet delay, and the route cost. The first set of data consists of an examination of a virtual area that is about fifty meters square and uses the node density as a variable.

The network will stretch outward in a circle that is 150 meters wide, beginning in the middle of the complex. For both the upstream and the downstream directions, a speed of 6 Mbps has been designated as the default. Following the separation of the erroneous and noisy signals, the relative error rate (PER) for the border area is calculated. The number of nodes, the signal-to-noise ratio, and the data rate all have a direct relationship to the data-handling capability of a corresponding device.

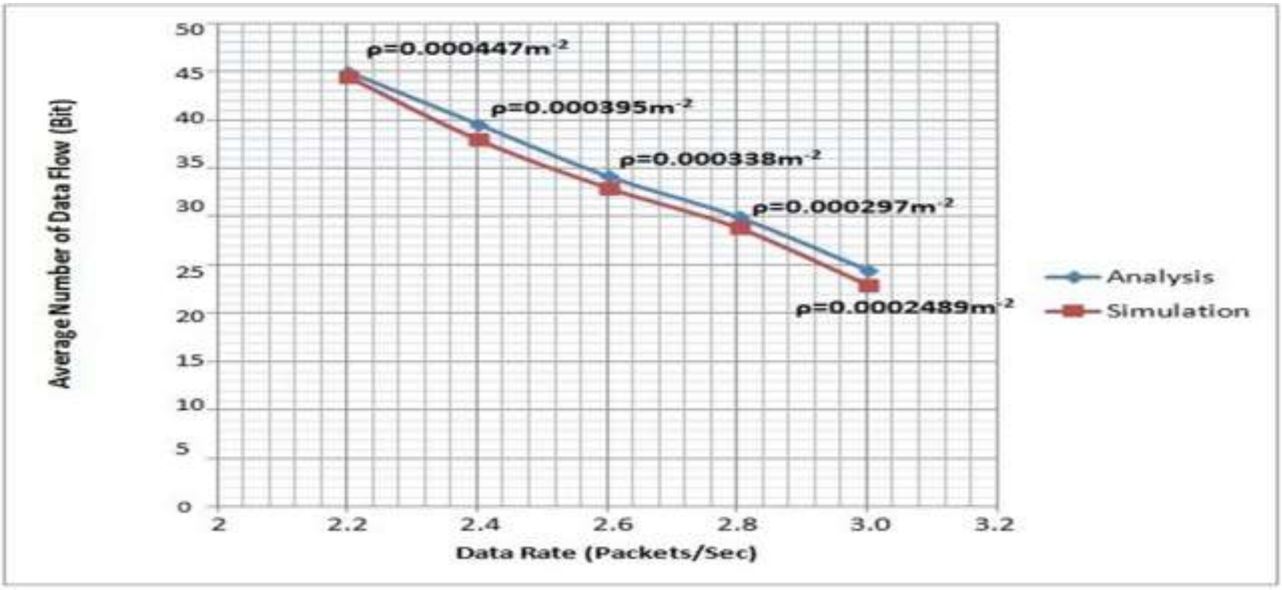

Figure 3.10 Data Flow VS Data Rate

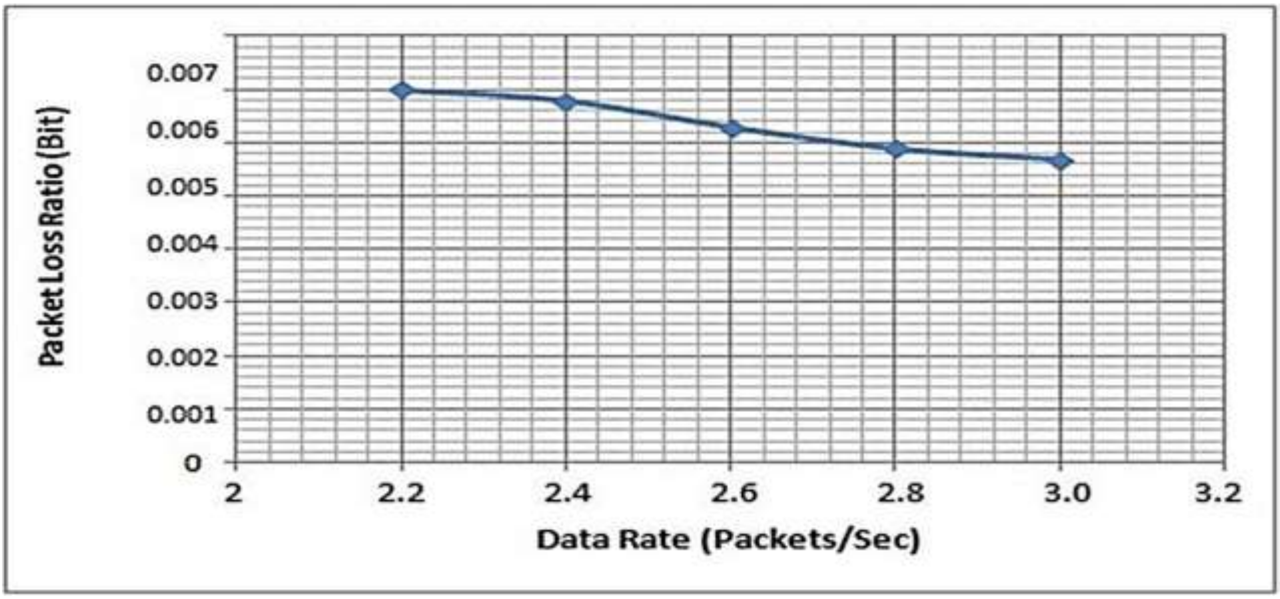

Figure 3.11 Packet Loss Ratio

SECURITY AND SIGNALING

To get access using a system of sensors There may be differences between the Application Programming Interfaces (APIs) that are used by different applications on a network device and the operating systems that are utilized by those programs. Through the use of a web-based graphical user interface (GUI), it is made simpler to get access to critical information in real time. It has been said by Seong-Joong Kim (2017) that this particular kind of stacking architecture ensures the safety of all of the digital devices that are located below it. A severe and sophisticated security policy is required because of the digital nature of the network and the continual upgrades that it receives.

Time is selected in the modeling environment, and for each period, the packet delay for each device is analyzed according to its priority and significant power values. This process is repeated for each different device. Latency refers to the amount of time that passes between a node and the cell or repeater that comes after it. There are two aspects that will determine the outcome: the strength of the network and the rates at which the nodes transmit data packets.

The whole setup and design will get wrong values, as stated by Daniel Minoli et al. (2017). This is because the execution phase will be delayed or terminated if it is delayed or terminated. In addition, any network cells that are now waiting for their time to report will also come to a stop at the same time.

Errors are more noticeable if the system is slow because they are more noticeable. When the barrier is reached, the system either restarts itself or launches a service that must be manually completed restore normality to the whole network. There are two ways that this may be accomplished.

Figure 4.3 Layers of IoT Security for enabling Inside HAN

C. **Gateway Architecture and Data Exchange Process**

The HAN-IoT setup that was discussed before lays the burden of connection formation and data exchange on the computer that is connected to the Internet of Things. The Central Gateway Unit (CGU) is responsible for controlling and monitoring the concentrators and sensors. This is accomplished by the gateway via the use of segmented parts when transmitting network communications over TCP/IP.

The CGU and the Internet of Things server are not as noticeable in HAN as the sensors that are installed on the devices and the server itself. This framework has been improved with new features that are depending on elements such as location, sensor limit range, smart meter capacity, and gateway connection, as stated by Sultan Shoaib et al. (2017). These features have been included to expand the capabilities of the framework.

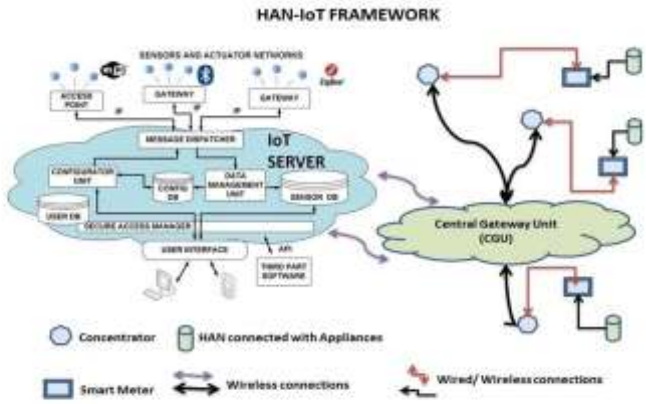

Figure 4.5 New HAN-IoT Architecture

In order to guarantee that all of the network devices are linked in the appropriate manner, it is necessary to check the gateway indexes in addition to the locations of the sensors and nodes. A number of considerations, including signal strength, range, and the border, are taken into account when determining the best method for transmitting data packets between nodes and between the CGU and the server that hosts the Internet of Things.

Al-Ali et al. (2017) state that ensure that the data transmission and energy conservation are carried out in the most efficient manner possible, the standard that is chosen must be durable, reliable, and economically feasible. A better design has the potential to avoid a variety of issues, including but not limited to system failure, security breaches, poor coverage of network boundaries, and gateway control. The network that contains all of the connections may be able to manage any problems that arise with the traffic in an environment that involves communication or a smart home.

CONCLUSION

This thesis will focus on the planning and implementation of artificial intelligence (AI) with smart energy utilization for HAN. In addition to transmitting data and messages via the use of IEEE 802.11a and Zigbee wireless protocols, the system that was built has the ideal layout combinations (Star-Mesh technology).

calculate the amount of data loss, error handling, and signal enhancement, this study makes use of the most effective adaptive filters. The Dijkstra algorithm utilizes the sensors and nodes that are located in close proximity to the HAN discover the most effective way for transmitting a message. The only objective of this tool is to identify the path that is both the most energy- and data-efficient.

The fact that the system is fully digital and automated makes it more susceptible to being attacked by cybercriminals. The implementation of a three-tiered security strategy inside the framework that is already in place would prevent this from happening. This cutting-edge security configuration guarantees that all of the data from each device will be preserved in its original condition.

Each and every piece of apparatus is able to communicate with the central hub. The setting of the HAN makes it possible to provide cloud services and remote help. Customers are provided with a link to the cloud as well as help with their data in real time by the platform. A wait time of no more than ten seconds is the very minimum, and users may access their data online at any time, day or night. Each and every item operates on its own. Machine learning has been experimented with in a variety of domains, including but not limited to the processing of data, the management of errors, the identification of appliances, and the creation of maps. The report offers a detailed and thorough overview of the results and findings that were obtained from the testing.

A programmed robot that is capable of operating on its own is also used for the aim of testing the suggested technology. Individuals have the ability to remotely monitor and change the robot's energy consumption via the use of wireless sensor networks. The implementation of the energy-aware automated system results in a considerable improvement in both the energy consumption of the robot as well as its efficiency and effectiveness.

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