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Increase Comfort and Security in a Smart Home Using a Prediction Algorithm and Z-Wave Protocol

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Abstract:

Having a comfortable and safe home is everyone's dream, comfort and home security can now be realized by IOT. Internet of Things (IOT) is a compulsory concept to share the advantages of continuously connected Internet connectivity. Smarthome is a fairly expensive technology, but smarthome function is certainly very useful compared to the expensive price. Expected Smarthome with comfort and home security can be realized, with the prediction algorithm and Z-Wave protocol then SmartHome can be realized with an affordable price.

Keywords — **Smart Home, Prediction Algorithm, Z-Wave Protocol, Comfort home, Home security.**

I. INTRODUCTION

In the development of technology, especially on the internet provides comfort in everyday life. With the internet we can do mobile computing anywhere, anytime, and by anyone for the sake of communication and work affairs. "My house is my palace" is everyone's dream, comfort and home security can now be realized by IOT. Internet of Things (IOT) is a concept that aims to expand the benefits of Internet connectivity is connected continuously. IOT little reviews before there, to turn off the lights in the house can use the light sensor attached to the lamp. But the function is limited, can only be used in the outer light of the house because if the light turns off and if it is dark the light will blink. Now with Smarthome all can be controlled, from turning on and off the room lights, closing and unlocking, and sending notifications to the occupants if anything suspicious happens at home. Smarthome benefits offered are certainly the same as the price to be spent, smarthome development needs to be considered for efficient. Therefore the author will discuss "Improve comfort and security with smart home by using prediction algorithm and wave protocol z. " Enhance comfort and security with smart home by using prediction algorithm. And Z-Wave Protocol".

II. RELATED WORK

So much research has been done in the field of smart home improvement in recent years. Some of the latest research done in the area of smart home improvement is described briefly in this section.

The study on design of a prototype for smart homes and energy efficiency using neural network by Teich, et.al. In 2017 [1] shows that as a part of smart homes, a subsystem consisting of three components including a neural network is designed to provide personalized services. Unique factor combinations of building specifics, user profiles and external influences lead to the necessity of self-adaptive systems for personal comfort. The system supports room temperature control in order to heat rooms energy efficiently at a set time.

Smart home systems require a software architecture that allows services to be deployed on virtual and hardware devices.The design of automated processes is the first step of later programming and implementation into smart home systems that will automatically supervise and re-train its components and will also allow live feedback.

The study on the hardware design of Smart Home System Based on zigBee on Wireless Sensor Network by Zhen-ya Liu in 2014 [2] presents the smart home system based on ZigBee technology and GSM / GPRS network, the smart home system the hardware circuit, using the CC2430 ZigBee wireless sensor networks, real-time acquisition of the parameters of temperature, humidity, th ree tables, infrared, smoke, gas, fire, theft alarm, home appliances Appliances such as home environment, through the wireless networking of multiple monitoring devices, household appliances in the home environment remote control and image of remote monitoring system by combining the formation a new type of smart home system, provides a feasible method for intelligent home environment.

The benefits and risks of smart home technologies" was studied by Wilson et al. in 2017 [3]. Shows that smart homes are a priority area of strategic energy planning and national policy. The market adoption of smart home technologies (SHTs) relies on prospective users perceiving clear benefits with acceptable levels of risk. This paper characterises the perceived benefits and risks of SHTs from multiple perspectives.

Policymakers can play an important role in mitigating perceived risks, and supporting the energymanagement potential of a smart-home future. Policy measures to support SHT market development include design and operating standards, guidelines on data and privacy, quality control, and in situ research programmes. Policy experiences with domestic energy efficiency technologies and with national smart meter roll-outs offer useful precedents.

Badenhop et al. in 2017 proposed an interesting work on the Z-Wave routing protocol and its security implications [4]. In this research explain Z-Wave is a proprietary technology used to integrate sensors and actuators over RF and perform smart home and office automation services. tocol have been made public, details regarding the network layer are not available for analysis. Using a real-world Z-Wave network, the frame forwarding and topology management aspects of the Z-Wave routing protocol are reverse engineered. A security analysis is also performed on the network under study to identify source and data integrity vulnerabilities of the routing protocol.

It is discovered that the topology and routes may be modified by an outsider through the exploitation of the blind trust inherent to the routing nodes of the network. A Black Hole attack is conducted on a real-world Z-Wave network to demonstrate a well-known routing attack that exploits the exposed vulnerabilities. As a result of the discoveries, several recommendations are made to enhance the security of the routing protocol.

Garciaa et al. in 2016 study the development of an intelligent system for smart home energy disaggregation using stacked denoising autoencoders [5]. In this research explain Energy sustainability remains one of the biggest challenges for the Philippines' energy sector with 51% of the demand coming from the residential and commercial sectors. Intelligent energy monitoring systems play a key role with the opportunity to contribute sizeable amount of energy savings by providing meaningful consumption feedback to home owners. The results using absolute mean loss and proportion of energy correctly assigned as metrics for the signal disaggregation. The results show that the model was able to decompose an aggregate appliance signal and provide an itemized appliance-level power consumption.

Stojkoska et al give a good review of Internet of Things for smart home: challenges and solutions" [6]. This study aims to contribute towards narrowing the gap between the existing state-of-the-art smart home applications and the prospect of their integration into an IoT enabled environment. a holistic framework which incorporates different components from IoT architectures/frameworks proposed in the literature, in order to efficiently integrate smart home objects in a cloud-centric IoT based solution.

the holistic framework ascertained in this paper can be used as a solid base for the future developers of Internet of Things based smart home solutions.

Stojkoska et., al. In 2014 studies on the use of prediction algorithms in smart homes[7]. In this work, he explain 'Smart Homes' or 'Intelligent Homes' are capable in making smart or rational decisions and increase home automation. This is done to maximize inhabitant comfort and minimize operation cost. Tracing and predicting the mobility patterns and usages of devices by the inhabitant, sets a step towards the objective. The paper discusses in detail, the role of certain Prediction algorithms to bring about next event recognition.

The effectiveness of the Prediction algorithms used is demonstrated ;making it clear how they prove to be a key component in the efficient implementation of a Smart Home architecture.

III. METHODOLOGY

All Prediction algorithms have in making the Smart Home for prediction algorithms help in predicting the subsequent behavior of possible occupants and is a key component in developing a Smart Home. Some form of prediction algorithm is an algorithm of IPAM, ONISI, Jacobs Blockeel algorithm, LZ78, LeZiUpdate, Active LeZi, and Adaptive FXL FXL. Election prediction algorithms used affects the working efficiency of the Smart Home. Prediction algorithm will learn the incoming data in the form of the daily behavior of the occupants of the house which further divide each existing smart home environment to support the occupant's behavior.

Z-Wave is a new type of RF, low cost, low power consumption, reliable, and suitable for short-range wireless communications technology. The wireless frequency of work is 908.42MHz (USA) ~ 868.42MHz (EU), adopt FSK (BFSK / GFSK) modulation, data transmit speed 9.6 kbps, signal range can be about 30 meters for indoor, outdoor can exceed 100 meters. With the increase in communication distance, equipment complexity, power consumption and system costs will increase, compared to traditional wireless communication technology, Z-wave technology consumes ultra low power and low cost technology, greatly accelerate the formation of private wireless networks.

Z-Wave is mainly used in home automation, remote control lamps and remote data acquisition applications such as control lights and tool controls, HVAC, Security & Protection. Z-Wave can transform individual devices into smart network devices.

Each Z-Wave network has a unique network address (home ID) 4 bytes (32 bits) long; Each Node ID is assigned by Z-Wave controller (hub). Each network can support a maximum ID of 232 devices. All Node IDs are assigned and managed by the main controller, the other control equipment simply forwarding commands from the main controller.

Utilizing low data format transmission, 40 kbps meet data transmission, previously adopted 9.6 kbps speed for data transmission. Compared to other wireless technologies, Z-Wave has a low bitrate transmission, moderate transmission distance, and competitive cost advantages.

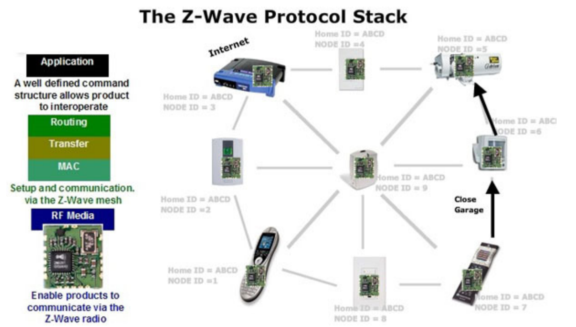

Fig. 1 Z Wave Protocol.

A. *Home Automation*

Smart Home systems can be described as automating or introducing technologies in the home environment to provide comfort, safety, comfort and energy efficiency to the device with the help of sensors and actuators. Adding intelligence to the home environment improves the quality of life and living standards. With the introduction of Internet Things, Smart home implementations are increasingly popular because of M2M communications.

The smart home system consists of many components such as sensors (such as temperature, motion detection, daylight sensors), controllers, actuators (such as switches and light appliances) and channels (wired and wireless). Such systems require one or more "human to machine" and / or "M2M" interfaces, so that people can monitor and control them. This may consist of a special terminal or other controller. From the last few years this may be an applicator running on a smart phone or web page. The device can communicate through an individual or by connecting everything with a wired network, or wirelessly. So we can use central controller to control it.

This system has many applications. As an energy-efficient, light intensity sensor can be used to keep the light level within a certain distance to reduce power consumption. Combining two or more sensors such as a light sensor with an automatic presence sensor can turn off the lights when no one is in the room. As a security it can be oriented on things. As the convenience of a reasonable temperature can be maintained in any room with the appropriate users or the environment.

This system requires a communication protocol. Communication protocol is one of the most serious issues For home automation because home-installed devices do not support the same protocol. This makes communication between them difficult to implement. Thus we must ensure that there is compatibility between devices. The most commonly used common protocols that support wireless communication are Z-Wave and ZigBee, and for cable communications are I2C.

B. *Smarthome Architectures*

Architecture in Smart Home can be accurately described as four layers:

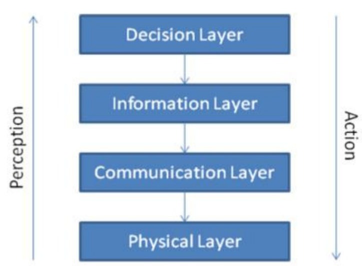

Fig. 2 Smarthome Architecture

1. Physical Layer: This layer has the basic hardware within the house including each device, transducers, and network hardware.
2. Communication Layer: This layer includes software to format and route information between agents, between users and the house, and between the house and external resources.
3. Information Layer: This layer gathers, stores, and generates knowledge useful for decision making.
4. Decision Layer: This layer selects actions for the agent to execute based on information supplied from other layers.

Perception is a bottom-up process. The sensors check the environment (e.g. the temperature of the home) and, if necessary, send the information to another agent through the communication layer. The database records the information in the information layer, updates the learners' concepts and predictions so, and alerts the decision layer of the presence of new data.

C. *Prediction Algorithms*

The predictive algorithm is chosen in the making of the smarthome because the prediction algorithm helps in predicting the possible behavior of residents and is a key component in building a smarthomee. The prediction algorithm will use incoming data in the everyday sense of the next home occupant of every smart environment available at home to support the behavior of its inhabitants.

Preferred prediction algorithms for constructing universal predictors or estimators for subsequent user actions. This scheme lyrics the dictionary zone id which is treated as a character symbol and uses the dictionary to collect statistics based on the context of the recorded movement, or phrase.

The occupants go to the bathroom, then the news and weather predictions will automatically appear in the bathroom mirror. When the occupants get ready and go to the kitchen for coffee, the bathroom lights will die, then the news program on the bathroom mirror will move into the kitchen. Furthermore, when the occupants leave for work, the smarthome will take care of the house and will order milk and bread from the grocery store, so when the residents of the house arrive the order has arrived. Smarthome works quickly in recording all the details of the occupant's interaction with his home at all times.

In an input sequence can be formally defined as follows: Let $\sum$ be the set of possible input symbols and let $A = a_1 ... a_n$ with $aj \in \sum$ be a sequence of input symbols of which the first i symbols, that is $a_1 \ldots a_i$. A Prediction Algorithm decides at first whether it is able to make a prediction and if so, returns the probability for each symbol $x \in \sum$, that x is the next element in the input sequence. These values define a conditional probability distribution P over $\sum$, where $P(x|a_1 \ldots a_i)$ is the probability for the singleton subset of ∑ containing x. There are two ways of calculating the probabilities: ondemand or live.

Some form of algorithm from the prediction algorithm is IPAM, ONISI, Jacobs Blockeel Algorithm, LZ78, LeZiUpdate, Active LeZi, FZI and Adaptive FXI. The selection of the prediction algorithm used affects the working efficiency of the smarthome.

D. LZ78 Algorithm

Variations of Lempel Ziv around there are so many. We now explain the algorithm that Lempel and Ziv gave in a 1978 paper, generally called LZ78. (An earlier algorithm, LZ77, was based on the same general idea, but is quite different in the implementation details.) The idea behind all the Lempel-Ziv algorithms is that if some text is not uniformly random; that is, if all the letters of the alphabets are not equally likely, then a substring that have already seen is more likely to appear again than a substring you haven't seen.

This is certainly true for any natural language, where words will get used repeatedly, where strings of letters which don't seem in words will hardly ever get used.The LZ78 algorithm works by constructing a dictionary of substrings, which we will call \phrases," that have appeared in the text. The LZ78 algorithm constructs its dictionary on the y, only going through the data once. This means that you don't have to receive the entire document before starting to encode it. The algorithm parses the sequence into distinct phases. We do this greedily. Suppose, such as, we have the string:

$$AABABBBABAABABBBABBABB$$

We start with the shortest phrase on the left that we haven't seen before. This will always be a single letter, in this case A:

$$A|AB|ABBBABAABABBBABBABB$$

The next phrase we haven't seen is ABB, as we've already seen AB. Continuing, we get B after that:

$$A|AB|ABB|B|ABAABABBBABBABB$$

Then you can check that the rest of the string parses into:

$$A|AB|ABB|B|ABA|ABAB|BB|ABBA|BB$$

Because we've run out of letters, the last phrase on the end is a repeated one. Now, how do we encode this? For each phrase we see, we stick it in the dictionary. The next time we want to send it, we don't send the entire phrase, but just the number of this phrase. Consider the following table:

TABLE I
Encode Case using LZ78

1	2	3	4	5	6	7	8	9
A	AB	ABB	B	ABA	ABAB	BB	ABBA	BB
A	1B	2B	0B	2A	5B	4B	3A	7

To decode, the decoder needs to construct the same dictionary. To do this, he first takes the binary string he receives, and inserts dividers and commas. This is straightforward. The first divider comes after one bit, the next comes after 2 bits. The next two each come after 3 bits. We then get 2^2 of length 4 bits, 2^3 of length 5 bits, 2^4 of length 6 bits, and in general 2^k of length k+2 bits. The phrases give the dictionary. For example, our dictionary for the above string is:

TABLE II
Dictionary Encode

0	1	2	3	4	5	6	7	8
∅	A	AB	ABB	B	ABA	ABAB	BB	ABBA

The empty phrase ∅ is always encoded by 0 in the dictionary.

How well have we encoded the string? For an input string x, let c(x) denote the number of phrases that x gets split into. Each phrase is broken up into a reference to a previous phrase and a letter of our alphabet. The previous phrase is always represented by at most $[log_2 c(x)]$ bits, since there are c(x) phrases, and each letter can be represented by at most $[log_2 N]$ bits, where N is the size of the alphabet (in the above example, it is 2). We have thus used at most:

$$c(x)(log_2 c(x) + log_2 N + 2)$$

E. Protokol Z-Wave

Z-Wave is a new type of RF, low-cost, low power consumption, reliable and suitable for short-range wireless communications technology. The wireless frequency of work is 908.42MHz (USA) - 868.42MHz (EU), adopting FSK (BFSK / GFSK) modulation, data transmit speed 9.6kbps, signal range weapon about 30 meters for indoor, while for outdoor can exceed 100 meters. With increasing communications distance, equipment complexity, power consumption and system costs will increase when compared to traditional wireless communications technology that has been there for so long. The Z-wave technology consumes ultra low power and low-cost technologies, thus greatly accelerating form a private wireless network.

IV. RESULT AND DISCUSSION

The evaluations of performance of Prediction Algorithms, the following metrics are used in the literature:

1. Prediction accuracy pr_{ac}
2. Prediction probability pr_p
3. Applicability a_p

The prediction accuracy and probability are computed by assigning a score to every prediction made by the algorithm and averaging over the number of predictions made by the algorithm.

Moreover, Z-Wave is commonly used in home automation, remote control and remote data acquisition applications such as control lights and tool controls that have been widely developed and used by the community, especially in developing countries, HVAC, Security & protection commonly combined with science artificial intelligence is a trend in the world of research. Z-Wave can also transform each device into smarter network devices.

Using predictive algorithms and the Z-Ware Protocol it is expected that a good smart home can be created and utilized to make the home comfortable and safe.

For example, some of the conclusions of this algorithm can be as:

1. Alarm On, Alarm Off, Bedroom Light, Coffee Maker On, Bathroom Light On (daily)
2. Bedroom Light, Bright Bathroom Light. Kitchen Light On, Kitchen Screen On (daily) Coffee Maker Off, Kitchen Light Off, Kitchen Screen Off (daily)
3. Other activities, such as television channels, will not be recognized by ED because it is significant because it can not be predictable regularity [7].

As long as all smart home devices connect to Z-Wave network users can check the IR remote control that is used as full access and control center to control the ON / OFF status of all the Z-Wave smart home devices used in everyday activities, while it can easily control this device. If the touch center controller is connected to the internet, smart home users can use their smartphones, tablets, PCs to control home appliances remotely. so that all the necessities of life becomes easier and fun, as the picture below is an example of a smart home whose device is connected with Z-Wave.

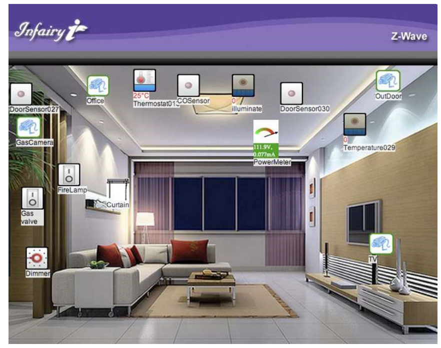

Fig. 3 Application of the z wave protocol and prediction algorithm

V. CONCLUSIONS

The most crucial step and backbone of the entire Smart Home framework. The LZ78 Algorithm is described, which primarily is used for a trie formation. The Active LeZi Prediction Algorithm is then introduced to overcome the drawbacks of LZ78 and helps in effective prediction of probable next event. LZ Wave is low cost, low power consumption, reliable, and suitable for short-range wireless communications technology. With the adoption of LZ wave and predictive algorithm is the optimal choice for logical implementation of Smart Home.

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