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Cloud Enabled Neural Network with Intelligent Sensor nodes for HVAC

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Abstract: ***HVAC (Heating, Ventilation and Air Conditioning) is the technology of indoor and vehicular environmental comfort and to control these systems. The status of building energy consumption is increasingly prominent. Indoor air pollution is 10times danger than outdoor due to incorrect functionality of heating, ventilation, and air condition system. For indoor environment quality, a novel real-time method for HVAC system operation is developed. Internet of things is used to monitor the indoor air quality by using embedded electronics, software and sensors and connectivity. This project aims to integrate air condition, ventilation and protected system on a single embedded system that alerts early warning for the unpredictable dangers. The wireless sensor nodes have limited processing power and memory. In order to embed intelligence into sensor nodes, a hybrid algorithm is proposed containing RNN (Random Neural Network) and LNP (Linear Non-linear Poisson) cascade model.***

Keywords: AIR QUALITY, HVAC, INTERNET OF THINGS.

I. INTRODUCTION

Internet of Things is a new technology in which devices and machines interact with the global world. It will be the next evolution of internet through which we can collect and analyze huge amount of data and useful information. A variety of devices can connect to the Internet, from small to large devices. There are two common technical approaches to HVAC management 1) Physical Model primarily based techniques (such as Model prophetic Control), 2) Recorder techniques. Recorder techniques are of two types: RNN: Random Neural Network, ANN: Artificial Neural Network. The physical model primarily based techniques square measure used for HVAC management, which need elaborated physical model of the building. Therefore, it's tough to implement on low value WSN. In order to embed intelligence into sensor nodes, interfacing the WSN with the cloud processing is necessary. The recorder techniques square measure used for various kinds of HVAC management.

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A centralized design for a sensible controller within which intelligence is embedded within the base station is planned. Identification of key components of a building management system such as a data processing engine, a user interaction interface subsystem, and an actuation infrastructure for sensory infrastructure, sensor data processing and energy-saving strategies to monitor fuel consumption and environmental characteristics [1]. The effective operation of an HVAC system depends to a large extent on its control system and optimization parameters. A good HVAC controller is implemented at the lower station by classifying RNN primarily based models, that is, the RNN occupancy computer model for estimating the amount of owners, the RNN PMV set point computer model for estimating the mean vote (PMV) based set points for heating.

In design, the zone / room has an indoor setting sensing element node that communicates with the HVAC duct sensing element node for airborne monitoring and the door sensing element node for estimating the quantity of occupants in each zone. Dempster-Shafer evidence theory, which combines sensory information derived from diverse sensors, assigns probability mass assignments (PMA) to raw sensor readings and finally makes a combination of mass determinations of occupancy status in a room.

The indoor setting sensing element evaluates the number of invaders and sends this information to the base station along with indoor air parameters (i.e. temperature, humidity, CO2, light weight intensity). If the area is occupied, the base station will control the HVAC to take care of the PMV, which can be evaluated by the RNN PMV set point estimator, or by operating the user-specified set points for heating and cooling. The information from the sensing element nodes is uploaded to the web portal through the gateways connected to the bottom station [2].

II. SURVEY

The survey analyzed many architectural solutions and compared them from different perspectives. Figure 1 shows the Linear Non-linear Poisson (LNP) cascade model.

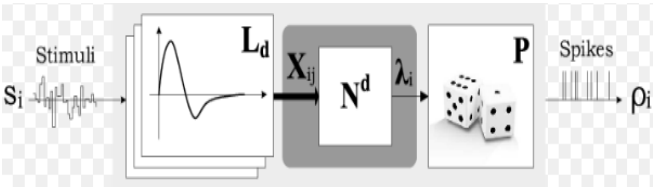

Fig. 1. Linear Non-linear Poisson Cascade Model

Table-I and Table-II shows the different architectural model and algorithmic model comparisons.

	Web-enabled Power Outlets	iPower	Sensor9k	AIM Architecture
Ambient Sensor Technologies	None	WSN	WSN, RFID, User action sensors	WSN, RFID
Energy-aware Technologies	Power meters	Wireless power meters and actuators	Root/Wireless power meters	Energy Management Devices (EMD)
Architecture Model	One-tier	Multitier	Multitier	Multitier
Support for Heterogeneity	None	OSGi	OpenGIS-based	OSGi
Control Logic Deployment	Centralized	Centralized	Centralized	Distributed
Interoperability	Low	Medium	High	High
Scalability	Low	Medium	High	High
Extensibility	Low	Medium	Medium	High

Table- I: Different architectures comparison

III. ALGORITHM AND ARCHITECTURE

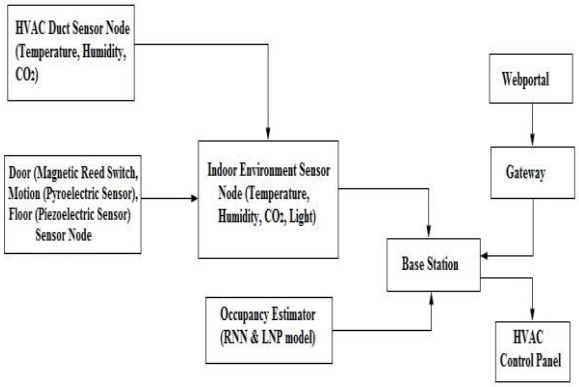

Fig. 2. System Block Diagram

A. PMV (Predicted Mean Vote):

PMV (Predicted Mean Vote) **recorder technique** is used for HVAC management. The PMV predicts the typical vote of an outsized cluster of individuals on the seven-point thermal sensation scale where:

+3 = hot
+2 = warm
+1 = slightly heat
0 = Neutral
-1 = slightly cool
-2 = cool
-3 = cold

The properties measured and therefore the maths needed to make the empirical match area unit terribly sophisticated, supported the deviation between heat loss and rate, and therefore the equations generated solely apply below constant conditions and at constant metabolic rates. However, because the conditions at intervals are designed with little variations, and therefore the article of clothing, metabolic rates then one of the occupants is expected, standard are made indicating thermal conditions that may provides a satisfactory expected mean vote, as an example, the ASHARE common place fifty five degree temperature represents as expected mean vote of between -0.5 to +0.5 for buildings wherever the occupants have metabolic rates in between one.

Sl.no	Algorithm/Model	Functions
1	HYBRID PSO-SQP (Particle Swarm Optimization-Sequential Quadratic Programming)	The model overcomes GD (Gradient Descent Algorithm-which had Zig-Zag behaviour) for finding global minima.
2	Lyapunov optimization techniques	Construct and stabilize virtual queues associated with indoor temperatures. No need to predict system parameter [3].
3	Data driven gray box model	Novel modeling and opimization approach [4].

Table- II: Different algorithmic model comparison

Figure 2 shows system architecture and Figure 3 shows the Predicted Mean Vote (PMV) thermal index calculation with Fanger Equation.

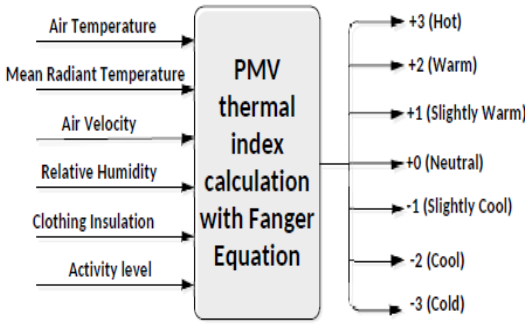

Fig. 3. Predicted Mean Vote

B. HVAC DUCT SENSOR:

Amphenol Advanced devices HVAC Duct Temperature Sensor measures the air temperature emitted from air ducts. The reading is fed back to an impression module and compared to the temperature setting on the air-con system [5]. The management module calculates the temperature delta and adjusts the HVAC system to reduce the distinction. Table-III shows different building types and methodologies used.

FEATURES:

1. High accuracy Original Equipment Manufacturer device
2. High sensitivity and
3. Excellent fungibility
4. Twist and lock installation

Building Type	Methodology	Findings
Office and Educational	Measurement survey, behavioral survey and adaptive model	Different thermal preference in different seasons
Residential	Artificial neural network, sliding window method	Temperature and Humidity are predicted by ANN.
Climate chamber	Spatio-temporal interpolation	Standard dense sensor network in measuring ACE [6].
Hospital	Statistical method and descriptive analysis	Microclimatic conditions [7].

Table- III: Different building types and methodologies

SPECIFICATIONS:
Resistance @ a pair of5°C: 2,795Ω ± 2.50%
Beta (25/85): 4073
Plastic: Nylon

APPLICATIONS:
1.HVAC vent temperature (automotive)
2.In cabin temperature (automotive)
3.Air Temperature
4.HVAC flow of air observance (industrial)
5.Industrial automation
6.Close atmosphere and method observance

IV. IMPLEMENTATION

Fig. 4. System Development

For HVAC application, reliability, easy installation and power consumptions are the major factor to select WSN TOPOLOGY [8]-[10]. In this project we are using mesh topology.

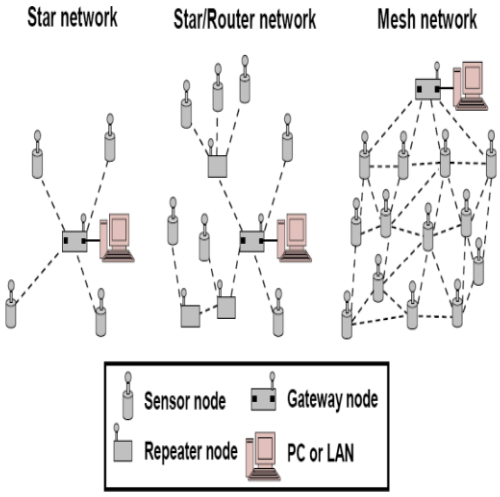

Fig. 5.WSN Topologies

A mesh network is that the third form of networking wherever every node will communicate with one another while not routing through a central receiving purpose as within the star network [11]. The central receiving purpose becomes merely another node during this network that's dedicated to assembling the info that square measure being capable the network. This design has the potential of permitting individual detector nodes to bypass a central station to transmit information solely to those nodes that use information, thereby minimizing the transfer of superfluous info. The multiple routing ways alter the network to regulate if some communication links square measure discontinuous over the network's life as its setting changes, that eliminates centralized failures and provides self-healing and organisation [12]-[14].

V. SIMULATION RESULTS

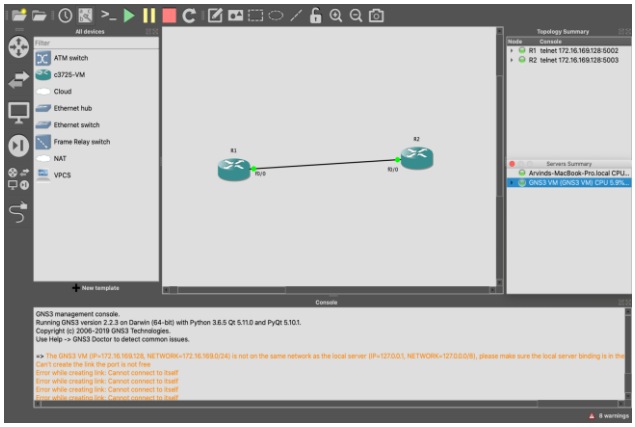

Fig. 6. Node to Node Communication and Configuration

VI. CONCLUSION

This work presents the implementation of IOT technology for monitoring and implementing the HVAC. It is done through wireless sensor networks using mesh topology. Reliable sensors are used to get the accurate results. The current work focuses on data transmission without loss of data which is collected from the sensor. Since CO2 concentrations take some time to accumulate in the presence of ventilation, the RNN (Random Neural Network) occupancy assessment algorithm takes time to estimate the number of invaders. The shortcomings of both techniques are reduced by proposing the hybrid algorithm containing RNN and LNP (Linear Non-linear Poisson) cascade model. The LNP cascade model is a simple functional model of neural spike response. It has been used successfully to initially describe the response properties of neurons in the visual system, especially in the sensory pathways. The LNP model generally refers to the use of reverse correlation or spike-triggered averaging to visualize neural responses using white-noise stimuli. Making this project to be more reliable in order to lessen the installation costs and low power consumption. It will react immediately to changes accoutred without any failure and with less latency time.

REFERENCES

1. Bellamkonda Jyothi, Dronamraju Sruthi, Ragipati Karthik, "Energy Monitoring Using Arm 7," *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, Volume-8 Issue-6, April 2019, pp. 441-445.
2. Krishnaveni K, Venkata Ratnam K, Prathyusha G, Gopi Krishna P, "Development of real time environment monitoring system using with MSP430," *International Journal of Engineering and Technology (UAE)*, 2018, 7(2), pp. 72-76.
3. Chengrun Qiu, Yang Hu, Yan Chen, Bing Zeng, "Lyapunov Optimization for Energy Harvesting Wireless Sensor Communications", *IEEE Internet of Things Journal*, Vol. 5, No. 3, June 2018.

4. Wenzhuo Li, Choongwan Koo, Seung Hyun Cha, Taehoon Hong, Jeongyoon Oh,"A novel real-time method for HVAC system operation to improve indoor environmental quality in meeting rooms", *Elsevier Building and Environment Journal*, Vol. 144, No. 2, August 2018,pp. 365-385.
5. Tuan Anh Nguyen, Marco Aiello, "Energy intelligent buildings based on user activity: A survey", *Elsevier Energy and Buildings Journal*, Vol. 56, 2013.
6. M. Trinath Basu, Ragipati Karthik, J. Mahitha, V. Lokesh Reddy, "IoT based forest fire detection system," *International Journal of Engineering & Technology*, Vol 7 No 2.7, 2018, pp. 124-126.
7. Xiaoxu Cai, Huixing Li, Guohui Feng, Shui Yu and Yibo Zhao,"HVAC system green retrofit survey and analysis of public institutions building in cold region" *Elsevier Building and Environment Journal*, Vol. 146, 2016,pp. 218-223.
8. ALESSANDRA DE PAOLA, MARCO ORTOLANI, GIUSEPPE LO RE, GIUSEPPE ANASTASI,SAJAL K. DAS,"Intelligent Management Systems for Energy Efficiency in Buildings: A Survey", *ACM Computing Surveys*, Vol. 47, No. 1, Article 13, May 2014.
9. Zakia Afroz, GM Shafiullah, Tania Urmee, Gary Higgins,"Modeling techniques used in building HVAC control systems: A review", *Elsevier Renewable and Sustainable Energy Reviews*, October 2017.
10. Abbas Javed, Hadi Larijani, Ali Ahmadinia, Rohinton Emmanuel, Mike Mannion, Des Gibson, "Design and Implementation of a Cloud Enabled Random Neural Network-Based Decentralized Smart Controller With Intelligent Sensor Nodes for HVAC", *IEEE Internet of Things Journal*, Vol. 4, No. 2, April 2017.
11. Nashreen Nesa and Indrajit Banerjee "Design IoT-Based Sensor Data Fusion for Occupancy Sensing Using Dempster–Shafer Evidence Theory for Smart Buildings", *IEEE Internet of Things Journal*, Vol. 4, No. 5, October 2017.
12. Liang Yu, Di Xie, Tao Jiang, Yulong Zou, Kun Wang,"Distributed Real-Time HVAC Control for Cost-Efficient Commercial Buildings Under Smart Grid Environment", *IEEE Internet of Things Journal*, Vol. 5, No. 1, February 2018.
13. Sahiti V., Raghava Rao K., Mohan Rao K.R.R, "Hashing technique data optimization for low power consumption in wireless sensor network," *Indian Journal of Science and Technology*, Vol. 9, No. 17, 2016.
14. Lakshmi Manoja C., Aruna Kumari D, "Geographical location based hierarchical routing strategy for WSN using movable routers," *Indian Journal of Science and Technology*, Vol. 9, No. 17, 2016.

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