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# Automation of 1.5tr Air Conditioing Systems Used in Different Cabins in Different Areas

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### *Abstract*

*India is the world's most populous country and temperatures in many states regularly exceed 40°C. Therefore, people living in humid climates need a means to control temperature. Scientists have determined that human comfort is between 22°C and 27°C. This research determines all the properties of air relevant to the operation of water pipes. Exploring automation in air conditioning systems with Passive Infrared Sensor is to develop and implement intelligent climate control solutions that leverage human presence detection. We use the right tools and techniques for plumbing installation in many rooms and cabins. Maintain and determine all aspects of loading and operating ductwork, including uneven friction, uneven cooling, and adequate air distribution at all locations. The goal is to reduce energy consumption, lower operational costs, and create environments that are both environmentally sustainable and fulfill to the needs of occupants in various settings, spanning residential, commercial, industrial, and institutional spaces. This article will focus on how to install a pipeline, how to make the necessary calculations for various losses, how to study the air velocity at various points of the pipeline, and how air should be distributed to each area.*

**Keywords:** Air duct, air flow, sensor, ESP32, cooling

## INTRODUCTION

Automation in air conditioning systems with Passive Infrared (PIR) sensors involves integrating advanced sensor technology to detect human presence and movement within indoor spaces. By utilizing PIR sensors, these systems can intelligently adjust temperature, airflow, and cooling/heating modes based on real-time occupancy data. This approach aims to enhance energy efficiency, reduce operational costs, and improve occupant comfort by ensuring optimal climate control only when and where it is needed [1-3].

## LITERATURE REVIEW

S. Dhanalakshmia, M.Poongothaib, Kaner Sharma [5] Heating ventilation and air conditioning system consume a substantial volume of energy within corporate buildings mainly due to lack of severe monitoring, which result in comparison, either energy efficiency or user comfort. We propose a simple HVAC control system to automate HVAC tasks in real time, taking into account power management. An automated real time HVAC system was built on top of an iot framework based on user feedback, demand response building, energy consumption and thermal comfort.

Oluleke Bamodu, Liang Xia, Llewellyn Tang [6] Energy consumption in buildings accounts for a large portion of world energy consumption. Since people spend approximately 90% of their time

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indoors, it is important to improve the indoor environment and reduce energy consumption. It is expected that, efficient placement of sensors and optimisation of existing control systems can play a major role in minimising discomfort and reducing energy consumption.

Yeonjin Bae, Saptarshi Bhattacharya, Borui Cui, Seungjae Lee, Liang Zhang, Piljae Im, Veronica Adetola, Draguna, Vrabie, Matt Leach, Teja Kurugant[11] This article provides a review of sensor systems in home/HVAC systems, specifically Management and Literature Survey . Effect on energy consumption and thermal comfort. The most common options suggested for improving sensor performance in new or existing buildings are: (1) improvement of current practices in sensor configuration/design and (2) further development of the sensor suite. (3) Install advanced sensor technology.

H. Edtmayer, D. Brandl, T. et al. Schlager, H. Gursch, M. Lugmair, C. Hochenauer[13] Increasing demands for indoor comfort in buildings and the urgent need for energy savings require the optimization of home HVAC systems. A lot of understanding and accuracy is required to achieve this goal. The aim of this research work was to develop a novel coupled simulation workflow for a digital twin with real-time, high accuracy virtual sensors.

C. Aghemo, J. Virgone, G.V. Fracastro, A. Pellegrino, L. Brazo, J.S. Savoyat, Kevyn Johannes[12] This article describes the first phase of the project, which consists in the selection of the show environment and the definition of management and monitoring strategies to reduce energy consumption for good lighting and air conditioning. Based on the analysis of buildings and rooms' characteristics, new control strategies have been proposed, both for lighting and for heating, in order to provide energy savings in buildings where heavy retrofitting works are not possible, like for historical buildings.

Mohsen Soori, Behrooz Arezoo, Roza Dastres[3] The Internet of Things (IoT) is transforming traditional factories into smart factories in Industry 4.0, using a network of connected devices, sensors and software to monitor and adjust the production process. Smart factories are factories that use connected devices and real-time data to optimize production processes, improve efficiency, and minimize environmental pollution of part production. The IoT is a critical component in the development of smart factories in terms of productivity enhancement of part production.

Oluleke Bamodu, Felix Osebor, Liang Xia, Ali Cheshmehzangi, Llewellyn Tang[7] HVAC system within buildings, optimizing (HVAC) system for energy efficiency requires improved environmental monetary as such as more sensors are necessary for monitoring the indoor space. This paper presents a low cost monitoring system and the testing of system on humidity condition, which is important parameter affecting thermal comfort, conditioning in the indoor environment and by extension energy consumption. Effective control of monitored temperature and humidity conditions at several positions in the room can significantly improve the thermal comfort feeling of the space and the energy consumption of HVAC systems installed in the building.

Mohd Javaid, Abid Haleem, Ravi Pratap Singh, Shanay Rab, Rajiv Suman [8] Sensors play an important role in factory automation and make the system intelligent. Different types of sensors are available depending on the need and application; Some of them are mass produced and can be found in the market at affordable prices. Sensor types include position sensors, pressure sensors, flow sensors, temperature sensors, and force sensors. Sensors can adapt to the various applications and has experience how they optimise them. Sensors application usually provide data measurement and device architecture control devices.

C. Papasinpa, J.P.M.G. Linnartz [16] The presence and behavior of people living in a building are considered important elements in creating an intelligent and responsive environment. However, the use of energy-smart buildings often faces the problem of unreliability of sensors. In this study, we address the need to improve housing affordability through the development of a system framework for smart home management.

Rongpeng Zhang, Meng Kong, Bing Dong, Zheng OâNeill, Hwakong Cheng, Fei Hu, Jian Zhu [9] Occupancy-based control (OBC) in smart buildings has the potential to improve energy efficiency. This technique has been shown to be useful in guiding the evaluation of selected sensors and providing information on sensor performance. The findings from this study had been considered in the following study when we integrated these sensors into a typical building HVAC system, tested their energy-saving potential with different control algorithms, and analyzed the impact of their detection errors on the overall performance of the integrated system.

José Joaquín Aguilera, Dragos-Ioan Bogatu, Ongun Berk Kazanci, Charalampos Angelopoulos, Daniel Coakley, Bjarne W. Olesen [14] The results show that mixed-use buildings with comfort structures can reduce energy consumption. Electric type comfort standard, without affecting the thermal performance of building works, can reduce energy consumption compared to air conditioning equipment without thermal effect performance, comfort or home atmosphere. A simulation-based analysis of control strategies for mixedmode buildings was made with the aim of defining an optimal operation in terms of energy use and thermal comfort.

Guilherme Garbossa, Alexandre Balbinot, Rafael pedroni[10] This article presents the design and implementation of a power meter used by the machine for the reading of cold air in case of failure of the main physical body. Thus ensure the continuous operation of the body and maintain the original strength and thermal comfort properties until the body changes. This paper presents a virtual temperature sensor capable to maintain the operation of an HVAC system used as a redundant sensor in electric buses for an autonomous and uninterrupted temperature control when a physical sensor presents failure.

Daniela Onofrejová, Peter Onofrej, Duša SimÅ¡ik[4] is essential to establish intelligent environmental control systems for safety, reliability and ease of use. The operation of building automation includes controlling the building climate without exceeding the limits, lighting the room according to the occupancy time, monitoring the malfunction of all machines and equipment, and reporting errors to the building engineer(s). maintenance staff. Ambient intelligence will play a very important role in new effective production systems. Savings in costs, improving safety and the whole management in a factory will enforce its competitiveness.

Yang Zhua, Matt Leach, Yeonjin Bae, Borui Cui, Saptarshi Bhattacharya, Seungjae Lee, Piljae Im, Veronica Adetol, Draguna Vrabie, Teja Kuruganti [11]. Sensors are an important source of information for fault diagnosis and diagnosis (FDD). However, sensors are often not designed, installed, measured, measured and maintained; This may negatively impact FDD performance. This paper reviewed sensor-related topics in building FDD by categorizing FDD applications as building-level, system-level, or componentlevel (or equipment-level) applications and reviewing sensor related topics for each category [15].

## PROBLEM DEFINITION

1. *Energy Efficiency:* Balancing the need for individualized climate control with energy-efficient operation to minimize overall energy consumption.
2. *System Synchronization:* Coordinating the operation of multiple air conditioning units to prevent conflicts, achieve consistency, and avoid unnecessary energy usage.
3. *Remote Monitoring and Management:* Implementing a reliable and user-friendly remote monitoring system for convenient control of the air conditioning units from different locations.
4. *Fault Detection and Diagnostics:* Developing mechanisms to detect and diagnose system faults promptly, ensuring quick resolutions to prevent discomfort and downtime.

5. *Adaptability to Location Variations:* Accounting for environmental variations in different locations, such as varying external temperatures and humidity levels, to maintain efficient and effective cooling.
6. *Cost-Effective Automation:* Striking a balance between implementing advanced automation features and cost-effectiveness, considering the initial investment and long-term operational costs.
7. *Integration with Building Management Systems (BMS):* Ensuring seamless integration with broader building management systems to synchronize the air conditioning system with other building functions for optimal efficiency.

## PROJECT OVERVIEW

Aim- Enhancing Comfort and Efficiency in Different Cabins at Various Locations. The aim of exploring automation in air conditioning systems with Passive Infrared (PIR) sensors is to develop and implement intelligent climate control solutions that leverage human presence detection. This approach seeks to optimize energy efficiency and enhance occupant comfort by dynamically adjusting heating, cooling, and airflow based on real-time occupancy patterns [16]. The goal is to reduce energy consumption, lower operational costs, and create environments that are both environmentally sustainable and fulfill to the needs of occupants in various settings, spanning residential, commercial, industrial, and institutional spaces (Figure 1).

## WORKING PRINCIPLE

1. *Thermostat Sensing:* The system's thermostat senses the temperature in each cabin individually.
2. *Temperature control:* The thermostat adjusts the air conditioner to maintain the user's desired temperature by sending electricity to the system depending on the high temperature.
3. *Working of the Compressor:* The compressor is an important component responsible for generating energy and distributing the refrigerant throughout the system.
4. *Evaporation and condensation:* The refrigerator goes through cycles of evaporation and condensation by absorbing heat from inside the house (evaporation) and releasing it to the outside (condensation) [17].
5. *Air Circulation:* The system's blower fan circulates the conditioned air through the ducts and vents, distributing it evenly in each cabin.
6. *Multiple Cabins Control:* Automation features enable independent control of each cabin's temperature, allowing for personalized comfort settings in different locations.
7. *Energy efficiency measures:* Today's systems often include energy-saving technologies such as variable speed compressors and smart sensors to increase efficiency and reduce electrical energy consumption.

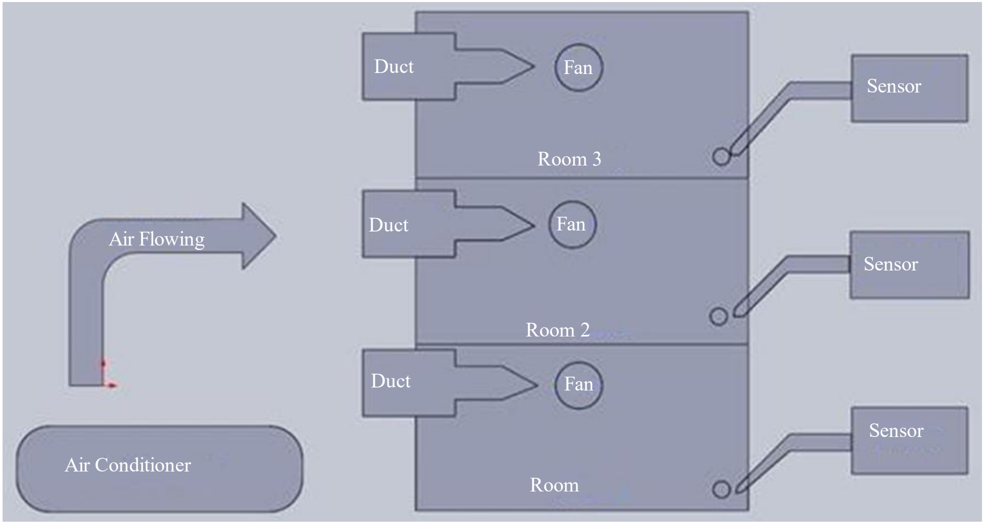

**Figure 1.** Flow diagram of Air Conditioner Sensor

8. *Remote monitoring and control:* Automation can include remote monitoring and control features that allow smart users to control air conditioners from multiple locations.

## METHODOLOGY

We are doing Automation in 1.5 TR Air Conditioning Systems uses in different cabins at different locations. As we know split air conditioner of 1 TR is capable to cool 1 room of size 10x10 and normal ac goes down up to 16 °C but the human comfort temperature is 22°C to 27°C. The AC will automatically switch on and off after detecting human presence using PIR Sensors (Figures 2 and 3).

## DESIGN & ANALYSIS

### Physical needs Analysis

Determine the specific needs of each building, taking into account factors such as size, occupancy and use. Consider environmental conditions at different locations to optimize system performance.

### Sensor Integration

Implement temperature, humidity, and occupancy sensors in each cabin to gather real time data. Integrate sensors with the air conditioning system to enable automatic adjustments based on the environment.

### Centralized Control System

Design a centralized control system to manage all air conditioning units across different locations. Implement a user-friendly interface for monitoring and controlling the system.

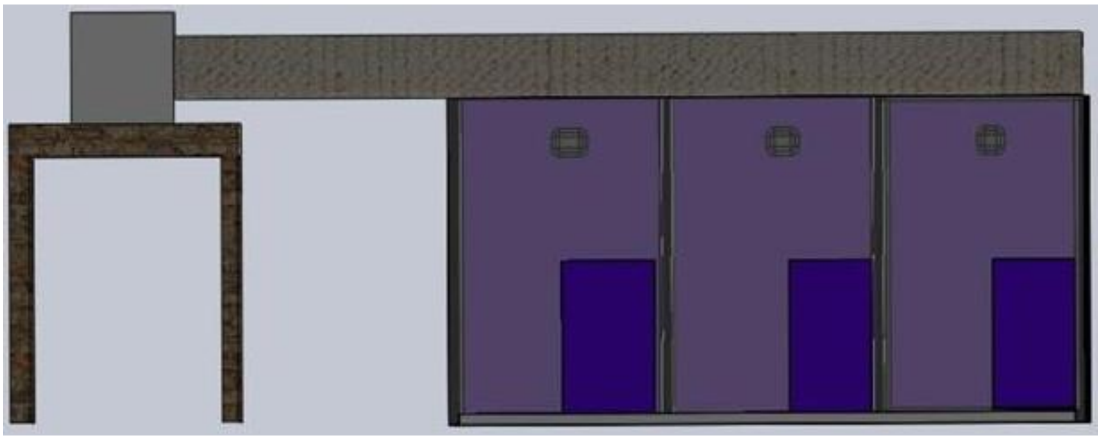

**Figure 2.** Front view of PIR sensor.

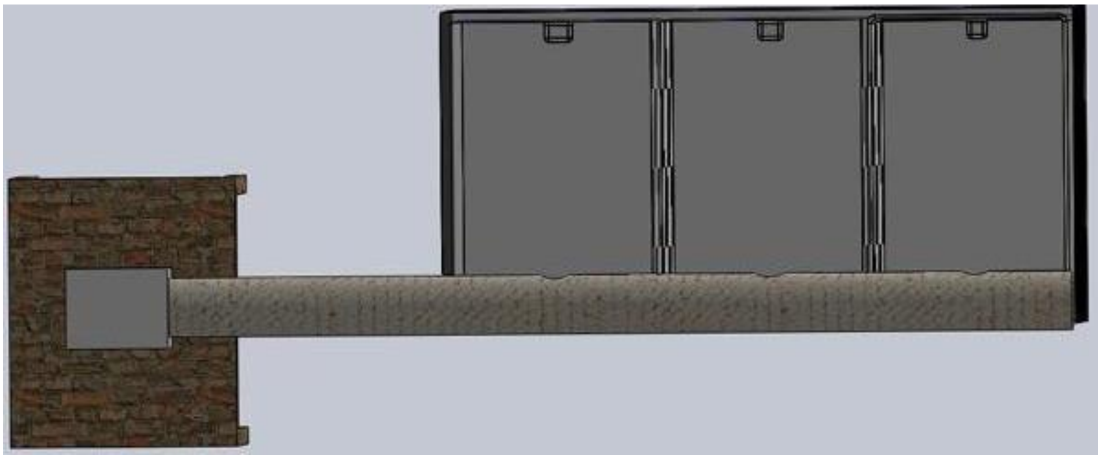

**Figure 3.** Top view of PIR sensor.

### Communication Protocol

Establish a reliable communication protocol (e.g., Wi-Fi, Bluetooth, or a combination) to facilitate seamless communication between the central control unit and individual AC units.

### Machine Learning Algorithms

Use machine learning algorithms to analyze historical data and predict the best location for each building. Enable the system to learn and adapt to changing environments and user preferences.

### Energy Efficiency Optimization

Develop algorithms to optimize energy consumption, considering factors like time of day, occupancy, and external weather conditions. Incorporate features such as sleep mode and temperature setback to conserve energy during periods of lower demand.

### Remote Monitoring and Control

Enable remote monitoring and control through a secure online platform, allowing users to adjust settings and receive real-time updates on system performance.

### Fault Detection and Diagnostics

Implement a diagnostic system to detect and alert users of any faults or malfunctions in the air conditioning units. Provide detailed reports for maintenance personnel to expedite troubleshooting.

## RESULT & CALCULATION

The cabins are located in the basement and they are not in direct contact sun the area of 1 cabin is 4.31m2. The total no. of cabins is 4, each cabin contains one person, one computer system, and one L.E.D bulb of 9 watts.

### Heat Released by 9-watt bulb

E=V*I*T

Where V = Voltage, E = Energy Transformed I = Current, T = Time
V*I = 9 so,
E = 9*60 = 540 J/s
= 32.4 KJ/min {1 J/s = 0.06 KJ/min}
So, for 4 cabins 32.4*4 = 129.6 KJ/min or 7776 KJ/sec (Table 1).

**Table 1.** Heat Released of computer system.

| 2 TR | Q=Qw+Qg+Qr | Total heat released by equipment and persons | Qwood | Qglass | T1 | T2 |
|---|---|---|---|---|---|---|
| 25200 KJ/sec. | 15446.79 KJ/sec | 7808.04 KJ/sec. | 6300 KJ/sec. | 1338.75 KJ/sec. | 40°C | 25°C |
| 25200 KJ/sec. | 12900.44 KJ/sec | 7808.04 KJ/sec. | 4200 KJ/sec. | 892.5 KJ/sec. | 35°C | 25°C |
| 25200 KJ/sec. | 10354.06 KJ/sec | 7808.04 KJ/sec. | 2100 KJ/sec. | 446.25 KJ/sec. | 30°C | 25°C |
| 25200 KJ/sec. | 7808.04 KJ/sec | 7808.04 KJ/sec. | 0 KJ/sec. | 0 KJ/sec | 25°C | 25°C |
| 25200 KJ/sec. | 5261.75 KJ/sec | 7808.04 KJ/sec. | -2100 KJ/sec. | -446.25 KJ/sec. | 20°C | 25°C |
| 25200 KJ/sec. | 2715.54 KJ/sec | 7808.04 KJ/sec. | -4200KJ/ sec. | -892.5 KJ/sec. | 15°C | 25°C |
| 25200 KJ/sec. | 169.23 KJ/sec | 7808.04 KJ/sec. | -6300 KJ/sec. | -1338.7 KJ/sec. | 10°C | 25°C |

**Heat Released by One person is 100 watts per day.**

So, 100/24*60 = 0.069 KJ/min.

For 4 person is 4*0.069 = 0.276 KJ/min or 16.02 KJ/sec.

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**Area of one cabin is 4.31m2, half cabin is made of wood and half is of glass.**

$Q = KA\,(T1-T2)/x$

Where K =Thermal Conductivity, T = Temperature X = wall thinness, A = area

## CONCLUSION

In conclusion, automation in 1.5TR Air Conditioning Systems for different cabins at various locations offers substantial advantages such as enhanced energy efficiency, customization, remote monitoring, and data analytics. However, these benefits come with challenges including initial costs, increased system complexity, dependency on technology, and limited adaptability in older structures. It is important to balance the pros and cons to ensure that the benefits of automation contribute to comfort, energy savings and overall performance.

## REFRENCES

1. Chia Chao Kang, Jian Ding Tan, Mohammadmahdi Ariannejad Smart sensor controller for HVAC system. 2023 The Author(s). Published by Elsevier Ltd
2. Liang Zhang, Matt Leach, Yeonjin Bae Sensor impact evaluation and verification for fault detection and diagnostics in building energy systems. 2021 The Author(s). Published by Elsevier Ltd.
3. Mohsen Sooria, Behrooz Arezoob, Roza Dastres Internet of things for smart factories in industry. 2023 The Authors. Published by Elsevier B.V. on behalf of KeAi Communications Co., Ltd.
4. Daniela Onofrejova, Peter Onofrejb, Dusan Simsik Model of Production Environment Controlled With Intelligent Systems. 2014 The Authors. Published by Elsevier Ltd.
5. S.Dhanalakshmi, M.Poongothai, Kaner Sharma IoT Based Indoor Air Quality and Smart Energy Management for HVAC System. 2020 The Authors. Published by Elsevier Ltd.
6. Oluleke Bamodu, Liang Xia, Llewellyn Tang An indoor environment monitoring system using low-cost sensor network. 2017 The Authors. Published by Elsevier Ltd.
7. Mohd Javaid, Abid Haleem, Ravi Pratap Singh, Shanay Rab, Rajiv Suman Significance of sensors for industry 4.0: Roles, capabilities, and applications. 2021 The Authors. Publishing services by Elsevier B.V. on behalf of KeAi Communications Co. Ltd.
8. Mohd Javaid, Abid Haleem, Ravi Pratap Singh, Shanay Rab, Rajiv Suman Sensors for daily life: A review. 2021 The Authors. Publishing services by Elsevier B.V. on behalf of KeAi Communications Co. Ltd
9. Rongpeng Zhang, Jian Zhang, Meng Kong, Bing Dong Development of a testing and evaluation protocol for occupancy sensing technologies in building HVAC controls: A case study of representative people counting sensors 2021 The Authors. Published by Elsevier Ltd.
10. Guannan Li, Qing Yao, Yunpeng Hu, Xi Fang, Luhan Wang Investigating thermostat sensor offset impacts on operating performance and thermal comfort of three different HVAC systems in Wuhan, China. 2022 The Authors. Published by Elsevier Ltd.
11. Yeonjin Bae, Saptarshi Bhattacharya, Borui Cui Sensor impacts on building and HVAC controls: A critical review for building energy performance. 2021 The Authors. Published by Elsevier Ltd.
12. C. Aghemo, J. Virgone, G.V. Fracastoro Management and monitoring of public buildings through ICT based systems: Control rules for energy saving with lighting and HVAC services. 2013 Higher Education Press Limited Company. Production and hosting by Elsevier B.V.

13. H. Edtmayer, C. Hochenauer, D. Brandl, T. Mach, E. Schlager Modelling virtual sensors for real-time indoor comfort control. 2023 The Author(s). Published by Elsevier Ltd.
14. José Joaquín Aguilera, Dragos-Ioan Bogatu, Ongun Berk Kazanci Comfort-based control for mixed-mode buildings. 2021 The Author(s). Published by Elsevier B.V.
15. Oluleke Bamodu, Felix Osebor, Liang Xia Indoor environment monitoring based on humidity conditions using a low-cost sensor network. 2018 The Author(s). Published by Elsevier Ltd.
16. C. Papatsimpa, J.P.M.G. Linnartz Propagating sensor uncertainty to better infer office occupancy in smart building control.