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Building Management System Integration with HVAC

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Abstract:

Reduced energy use is currently the quickest option to minimise the usage of fossil fuels and, thus, greenhouse gas emissions. HVAC (Heating, Ventilation, and Air Conditioning) systems are utilised to keep an indoor environment comfortable for its occupants. Combining these two elements, energy economy and comfort, presents a significant problem for building operations. This study provides a design method to controlling an HVAC, with the goal of reducing energy consumption in the functioning of a building's HVAC system. The system was created with a Raspberry Pi acting as a coordinator node and wireless connections to sensor nodes for environmental variables and electrical measurement nodes. The coordinator node sends the data it receives to the cloud for storage and further processing. Using an X Bee-based solid state relay, the control system handles the HVAC equipment's set point as well as the turning on and off of the HVAC compressor. The HVAC temperature management system is based on a computation of the Predicted Mean Vote (PMV) index, which is used by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) to determine the appropriate set point to meet the thermal comfort of 80% of users. To identify comfort zones, this method integrates humidity and temperature values. The compressor control decisions are made by the coordinator node based on the PMV index value. as running with the same setpoint of 26.5 degrees Celsius, the proposed PMV-based temperature management system for HVAC equipment provides energy savings ranging from 33% to 44% as compared to the built-in control of the HVAC equipment.

***Keywords* — BMS, Energy Saving, HVAC, Control System.**

INTRODUCTION:

Building Management Systems (BMS) control and monitor a building's large energy-consuming systems, such as HVAC, lighting, fire, and security systems. A BMS's goal is to maintain occupant comfort and safety while offering energy efficiency and lower operational expenses. A BMS's proper operation is critical for good building performance and provides the most cost-effective way to achieve energy reductions in ordinary structures.

HVAC systems are made up of a variety of components such as boilers for heating, chillers for cooling, air handling systems for air conditioning, and a variety of ancillary components such as pumps and fans. The BMS regulates the operation of the various HVAC parts using data from sensors that measure essential factors such as temperature, relative humidity, carbon dioxide levels (as a measure of indoor air quality), system pressure, and occupancy. [1]

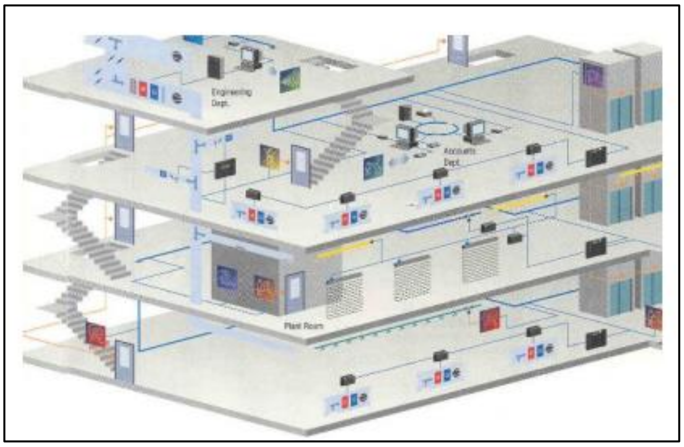

Figure 1: Building Management System

A Building Management System (BMS) is a sophisticated control system that is used to manage and monitor numerous building systems such as HVAC, lighting, security, fire, and other systems. A BMS's primary goal is to optimise the functioning of these systems, minimise energy consumption, and increase building occupant comfort and safety. The BMS is typically made up of a building automation controller (BAC) and a range of data-collection sensors. This information is used by the BAC to make decisions about the functioning of the HVAC systems, lighting, security, and other building systems. [2]

Achieving and maintaining a strong NABERS Energy rating in high performance buildings is now essential to keeping a building's rental income and asset value. If the performance of a building deteriorates, a BMS is a crucial diagnostic tool. The BMS also aids with a variety of other HVAC functions:

- providing useful data for scheduling maintenance contractor visits;
- providing data for on-charging occupants for after-hours use and energy consumption where the tenancy power supplies are provided by the landlord;
- ensuring NABERS Energy targets are met; and
- providing diagnostic capabilities to proactively improve any non-performance.

BMS Basics:

Most buildings have a number of direct digital control (DDC) systems located with the separate HVAC equipment or in plant rooms as part of the BMS. These controllers are connected via a local area network to a head end (or supervisor) station, which normally provides a user interface for monitoring and changing control parameters. BMS employ communication protocols, which are regulations used by electronic components or microprocessors when communicating with one another1. There are various sorts of communication protocols, and it is critical to establish an open standard protocol as opposed to a proprietary or closed protocol 2.

The specification of 'open standard protocols' for BMS provides interoperability across various building services systems, with operational, energy, and water efficiency benefits. Open standard protocols also make it easier to integrate components and systems such as HVAC, lighting controls, security/access, and lifts, while also allowing for future planning. [3]

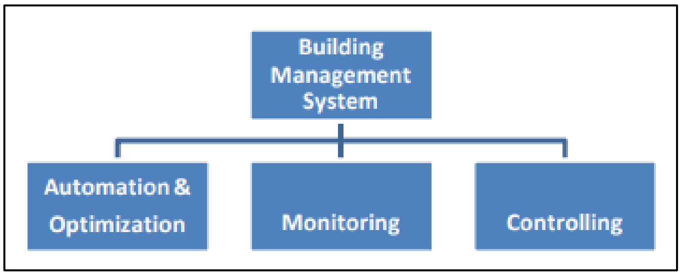

Figure 2: Functions of basic Building Management System

Building Management System is based on controlling temperature, humidity, and carbon dioxide inside the building. The basic functions of BMS can be seen in figure 2. The priority is given to maintaining a specific temperature in a building by controlling heating and cooling, which is done by fan, ventilation, and damper operations. Aside from that, the reduction of carbon dioxide followed by a rise in oxygen has been preserved as an important element.[4]

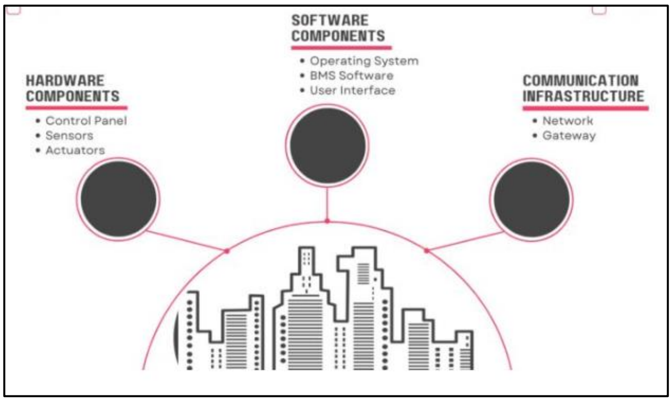

Figure 3: Components of BMS

Developing Specifications for a BMS:

The replacement of a BMS is an excellent opportunity to explore features for HVAC and other system optimisation, such as energy monitoring capabilities and interfaces (such as intuitive visuals, exception reporting, and trending capabilities). BMS standards should include the following to ensure optimal functionality:

a detailed functional description that includes an accurate points list for all things

- monitoring, reporting, and exception reporting.
- commissioning and fine-tuning for at least 12 months.
- end-user training on how to use and optimise the system.

Functional Description:

A functional description describes the control sequences and optimisation algorithms that the BMS specialist will programme. A points list in table form details these requirements as inputs and outputs to the BMS from various sensors, actuators, and equipment. When creating a functional description, it is critical to address the needs of all prospective BMS users, including the HVAC Maintenance Contractor, who is in a unique position to deliver dependability and energy savings. Before beginning engineering on the BMS and programming during the early stages of a project, it is critical that the BMS contractor meet with all stakeholders to identify the functional description.

A Facility Manager's duties include monitoring, reporting, and exception reporting. Any functionality that identifies and highlights problems with HVAC performance as they arise is advantageous to Facility Managers who do not have the time to conduct extensive monitoring or negotiate laborious control routines and diagnostic procedures. Data storage for purposes such as NABERS assessments is also crucial, which means data backup must be considered.[5]

Operation and Maintenance of BMS:

End users of BMS, such as Facilities Managers and Maintenance Contractors, must be familiar with the BMS's capabilities and operational parameters. If necessary, a BMS professional should be hired to update information in operating and maintenance manuals. A BMS professional will also be required for control algorithm optimisation, re-programming, setting up reporting functionalities (such as for NABERS), and setting up monitoring and diagnostic panels.

It is important that diagnostic screens are set up for the verification of key HVAC system functions including:

- improved economic cycle operation
- correct operation of variable air volume terminals (with the goal of eliminating wasteful re-heating);
- modulation of fans and pumps via variable speed drives;
- chiller and boiler operation, including the re-setting of flow temperatures and the detection of leaking control valves, such as in re-heater batteries.

Occupancy times and control settings for space temperature and relative humidity (RH) must be selected to avoid over conditioning. Some considerations in setting the BMS include:

- public holidays should be programmed to eliminate wasteful operation;
- after-hours operation should be limited to those areas requiring operation;
- temperatures for winter operation should be set at 20-21°C, and 24-25°C for summer operation;
- RH can vary from 35-60%, with no significant impact on occupant comfort; and
- transient areas where occupants spend relatively short periods of time can typically tolerate wide temperature deviations of 10°C.

OBJECTIVES:

- To study of Functions of basic Building Management System.
- Analysing the Operation and Maintenance of Building management system.
- To study of how to manage and monitor various building systems.

RESEARCH METHODOLOGY:

On a broad scale, raw market data is acquired and compiled. Data is constantly screened to ensure that only validated and authenticated sources are taken into account. In order to give the most accurate estimations and forecasts feasible, research adopts extensive and iterative research methods focused on minimising deviation. For segmenting and estimating quantitative components of the market, the company employs a combination of bottom-up and top-down methodologies.

REVIEW OF LITERATURE:

There have been few research on the thermal-comfort needs of people with physical impairments. These individuals may have altered thermal requirements as a result of their handicap, as well as postural and movement problems, and possibly pharmaceutical therapies (Parsons, 2002). [6]

The most difficult task that communities confront globally is controlling and monitoring the functioning of built environment facilities in a sustainable manner. This is especially true in a developing country like Nigeria, where sustainability is not prioritised. From this viewpoint, effective usage of BMS in the built environment is representing a key strategy in regard to economic, environmental and social perspectives (Kumara and Waidyasekara, 2013). Higher energy efficiency, lower operating and maintenance costs, higher indoor quality, greater occupant comfort and productivity are the major achievements of a good BMS. As a result, individuals/organizations/government must be eager to pay significantly in order to install, commission, operate, and maintain BMS. According to Forsberg and Malmberg (2004), the built environment plays an important role in today's society since it is the consequence of a number of social and economic processes that are essential to sustainable development. As the earth's physical environment deteriorates, the goal of sustainability has become a mainstream of architectural design aims in recent years. [7]

After researching some significant instances of intelligent buildings in the United States and Canada, Frost and Sullivan (2009) revealed an average predicted payback time of three and a half years or less for intelligent building technology. Hartman (2005) has assessed the potential benefits of modern technologies by comparing the electric energy usage of a cooling system for an office building in the southwest United States when an optimised traditional system is switched to a network-based system at the same initial cost. When the conventionally optimised cooling system was modified, the electric energy budget for cooling was decreased in half. [8][9]

RESULT AND DISCUSSION:

Energy consumption statistics break down the total building energy use into the energy used by cooling equipment, cooling tower fans, chilled water systems, cooling water systems and water pumps. In table 1, an hourly BIN method is used to calculate buildings' energy consumption. The number of hours between 8:00 and 20:00 is accounted for in the temperature range of 20-37°C, according to the values of the outdoor dry bulb temperature in Xian. To make calculations simpler, the programme has assumed that the load on the air conditioner is proportional to the difference between the temperature inside and outside. Then, based on sample data, total energy consumption is added up by air conditioning load and equipment energy consumption.

Cooling load rate (%)	>80	$60<\varphi\leq 80$	$40<\varphi\leq 60$	$20<\varphi\leq 40$	≤ 20
Temperature (℃)	$t>32$	$29<t\leq 32$	$26<t\leq 29$	$23<t\leq 26$	$t\leq 23$
Running time (h)	116	168	193	218	293
Number of working machines	4	4	3	2	1
Power of cooling water pump (kW)	120	120	90	60	30
Power of cooling tower (kW)	30	30	22.5	15	7.5
Energy consumption in summer (kWh)	60,796	62,302	48,143	28,015	10,955

Table 1: Energy consumption under different loads in summer

According to table 1, the load ratio is typically less than 20% on most days, then it is between 20% and 40%, but these two categories use the least energy. [10]

Figure 4 depicts a 50% decrease in electrical demand between 2002 and 2003 following retrofits. The creation of a digital building management system was the key to this success. The system has a dedicated Internet site that continuously tracks CO2, humidity, and temperature. The BMS uses this air quality observation to control how much stale air is exhausted from the building's HVAC system and how much fresh air is introduced.

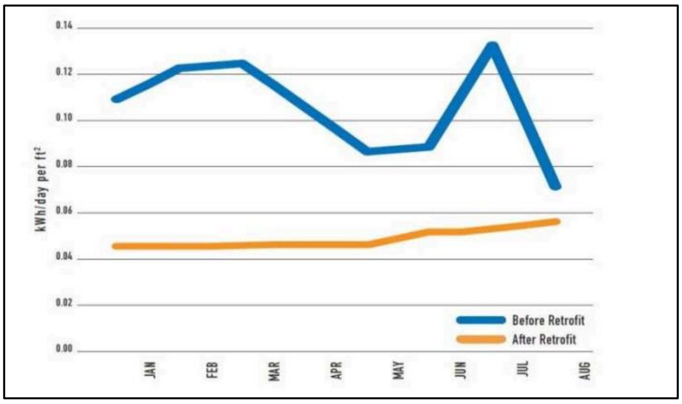

Figure 4: Electrical demand in building

The HVAC and lighting systems are timed to start up and shut off by BMS, which lowers energy consumption. Each floor is sub-metered, and each group using a floor is responsible for their portion of the energy costs for HVAC and lighting. For instance, lighting is set to turn off at 18:00; employees who work later must call in with a password to override the system. The additional lighting load is then billed to their group. Additionally, new, high-efficiency light fixtures with motion sensors were retrofitted into the lighting system. Together, these modifications decreased the building's annual energy consumption by 2,700 Btu and 1,072,000 kWh [11].

CONCLUSION:

An essential tool for managing and optimising HVAC systems in commercial buildings is a building management system (BMS). A BMS can improve comfort and safety, lower energy costs, and operational efficiency. To ensure that their HVAC systems run as efficiently as possible and give building occupants a comfortable and secure indoor environment, building managers must invest in a BMS. The Q-NEX technology can be integrated into a campus-specific building management system to create a comprehensive campus management solution.

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