First Review Document

Proposing Energy-Efficient Urban Spaces

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Abstract

Smart Cities are becoming a focus of governments all over the world. They are supposed to be a delicate balance of economics, technology and public planning. However, free spaces to build new cities is a big problem for most sovereign states, smart cities projects are replacing classical infrastructure in existent urban areas. Countries all over the world have also pledged to become carbon neutral or carbon negative before the end of the first half of the 21st century. And governments are increasingly trying to fit both a smart city and green energy resources like the sun and the wind in one single pipeline.

Most urban spaces, however, are haphazard in planning of residential vs financial spaces. There is also no fixed energy consumption pattern in most population groups. Finally, installing renewable energy production tools might seem not only costly but also unfavorable since energy consumption is not uniform throughout the year for most population groups. This means that policy making needs to keep in mind the more individual requirements of the geography and the people of the place. So, implementation of a smart city model becomes very difficult.

In this project, we aim to introduce a simple algorithm that can be used to build a greener smart city using the study of energy consumption patterns of its people, possible smart devices that can regulate this consumption and economics involved in the same; and to simulate the same on the model of a simple office.

Keywords: IoT, smart city, energy consumption, simulation, finances, policy making, machine learning, algorithm, urban spaces

Introduction

The 17 UNDP goals proposed in 2015 enlist the strong need for humanity to move towards safer, equitable and sustainable living standards. One of the greatest challenges in the same is the pattern of energy consumption and supply that involves a massive amount of emission of greenhouse gasses and heat despite numerous conventions over the last five decades.

Urban regions alone account for 60-80 percent of the total greenhouse gas emissions on the planet and are responsible for the consumption of 80 percent of the global energy. This involves heating, ventilation, air conditioning, lighting, and other major appliances. And as per independent research conducted by the IBM, seven-tenths of world population shall live in cities by 2050 while 50% of global energy shall be consumed by the buildings in the cities alone.

City officials and governments across the globe have struggled so far to effectively analyze, visualize, and translate data from thousands of buildings into policy and program recommendations – partly due to the issue in logistics, partially due to economic and political constraints. Computers, however, provide not only with tools that can be used to benchmark consumption and supply but also to develop models that can compare and demonstrate impacts of energy-efficiency based improvements on the same.

Objectives

This project aims to study patterns of energy consumption and related costs and to further suggest IoT-based solutions to improvise upon the same by -

1. Visualizing energy consumption of buildings in an urban setup.
2. Developing a computer-aided benchmark and baseline for energy efficiency of buildings in cities.

Problem statement

1. Using models of machine learning and statistics to visualize energy consumption of buildings in an urban setup.
2. Developing a computer-aided benchmark and baseline for energy efficiency of buildings in cities.
3. Aiding in the implementation of the following UNDP goals:
   - Goal 7: Affordable and Clean Energy;
   - Goal 8: Decent Economic Growth;
   - Goal 11: Sustainable Cities and Communities;
   - Goal 12: Responsible Consumption and Production; and
   - Goal 13: Climate Action

Literature Review

S. No.	Title	Authors	Year	Advantages	Disadvantages	Scope for future work
1	Machine Learning-Based Approach to Predict Energy Consumption of Renewable and Nonrenewable Power Sources	Prince Waqas Khan *et al.*	2020	Compared many load forecasting methods using ML. Another advantage is the models used are compared to hybrid models Moreover, simple ML models are used such as Mean absolute error, mean squared error, mean absolute percent error, etc.	The logarithmic error is high. Very simple mathematical models are used making the readings absolute. The idea is based on statistics with no further futuristic use.	The models can be made logarithmic rather than regressive. The data is considered for only a single space, and could be made better for better regression. Could be used hybrid models as well.
2	Energy consumption prediction by using machine learning for smart building: Case study in Malaysia	Mel Keytingan M. Shapi *et al.*	2021	The data collected is for a shopping district that is a very large sample. Skewness and kurtosis values are accrued for the model making it future proof. Accuracy is very high ranging between 90-92%	The models k-NN, SVM, ANN were used in accordance with which are not compatible with each other, and were used as comparators rather than providing solutions. The data testing was normal, which reduces the accuracy of kurtosis. Model development environment is time consuming.	The project takes too much time to emulate SVM hence a faster system could make the data more sublime and ecstatic. Rather than using three different models, using hybrid versions will be better.
3	Machine learning for estimation of building energy consumption and performance: a review	Saleh Seyedzadeh *et al.*	2018	Was based on electric and solar energy. Showed the comparisons using various sensors and iot devices with energy conservation over a long time.	Here they have also used the SVM model hence increasing the computation time. GP modeling making the cost inefficient	Simpler models used due to computation limits , could be improved with better systems. Need an hybrid model for better accuracy as the number of variables increase with IoT devices and sensors.
4	Accuracy analyses and model comparison of machine learning	Zhijian Liu *et al.*	2019	Here ANN and SVM are used and also made use of their hybrid, making improvements in previous papers Since the sample of the data is very large making	Since computation of SVM is already hard, making hybridization harder. Though the accuracy for the hybrid is high, the computation time is very slow.	The model can be introduced to fewer constraints,which could make the computation faster. Model structure although simple has many flaws, could be introduced to better structural models.

	adopted in building energy consumption prediction			data more reliable as well.		
5	Improving energy consumption of commercial building with IoT and machine learning	Javed *et al.*	2018	Neural networks were embedded with IoT subsystems. It predicted 68% reduced cost effectiveness over a period of 10 years.	IoT sub-systems used were expensive and expansive , leading to inflated results. On a minor scale the project was based on a complex leading to miss aligned perpetuations in the result as well.	Simpler IoT devices could be used, as they are cost effective, and easier to install and maintain. The models used for future prediction are simpler using random neural networks. Since smaller sensors could also be used, solar energy could also be incorporated to make profits soar even higher.
6	A Novel Method for Analyzing Weather Effect on Smart City Traffic	Aram Nasser and Vilmos Simon	2021	Made use of many real life variables such as wind, sunlight and rain; This gave us the idea to implement a real life visualization model for the project.	The models used advanced statistical models for rain variables and others.	The model could be simpler. Sensors used could be better.
7	A Systematic Survey on the use of Fuzzy Graph Structures in India's Smart City Development	B. Angel and D. Angel	2021	FGS model was used making the system future proof. Graphs make connectivity easier and vivid.	More inclined towards urban spaces only. Require precise network hence not cost effective.	Can be made more inclined to energy savings rather than quality of life. Needs to be more cost effective.
8	Exploring The Relationship Between Smart City, Sustainable Development And Innovation As A Model	Procopie Florin Guşul and Alina Ramona Butnariu	2021	Easy explanation of interdependence of economy and innovation. Gave better scope for our own project.	Was completely theoretical, had less mathematical models involved.	Could introduce better results. Data samples were scarce, and needed more data for future integrations.

	For Urban Economic Growth					
9	Smart cities and the European Vision	Carmen Florina Fagadar *et al.*	2021	Compared many semi-urban and urban spaces of many scoops of notions including both developing and developed. Good sample space, making comparisons easy to frame and understand.	Solutions in the problems were more inclined towards colder regions; Lacked diversification in results. Was majorly theoretical; Lacked mathematical and statistical models.	Integrating ML will take the study to greater heights. Need more solutions to semi-urban and suburban regions. Lacking a practical approach hence could introduce theoretical variables for better future results.
10	Optimizing Task Allocation for Edge Micro-Clusters in Smart Cities	Yousef Al Hailey et al.	2021	The resource management for clusters is reduced to a mixed integer problem. Greedy algorithm is employed to create the most energy-efficient cluster head selection protocol. The makespan is minimized.	The scope of the project is too large to be evaluated using a quasi-realistic setup on breadboards. As a consequence, the model proposed is not generic.	Scaling up the model to be functional in IoT environments other than just Raspberry Pi would help generalize the model and implement it in more varied and realistic situations.
11	The Network Architecture Designed for an Adaptable IoT-based Smart Office Solution	Karol Furdik et al.	2013	A balanced approach towards the human needs of an IoT-enabled office space are taken into consideration. The audit of data is possible and the result is a cost-effective solution.	The major drawback is the lack of specialization of IoT services. Different IoT services are required in different rooms and spaces. This project only explores a limited set of users and rooms.	Creating solutions more compatible with individual requirements.
12	Understanding Smart Cities: An Integrative Framework	Hafedh Chourabi,Taewoo Nam,Shawn Walker,J. Ramon Gil-Garcia,Sehl Mellouli ,Karine Nahon,T	2012	One of the very few papers which takes into consideration various countries at once Various challenges to the creation of a smart city such as technical,managerial,organizational etc. have been identified Rich literature has been considered Clear and concise	More visual and diagrammatic representations are required so as to address rather complex topics Lack of examples of real-world smart cities,rather countries and their current scenarios are considered	Case study of current smart cities can also be discussed More diagrams and flowcharts can be added so as to make the information more appealing to the readers

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13	Conceptualiz ing Smart City with Dimensions of Technology, People, and Institutions	Taewoo Nam & Theresa A. Pardo	2011	More focus on the fundamental building blocks of smart cities Real-world smart cities have been discussed	Different types of smart cities have been mentioned such as ubiquitous cities,hybrid cities,wired cities etc.,but no brief description is given The paper lacks in depth analysis of smart cities,it offers a more broader analysis of the same	Brief discussion about the different types of smart cities In-depth analysis of the various intricacies involved in the creation of a smart city	

14	Exploring The Relationship Between Smart City, Sustainable Development And Innovation As A Model For Urban Economic Growth	Procopie Florin Gușul, Alina Ramona Butnariu	2021	Recent work makes the study more likely to chosen as a part of literature Focuses on the environmental impact of smart cities	Lack of information regarding the environmental impact of smart cities The literature hasn't been utilized properly	Proper analysis of scholarly articles can give new insights Brief discussion about the environmental impact of smart cities	

15	The Network Architecture Designed for an Adaptable IoT-based Smart Office Solution	Karol Furdik et al.	2013	A balanced approach towards the human needs of an IoT-enabled office space are taken into consideration. The audit of data is possible and the result is a cost-effective solution.	The major drawback is the lack of specialization of IoT services. Different IoT services are required in different rooms and spaces. This project only explores a limited set of users and rooms.	Creating solutions more compatible with individual requirements.	

16	Using Social Network Data To Improve Planning And Design Of Smart Cities	Raquel Pérez-del hoyo , Higinio Mora & José Francisco Paredes	2018	Clear and concise The aspect studied is generally liked by readers	Lack of literature survey; Insufficient data visualizations;	Proper literature survey can be done Addition of more visualizations will give a more detailed study touch to the work
17	From Smart Cities to Human Smart Cities	Álvaro Oliveira, Margarida Campolargo	2015	Eye catching topic has been studied Not much relevant literature exists,as a result,addition of this work will greatly benefit future readers	Although challenges have been identified in this paper,the solutions to handle the same aren't present in sufficient amount; Since the My-Neighborhood project was implemented in only 4 cities,as a result,it is difficult to believe that the same conclusions are valid for other cities as well	More focus on the methods to tackle the challenges identified Discussion about the results from different projects can be included

Conclusion

The studies made by our group through the literature survey and through the references presented give us a clear understanding of the factors involved in planning and constructing a smart city, the various considerations to be taken in for its sustainability and the human needs of the same. We also understand that energy consumption and provision can be visualized and regulated, at least theoretically at present. Moreover, the energy sector is also a booming sector, on an economic basis, as after Tesla's introduction of EV, green energy is much more in demand. And we shall take into account all of these while working further on the project idea.

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