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Smart Environments

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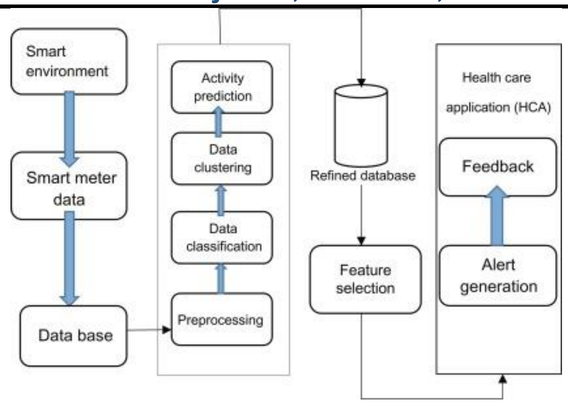
Abstract

Smart Environments contains contributions from leading researchers, describing techniques and issues related to developing and living in intelligent environments. Reflecting the multidisciplinary nature of the design of smart environments, the topics covered include the latest research in smart environment philosophical and computational architecture considerations, network protocols for smart environments, intelligent sensor networks and powerline control of devices, and action prediction and identification. Smart Environments are an extension of pervasive computing. According to Mark Weiser, pervasive computing promotes the idea of a world that is connected to sensors and computers. Poslad differentiates three different kinds of smart environments for systems, services and devices: virtual (or distributed) computing environments, physical environments and human environments, or a hybrid combination of these. *Technologies for Smart Environments* are Wireless Sensor Networks, Power Line Communication Technologies, Wireless Communications and Pervasive Technology, Middleware, Home Networking and Appliances, Algorithms and Protocols, Designing for the Human Experience, Prediction Algorithms, Location Estimation (Determination and Prediction) Techniques, Automated Decision Making. Benefits Automated Decision Making are The Smart Workflow, Preventing and Resolving Errors Automatically, Compliance with Regulations and Contracts, Consistent, Fast, and Error-Free Decisions. Challenges in Automated Decision Making are Involvement of Humans, Controlling Data, Making Multi-step and Long-term Decisions, Supporting Automated Decision-Making Environments, Takeaway. A smart environment uses technologies such as wearable devices, IoT, and mobile internet to dynamically access information, connect people, materials and institutions, and then actively manages and responds to the ecosystem's needs in an intelligent manner. *Privacy, Security, and Trust Issues* are Lessons from an Adaptive Home, Smart Rooms, Smart Offices, Perceptual Environments, Assistive Environments for Individuals with Special Needs, Ongoing Challenges and Future Directions.

Keywords: Smart Environment, Features, Technologies, Applications, Challenges, Future Trends.

Introduction

Smart Environments



Smart Environments [1] contains contributions from leading researchers, describing techniques and issues related to developing and living in intelligent environments. Reflecting the multidisciplinary nature of the design of smart environments, the topics covered include the latest research in smart environment philosophical and computational architecture considerations, network protocols for smart environments, intelligent sensor networks and powerline control of devices, and action prediction and identification. Smart Environments [2] are an extension of pervasive computing. According to Mark Weiser, pervasive computing promotes the idea of a world that is connected to sensors and computers. These sensors and computers are integrated with everyday objects in peoples' lives and are connected through networks. Smart environments have the potential to allow users to engage and interact seamlessly with their immediate surroundings. This has been made possible by the introduction of intelligent technologies, coupled with software-based services. It is evident that technological advances have provided a new era for both sensing technology and computational processing to facilitate the vision of smart environments. Although a number of challenges exist in their deployment, a number of large-scale programs are endeavouring to progress their uptake further.

Definition

A small world where different kinds of smart device are continuously working to make inhabitants' lives more comfortable." Smart environments aim to satisfy the experience of individuals from every environment, by replacing the hazardous work, physical labour, and repetitive tasks with automated agents. Poslad differentiates three different kinds of smart environments for systems, services and devices: virtual (or distributed) computing environments, physical environments and human environments, or a hybrid combination of these:

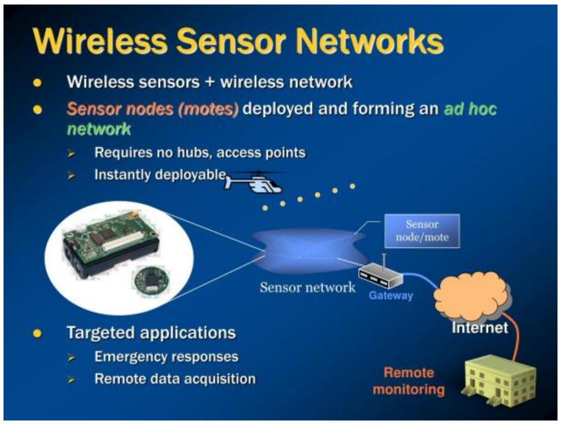
- ***Virtual Computing Environments*** **enable smart devices to access pertinent services anywhere and anytime.**
- ***Physical Environments*** **may be embedded with a variety of smart devices of different types including tags, sensors and controllers and have different form factors ranging from nano- to micro- to macro-sized.**
- ***Human Environments*****: humans, either individually or collectively, inherently form a smart environment for devices. However, humans may themselves be accompanied by smart devices such as mobile phones, use surface-mounted devices (wearable computing) and contain embedded devices (e.g., pacemakers to maintain a healthy heart operation or AR contact lenses).**

Features of Smart Environments

1. ***Remote Control of Devices*****, like Power Line Communication Systems to Control Devices.**
2. ***Device Communication*****, using middleware, and Wireless Communication to form a picture of connected environments.**
3. ***Information Acquisition / Dissemination*** **from Sensor Networks**
4. ***Enhanced Services*** **by Intelligent Devices**
5. ***Predictive and Decision-Making*** **Capabilities**

Technologies for Smart Environments

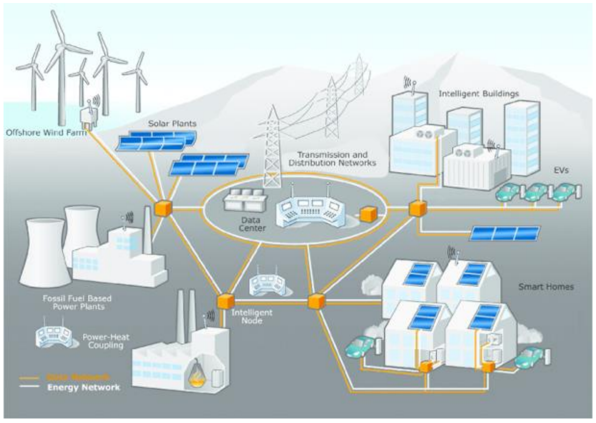
Wireless Sensor Networks



Wireless Sensor Networks (WSNs) [4] allow for innovative and attractive solutions, as well as for pervasive environmental monitoring by providing many important benefits such as real time access to data, coverage of wide areas, long-term monitoring, and system scalability. These networks consist of a large number distributed devices, each including sensing, processing, and wireless communications capabilities, and their uses have greatly improved remote environmental

sensing, the monitoring of several physical systems, and risk assessment and management. Environmental monitoring is fundamental to understand our ecosystem in order to prevent adverse effects on human health and environment. Urban noise affects more than quality of life and can cause long-term physiological damage. In this context, Wireless Acoustic Sensor Networks (WASNs) have become a promising solution to monitor urban noise and recognize acoustic events with a high performance. The study provides a significant example of development of novel system that utilizes WASNs for the recording, transferring, post-processing, and recognition of urban noise in order to create and visualize noise maps of acoustic events, as well as to present additional information and noise statistics. Experimental results demonstrated that the proposed system can measure the urban noise and recognize acoustic events with a high performance in real-life scenarios. The constant checking of plant health and the prompt detection of their pathogens are very important issues in environmental monitoring. Recent advances in technology, instrumentation, and procedures have created new opportunities for the real time monitoring and rapid and accurate identification of environmental disease. The development of a low-cost and wireless wind data acquisition system that allowed for multiple synchronized wind measurement points enabled the data-intensive modelling of the interaction of an arid foredune system with its shrub vegetation. Given the scenario of global change, the monitoring of environmental aspects is very important in coastal areas, as many of them present aeolian sedimentary environments in arid zones that need special protection. Deploying IoT sensors in WSNs is a crucial issue in network design and affects most important performance metrics like increasing coverage, strengthening connectivity, improving robustness, and increasing the lifetime Therefore, a sensor deployment method must be carefully designed to achieve such objective functions without exceeding the available budget. In addition, a dynamic network deployment method based on the hybrid hierarchical network to realize a low-cost, energy-saving, and real-time dynamic sensing system for overhead high-voltage transmission lines. The method enhances the practicability of the network and improves the monitoring efficiency of the smart grid. Another hot topic of WSNs is the connectivity among different nodes and systems; with the advent of the 5G technology, various types of massive wireless IoT services are becoming pervasive. In this scenario, the spectrum will be more and more congested, and frequency resources will thus become scarce. A possible solution could be the spectrum sharing supported by an automated frequency coordination system. A modified version of Kriging interpolation for the recapitulation of a radio environment map on the basis of the Support Vector Machine (SVM) based variogram model was proposed. The nonparametric modelling approach has a crucial role in making a confident decision regarding spectrum sharing and, therefore, in the future development of wider WSNs devoted to environmental monitoring.

Power Line Communication Technologies

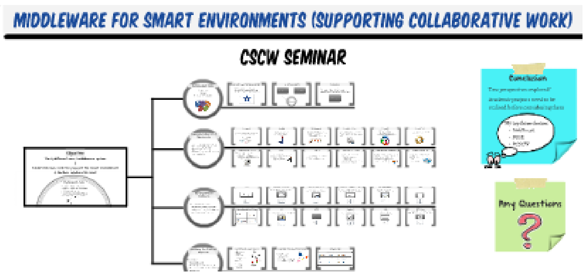


Internet access and in-house networking are becoming as vital as electricity for any establishment, including houses. The broadband Internet market calls for research on new techniques to provide broadband Internet services efficiently and affordably without compromising on the quality of services. Power Line Communication (PLC) [5] is such an emerging technology that uses 'no new wires' and provides networking services using the electrical wiring already deployed extensively throughout the world. This chapter discusses the key attributes of PLC technology and its development to support high data rates, which effectively transforms the power grid into an information highway. In addition, the chapter introduces current research in PLC networking to develop a high-speed PLC networking protocol operating at 70–100 Mbps and aimed at supporting high quality audio and video services in smart environments. This new technology will be well positioned to revolutionize in-home entertainment networking by providing a simple, reliable, and cost-effective solution for smart consumer products such as personal video recorders, media centers, High-Definition (HD) televisions and internet home appliances.

Wireless Communications and Pervasive Technology

A decade of hardware and software progress (PDAs, wearable computers, wireless networks, devices for sensing and remote control) provided the basic elements for progressing from the Mobile to the Ubiquitous Computing age, now also called the Pervasive Computing age [6]. We can envisage a physical world with pervasive, sensor-rich, network-interconnected devices embedded in the environment. The nature of ubiquitous devices makes wireless networks the easiest solution for their interconnection. Hence, wireless and mobile communications are a fundamental building block of smart pervasive computing environments. In this chapter we analyse the status of the art of wireless communications, and discuss the evolution of this field with respect to the requirements of pervasive computing environments.

Middleware

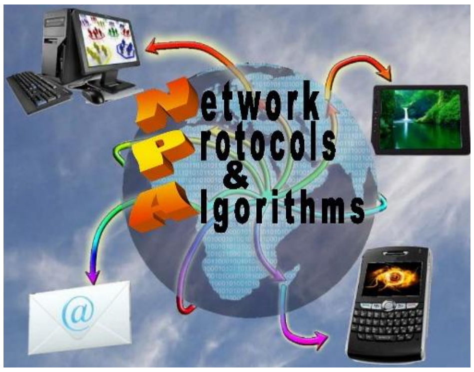


Self-configuring middleware [7] that manages the processes of context information acquisition and representation from smart closed environments, targeting the development of context aware applications. The environment context information is modelled using three sets: context resources, context actors and context policies. The context model artifacts are generated and administrated at run time by a management infrastructure based on intelligent software agents. The self-configuring property is enforced by monitoring the closed environment in order to detect variations or conditions for which the context model artifacts must be updated.

Home Networking and Appliances

Internet of Things is a physical device and objects that collect data, store, and analyse the data. In-home appliances [8] manually operated activities and functions. The IoT uses technical product elements, in-home appliances rapid changes in society. The IoT system design development, control and monitoring in various applications such as health, transport, agriculture, home appliances, etc. We propose a framework model future smart home appliances using IoT which helps the developer to build infrastructure home automation applications accordingly to the user specifications and the requirements. The proposed model is the best solution to use smart home applications with the use of sensors, communication, smart home operations, controlling with the use of mobile apps and Arduino. The system will provide security, smart home automation. In future, it will be extended to develop intelligent smart-based application with an integrated environment and reporting applications.

Algorithms and Protocols for Smart Environments



There are four broad types of converging technologies that are currently used to build smart applications [9]. These include the Internet of Things (IoT), Artificial Intelligence (AI), Cloud Computing and Blockchain. The EU-Korean research and innovation project DECENTER intends to play a pivotal role in the integration of such technologies in a new Fog Computing

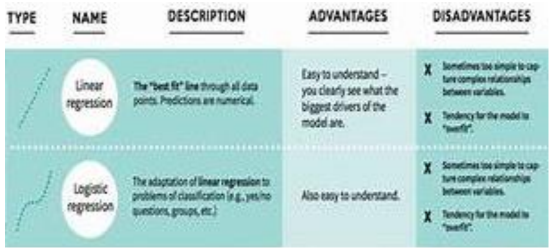
Platform. The DECENTER Fog Computing Platform would help address the resource requirements of smart applications and provide high Quality of Service (QoS) to various AI-based applications. Due to the various uncertainties of the Fog Computing environment, the project aims at also providing Service Level Agreements for the offered services, which include assurances, ranking and verification of Edge-to-Cloud deployment options. Our present work focuses on the use of stochastic methods, particularly, the Markov Decision Process to deliver a QoS model of the smart application in relation to the available Cloud computing resources. This work presents the algorithm, which is used to achieve high QoS of smart applications and its implementation considerations. Our findings support the understanding that dynamic Edge-to-Cloud computing environments require a stochastic approach to establish assurances for high QoS operation of the applications. It is shown that the required assurances can be expressed as a probability value for confidence, which is calculated by the stochastic method.

Numerous municipalities employ the smart city model in large cities to improve the quality of life of their residents, utilize local resources efficiently, and save operating expenses. This model incorporates many heterogeneous technologies such as Cyber-Physical Systems (CPS), Wireless Sensor Networks (WSNs), and Cloud Computing (ClCom). However, effective networking and communication protocols [10] are required to provide the essential harmonization and control of the many system mechanisms to achieve these crucial goals. The networking requirements and characteristics of Smart City Applications (SCAs) are identified in this study, as well as the networking protocols that can be utilized to serve the diverse data traffic flows that are required between the dissimilar mechanisms. Additionally, we show examples of the networking designs of a few smart city systems, such as smart transport, smart building, smart home, smart grid, smart water, pipeline monitoring, and control systems.

Designing for the Human Experience in Smart Environments

Mark Weiser originated the term *ubiquitous computing* (ubicomp), creating a vision of people and smart environments augmented with computational resources that provide information and services when and where desired [11]. What is clear from this articulation of ubicomp is that people and their activities are central to this vision and realizing the vision requires us to address a number of clear goals. First, the everyday practices of people need to be understood and supported. Second, the world needs to be augmented through the provisioning of heterogeneous devices offering different forms of interactive experience. The networked devices must be orchestrated to provide for a holistic user experience.

Prediction Algorithms for Smart Environments

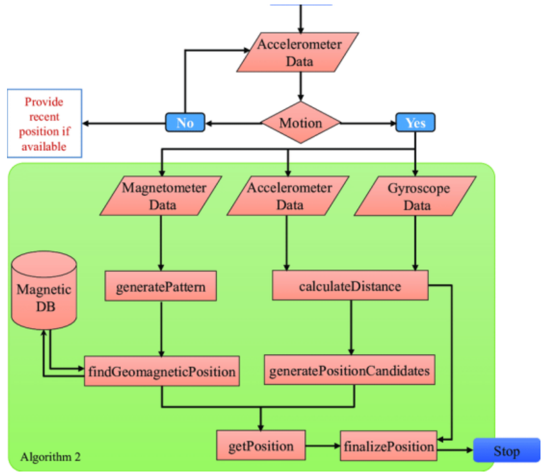


TYPE	NAME	DESCRIPTION	ADVANTAGES	DISADVANTAGES
	Linear regression	The "best fit" line through all data points. Predictions are numerical.	Easy to understand – you clearly see what the biggest drivers of the model are.	X Sometimes too simple to capture complex relationships between variables. X Tendency for the model to "overfit".
	Logistic regression	The adaptation of linear regression to problems of classification (e.g., yes/no questions, groups, etc.)	Also easy to understand.	X Sometimes too simple to capture complex relationships between variables. X Tendency for the model to "overfit".

We live in an increasingly connected and automated society. Smart environments embody this trend by linking computers to everyday tasks and settings. Important features of such environments are that they possess a degree of autonomy, adapt themselves to changing conditions, and communicate with humans in a natural way. In order to meet environment goals such as maximizing comfort, minimizing cost, and adapting to inhabitants, a smart environment must rely upon tools from artificial intelligence such as prediction [12]. First, models of various devices can be learned from observation and used to predict their behaviours in the future. Second, predicting an inhabitant's next action may be needed for the environment to automate selected repetitive tasks for the inhabitant, to detect anomalies that could indicate security or health concerns, and to identify ways of improving control of the environment. The results of a

prediction algorithm may ultimately be input to a decision-making algorithm that selects actions for the house to execute. In this chapter we summarize prediction techniques developed for these purposes, then provide an in-depth look at the role of prediction in the MavHome smart home.

Location Estimation (Determination and Prediction) Techniques in Smart Environments



A smart environment is, by definition, context-aware: by combining inputs from multiple pervasive sensing devices, applications in the smart infrastructure should be able to intelligently deduce the intent or attributes of an individual without explicit manual input. Location [13] is perhaps one of the earliest, and still most common, examples of such context. There are myriad examples of pervasive applications where the system uses the location of a mobile individual, or sometimes groups of individuals, to customize or adapt to the computing environment. A smart environment must be able to both determine and predict the location of an individual. In this chapter, we shall look at the various protocols, algorithms and technologies used for effective location prediction in smart environments. We shall first study the various research prototypes and techniques used to obtain the location information of a mobile user or device in a smart environment. We will then develop a unifying approach toward location prediction and finally concentrate on the problem of location prediction for both the geometric and symbolic group of location reporting technologies.

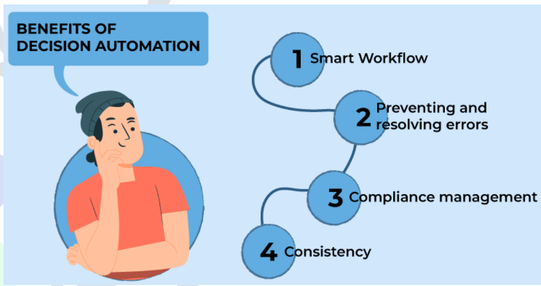
Automated Decision Making in Smart Environments

Using artificial intelligence, data analysis, and business rules, decision automation [14] assists organizations in automating the decision-making process. In addition to increasing productivity, automated decision-making reduces risk and error. Consistency is maintained across all decisions, which is not found when it is left to an individual or group.

An organization's daily operations are usually governed by routine and repetitive decisions. Organizations tend to make operational decisions that support their everyday operations.

Benefits of Automated Decision Making

Automated decision-making can be used for a variety of purposes, but three main organizational problems can be solved by automating decision-making.



The Smart Workflow

As new information comes in from a range of interconnected data points, automated decision-making workflows must continuously adapt. The data points are selected based on their specific properties. Data points are analysed based on changes in their properties to make automated decisions. Workflows become smarter when this happens seamlessly.

Preventing and Resolving Errors Automatically

Using and knowing an automated workflow system, errors can be identified, repaired, or responded to without requiring human intervention. By automating these processes, errors can be spotted and corrected faster, resulting in faster and more robust systems.

Compliance with Regulations And Contracts

Regulatory compliance is also enhanced by automated decision-making. As an example, consider a theatre's audio setup. Decibel levels can be reduced to regulation levels by an automated decision if they reach prohibitive levels. Increasing compliance with business rules and industry regulations can be achieved through automated decision-making.

Consistent, Fast, and Error-Free Decisions

One of the main advantages is the ability to make quick, error-free decisions. The automated process also ensures consistency since it offloads the decision-making process from the human. By doing so, artificial intelligence can self-correct and take remedial measures supervision. Every business decision is automated 24/7, removing any room for inconsistency without constant or error as with business rule decisions are data-driven.

Challenges in Automated Decision Making

Involvement of Humans

In an ideal decision automation process, some human input would be allowed along with a fully automated process. The drawback here is that it introduces a disconnected experience to the automation process. Consequently, there is no end-to-end view of everything needed to make a decision.

Controlling Data

Decision automation applications require organizations to be agile while maintaining data control, retrieval, and storage. For auditing, this is essential. Managers need to constantly develop strategies to handle the influx of data generated by the Internet of Things, which is growing by the day.

Making Multi-step and Long-term Decisions

There are some cases in which one decision may be dependent on the results of another related decision. A multi-step decision involves several steps. A long-running decision occurs when interdependent decisions are made one after another. There can be a lot of complexity and difficulty in following these.

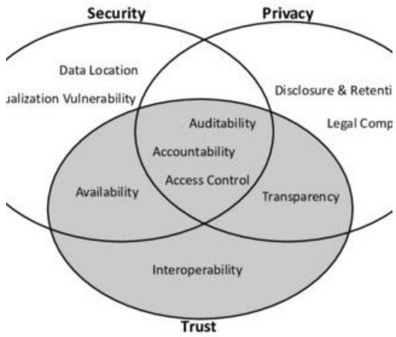
Supporting Automated Decision-Making Environments

The business rationale is essential when deploying decision automation. It is also necessary to allocate adequate resources to them. It may be possible for poorly implemented systems to work against the organization's purpose completely, creating unneeded decision criteria or integrating too many other sources of information.

Takeaway

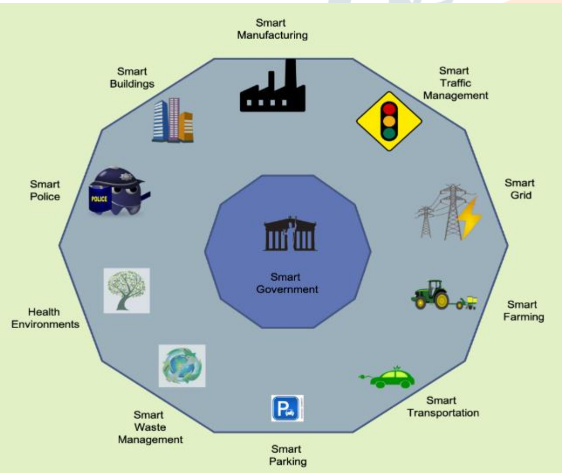
Decision automation will eventually help organizations to make better quality decisions as these will be data-driven. Decision automation works more effectively in the case of repetitive operation decisions. Decision automation is an opportunity for organizations to leverage the power of technology to free up employees' time for more focused work.

Privacy, Security, and Trust Issues in Smart Environments



Smart environments are becoming ubiquitous despite many potential security and privacy issues [15]. Smart environments are becoming increasingly popular for end users, with smart homes reaching a household penetration of 9.5% worldwide in 2019 and an expected increase to 22.1% by 2023. Suffering from a health impairment by equipping their households with connected health devices (e.g., blood pressure monitors) and sensors (e.g., drop sensors) -often referred to as smart health environments. However, such smart environments of home and health applications also introduce potential security and privacy issues. While there is an increasing body of research on the security and privacy vulnerabilities of smart environments (and how to address these vulnerabilities), it remains an open question, to which extent end users are aware of these issues. Smart homes – a residence with innovative, interconnected, and automated technologies – can enhance the resident's quality of life and well-being. Despite these potentials, users' may have concerns about the increased automation which negatively influence their technology acceptance. Missing trust in automated technologies and privacy concerns have been identified as crucial barriers for smart home adoption. Still, privacy and trust [16] perceptions in smart homes have not yet been deeply understood. Also, the effect of different automation levels has not been studied so far. Trust in smart home technologies comprises multiple dimensions of not only trust in the functionality of the technology but also in the human stakeholders involved and in connected technologies. Privacy in smart home does not only regard informational privacy (data protection) but also physical, social, and psychological dimensions of privacy which are often neglected. The results show that privacy and trust in smart home are interdependent. The degree of automation strongly influences privacy and trust perceptions – with a higher automation leading to more concerns. The negative impact of the level of automation on privacy and trust perceptions is a guide for the development of smart home technologies that meet users' acceptance.

Applications

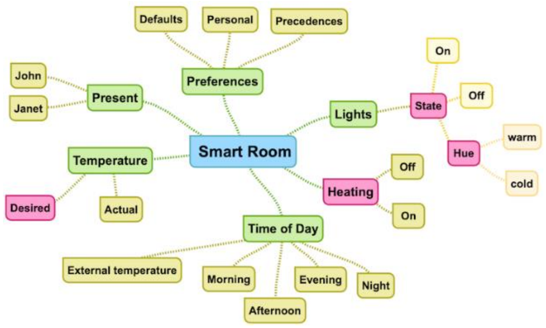


Although some IoT systems are built for simple event control where a sensor signal triggers a corresponding reaction, many events are far more complex, requiring applications to interpret the event using analytical techniques to initiate proper actions. Artificial Intelligence of Things (AIoT) applies intelligence to the edge and gives devices the ability to understand the data, observe the environment around them, and decide what to do best with minimum human intervention. With the power of AI, AIoT devices are not just messengers feeding information to control centers. They have evolved into intelligent machines capable of performing self-driven analytics and acting independently. A smart environment uses technologies such as wearable devices, IoT, and mobile internet to dynamically access information, connect people, materials and institutions, and then actively manages and responds to the ecosystem's needs in an intelligent manner.

Lessons from an Adaptive Home

Over the last decades, population growth in urban areas and the subsequent rise in demand for housing have resulted in significant space and housing shortages and investigates the influence of smart technologies on small urban dwellings to make them flexible, adaptive and personalised. The study builds on the hypothesis that adaptive homes [17] and smart technology could increase efficiency and space usage up to two to three times compared to a conventional apartment and encompasses a comprehensive semi-systematic literature review that includes several case studies of smart adaptive homes demonstrating various strategies that can be employed to enhance the functionality of small spaces while reducing the physical and psychological limitations associated with them. These strategies involve incorporating time-dependent functions and furniture, as well as division elements that can adapt to the changing needs of users in real-time. This categorises types of flexibility and adaptation regarding the size of the moving elements, the time that the transformation takes and whether it is performed manually (by a human) or automatically (by a machine). Results show that smart and adaptive technology can increase space efficiency by reducing the need for separate physical spaces for different activities. Smart technology substantially increases the versatility and multifunctionality of a room in all three dimensions and allows for adaptation and customisation for a variety of users.

Smart Rooms

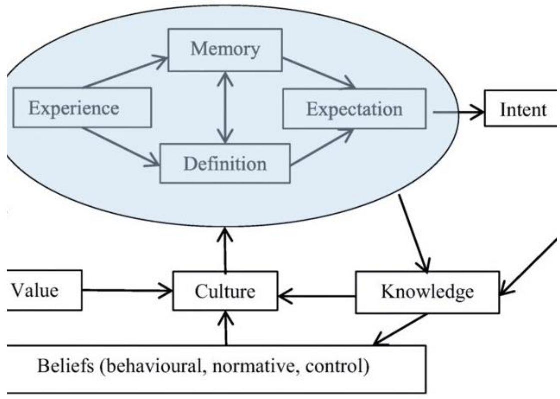


The Internet of Things (IoT) is a concept where internet connectivity can exchange information with each other with objects around it. The essence of IoT is interconnected devices that produce and exchange observation data, facts, and other data, so that it is available to anyone. The smart room model [18] is designed using sensors and micro-controllers to automate the use of electronic devices and the security of a room using the concept of the Internet of Things. The concept in this smart room can be implemented and the automation process in this smart room can have a major impact on the efficiency of operational costs, especially electricity payments and improve home security because there is automatic control.

Smart Offices

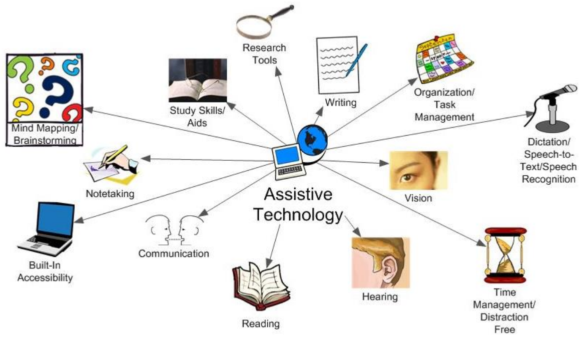
Smart office [19] concepts became popular with the profound use of advanced technologies in office environments. Although organisations have been adopting smart office concepts aiming to provide efficient and effective workplaces for their users, the literature has paid little attention to a user point of view. In particular, the literature has a wide range of the definition of the smart office concept, mainly revolving around technology development, and user perspective is mostly missing. Even though it is widely acknowledged that user preferences and expectations are significant to be considered when designing workplace environment, it is unclear what expectations and preferences users have for smart office concepts and what specific aspects validate smart office designs and distinguish them from other (non-smart) office types. Thus, it would be of high scientific and societal interest to gain empirical evidence to understand the user perspective for smart office environments.

Perceptual Environments



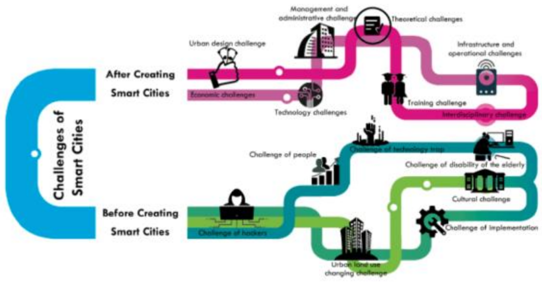
The construction of a perceptual system [20] in a smart environment is fundamental for the building space to understand the state of its surroundings and the need of its users, as well as provide personalised services to them. A properly constructed perceptual system can effectively improve the intelligence level of the smart environment and optimise resource utilisation, minimising unnecessary waste by reducing the number of sensors. This paper will analyse how to build an optimal intelligent perceptual system for architectural spaces with the help of knowledge in human physiology, cognition, and information science. It will propose possible technologies and design strategies to improve the efficiency and accuracy of information perception in a built space through eight case studies and that the perception system in a smart environment consists of two levels: sensory and cognitive. The first level is the sensory level, that is, the information of the external environment is acquired through the sensory organs and is mapped from the external stimuli to the subject. To construct sensory-level perception in a smart environment, this paper adopts concepts from human physiology to build four categories of perceptual systems for architecture—visual, auditory, haptic, and olfactory-gustatory—and explores the possible ways to implement each system design with specific case studies. The second level is the cognitive level, that is, the sensory information obtained in the first level is analysed and processed by the brain to form meaningful signals or visual images, which are cognitively comprehensible to the subject. To better understand the users' needs in the space, this paper advocates the construction of multidimensional information perceived on a multimodal sensory system as a way to enhance the cognitive ability of the built environment. We also introduce systematic methods for establishing multimodal sensory systems, design strategies for the spatial layout of various sensory systems, and applications of machine learning algorithms to understand environmental information of the users' real-time demands.

Assistive Environments for Individuals with Special Needs



As we age, we experience normal declines in vision, hearing, cognition, and movement. We also accumulate chronic conditions such as arthritis, heart and circulatory disorders, glaucoma, and tinnitus. Quality of life and independence are impacted by disabilities, and our health and caregiver systems will be increasingly stressed as the numbers increase. Hence, there is a significant need today to innovate cost-effective ways to help elders maintain their independence, and at the same time, reduce caregiver burden. The impressive wireless and portable technologies we have today and the emerging mobile computing paradigm offer a unique and real opportunity for us to innovate pervasive [21] applications and environments designed to support the elderly. Such environments will enable cost-effective self-care and will maintain a higher quality of life and independence for our oldest population. In this chapter, we define assistive environments for the elderly, and we follow a scenario-based approach to illustrate the benefits of these environments to the elders. We then present a specific assistive environment, which we prototyped, and which we call the University of Florida Rehabilitation Engineering Research Centre (RERC) Smart House. We present our reference middleware architecture and several applications that we built in that experimental house. Finally, we review research on smart environments for elders with disabilities, and elder health care applications and practices.

Ongoing Challenges and Future Directions



The Internet of Things (IoT) has become a popular technology for creating smart environments that offer convenient and efficient services to benefit society. These environments are available online but are vulnerable to attacks. The main aim of IoT is to create a virtual system allowing communication between people and devices, and among the devices themselves. However, many smart devices face problems such as limited memory, storage capabilities, battery capacity, and hardware resources. This study discusses applications of smart environments such as smart homes, parking, and traffic. It highlights the challenges [22] that need to be addressed when applications design and implemented and identifies ongoing problems in IoT and suggest future trends for researchers in the development these techniques that can positively benefit the community.

References

1. Diane J. Cook, Sajal K. Das, "Smart Environments: Technology, Protocols and Applications", DOI: 10.1002/047168659X, Wiley, ISBN: 978-0-471-54448-7, Jan 2005.

2. https://en.wikipedia.org/wiki/Smart_environment.
3. Hutton, D. M, "Smart Environments: Technology, Protocols and Applications", Kybernates, Vol. 34, No. 6, pp. 903 – 904, https://doi.org/10.1108/03684920510595580, 2005.
4. Anna Lanzolla and Maurizio Spadavecchia, "Wireless Sensor Networks for Environmental Monitoring", Sensors 2021, 21, 1172, https://doi.org/10.3390/s21041172, https://www.mdpi.com/journal/sensors.
5. Haniph A. Latchman, Anuj V. Mundi, "Power Line Communication Technologies", https://doi.org/10.1002/047168659X.ch3, Sep. 2004.
6. Marco Conti, "Wireless Communications and Pervasive Technology", DOI:10.1002/047168659X.ch4, Jan 2005.
7. I. Anghel, T. Cioara, I. Salomie, M. Dinsoreanu, A. Rarau, "Middleware for Smart Environments Management", International Journal of Computers, Communications & Control (IJCCC), ISSN 1841–9836, Vol. V, No. 2, pp. 148–159, 2010. https://www.researchgate.net/publication/229031002_Middleware_for_Smart_Environments_Management.
8. Srinivas, P., Swami Das, M., Malathi Latha, Y.L., "Future Smart Home Appliances Using IoT", Innovations in Computer Science and Engineering, Vol. 171, Springer, https://doi.org/10.1007/978-981-33-4543-0_16, 2021.
9. Petar Kochovski, Vlado Stankovski, "Algorithms for a Smart Construction Environment", Fifth International Symposium on Algorithmic Aspects of Cloud Computing, ALGOCLOUD 2019, Munich, Germany, pp. 1–14, Sep. 10, 2019.
10. Dimitris Kanellopoulos, Varun Kumar Sharma, Theodor Panagiotakopoulos and Achilles Kameas, "Networking Architectures and Protocols for IoT Applications in Smart Cities: Recent Developments and Perspectives", Electronics 2023, 12, 2490, https://doi.org/10.3390/electronics12112490, https://www.mdpi.com/journal/electronics, 2023.
11. Gregory D. Abowd, Elizabeth D. Mynatt, "Designing for the Human Experience in Smart Environments", https://doi.org/10.1002/047168659X.ch7, Sep. 2004.
12. Diane J. Cook, "Prediction Algorithms for Smart Environments", Smart Environments: Technologies, Protocols, and Applications, DOI:10.1002/047168659X.ch8, Jan 2005.
13. Archan Misra, Sajal K. Das, "Location Estimation (Determination and Prediction) Techniques in Smart Environments", DOI:10.1002/047168659X.ch9, Jan 2005.
14. https://quixy.com/blog/what-is-decision-automation.
15. Oksana Kulyk, Benjamin Reinheimer, Lukas Aldag, Peter Mayer, Nina Gerber, and Melanie Volkamer, "Security and Privacy Awareness in Smart Environments -A Cross-Country Investigation", Springer AsiaUSEC 2020, Feb 2020.
16. Eva-Maria Schomakers, Hannah Biermann, Martina Ziefle, "Understanding Privacy and Trust in Smart Home Environments", HCI for Cybersecurity, Privacy and Trust, DOI:10.1007/978-3-030-50309-3_34, Jul. 2020.
17. Thomas Goessler and Yamuna Kaluarachchi, "Smart Adaptive Homes and Their Potential to Improve Space Efficiency and Personalisation", 13, 1132, https://doi.org/10.3390/buildings13051132, https://www.mdpi.com/journal/buildings, Buildings 2023.
18. R Y Endra1, A Cucus1, F N Affandi, "The Concept and Implementation of Smart Room using Internet of things (IoT) for Cost Efficiency and Room Security", The First International Conference on Engineering and Applied Science Journal of Physics: Conference Series 1381, 012018IOP Publishing, doi:10.1088/1742-6596/1381/1/012018, 2019.
19. Deniz Tuzcuoğlu, Bauke de Vries, Dujuan Yang, Aslı Sungur, "What is a smart office environment? An exploratory study from a user perspective", Journal of Corporate Real Estate, Vol. 25, No. 2, pp. 118-138, Emerald Publishing Limited, 1463-001X, DOI 10.1108/JCRE-12-2021-00, 2023.
20. Jie Liu, Dan Luo, Xinyi Fu, Qi Lu, Karen Yixin Kang, "Design Strategy of Multimodal Perception System for Smart Environment", Internet of Things for Smart Environments, pp. 93-115, Springer, 2023.

21. Abdelsalam Helal, Choonhwa Lee, William C. Mann, "Assistive Environments for Individuals with Special Needs", Smart Environments: Technologies, Protocols, and Applications, DOI: 10.1002/047168659X.ch16, Jan. 2005.
22. Enas Faris Yahya, Marwan B Mohammed, "The Challenges of Smart Environments and Future Trends Supported by the Internet of Things", International Journal of Advanced Multidisciplinary Research and Studies (IJAMRS), 3(3), pp. 538-534, ISSN: 2583–049X, 2023.