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AI-Driven Smart Cities: Innovations For A Sustainable Future

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Abstract:

With the world progressing at a very fast rate in the technological field, many smart cities, including cloud computing, IoT, and the 4th Industrial Revolution, Smart cities, as a concept, try to envision the most effective and environmentally friendly way to design and build cities. These cities are characterized by five main components: smart security, smart monitoring, smart healthcare, smart buildings, and smart home applications. However, there are conflicts in [1]the integration of these components that dwindle their effectiveness as planned. Based on these challenges, this paper introduces a new approach using artificial intelligence (AI). Thus, using AI, it is possible to reach a level of passive control with city development and make decisions on its management in real time, which will be useful in dynamic urban systems. The creation of an AI technique for real-time data processing of the collected information, better compatibility between the components of smart cities, and environmental protection are the benefits of the proposed system. The objective of this approach, therefore, is to address existing challenges and provide a framework to develop stronger and better-built infrastructure in cities.

Keywords*: AI-Driven Smart Cities, Artificial Intelligence, Urban Sustainability, Smart City Innovations, Sustainable Urban Development, IoT in Smart Cities, Autonomous Systems, Real-Time Decision Making, Environmental Sustainability, Smart City Integration.*

1 Introduction

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The smart city is a revolutionary concept that is based on the integration of different electronic modules to enhance the information from up to down for the easiness of customers (M. N. Islam Sarker, 2021). The smart city is usually referred to as a technology-based environment in which it uses the ICT technology to improve the quality of life changes in cities for the betterment of cities to make it sustainability (Vitunskaite, 2019)In the recent days the urbanization concept witnessed high rates to becomes a phenomenon in the whole world. Even in China, a in promoting, it's increased from 36% to 51.27% (Velasquez, 2018) urbanization has a massive role in promoting smart cities to the next level and transformation of nature to the next level. Due to urbanization, challenges also come at fastly as (air pollution, sustainable cities, traffic jams etc.) these changes needed are needed to be done future shortly for the betterment of cities (Nanjie, 2023)To solve these issues like air pollution and traffic jams sustainability and weather forecasting the smart concept was introduced for the betterment of these issues and makes the cities more sustainable (ALUSI A, 2011)In 2009 that was the year when smart cites proper highlighted and comes out to the whole world this initiate takes by the IBM by introducing the smart city for the betterment of style lifestyle. In this perspective, IBM got great support from universities and government agencies towards smart cities (GIBSON D, 1992)A smart city can be said to be smart because that is intelligent and interconnected over the internet (IBM, 2013)However, smart cities components have already been installed, like smart monitoring, smart homes, and smart healthcare; these all kinds of things are part of the smart cities vision (Harrison, 2010)

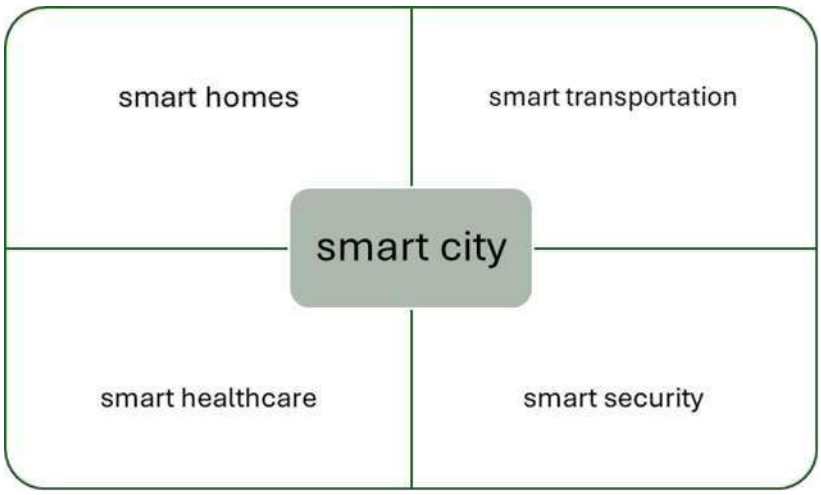

Figure 1

(Mohanty, smart cities: The internet of things is the backbone, 2016)

In the recent survey report that the 54 percent across the globe are lived in the urban areas (cities). With the passage of time, it will reach up to 66% in the year 2050. The changes are making fastly in the urban areas that's creating environmental and social issues but economic as well. The social and economic subsidy is very important for urbanization to manage the population needs. Due to advancements in technologies, the urbanization populations are in control and making it easier, like smart cities, which are needed most nowadays with the help of IoT-based technologies using sensors (Luckey, 2020)[11].Large-scale implementation and wide with as well as policy-making for renewable energy at large scale in worldwide.[12] Mobility issues for characterization in smart cities to tackle this issue for urbanization.[13]Prediction of real time environment from road in order to avoid

this.[14].Prediction of based on outside liar in order to cope with this issue.[15]improving collection and qualitative measurement data. AI can accurately find patterns in data sets for better analysis. AI and IoT can provide tools to monitor air pollution in real-time. AI technology can discover sources of air pollution quickly and accurately[16], And doing manual segmentation of these images to use them in different applications is a challenge and a never-ending process.[17]using edge computing for faster processing in perception of road[18]In our future work this system will implement and predict the medicine based on the data generated.[19]effiency and privacy can be approved in real time using this technique.[20]e built AI-VEmoBAR and to predict future misbehavior or malfunction by malicious attackers.[21] For future work, the working of the real-time environment with analyzing for fire outbreaks based on the Internet of Vehicles (IoV)[22], further research regarding physical acquisition methods for smart devices such as chip-of and JTAG should be performed[23]for future studies.Four research hypotheses are After going through different literature, we found that there are still issues in smart cities that need to be covered in different components within smart cities.[24] The smart key challenged issues were real-time prediction, behavior changes in multi-agents, traffic control congestion, classification issues, and knowledge-based issues still present in different components of smart cities[25] . Here, we proposed the concept of artificially intelligence-based smart cities, which make them more reliable in terms of security parameters, sustainability environment issues, and collaboration issues between the different components of smart cities. Artificial intelligence makes the smart city more intelligent in terms of decision-making sustainability and security flues and enhances the smart cities' parameters by using artificial intelligence, there would be a centralized system that will collaborate with different components of smart cities to make an integration of an entire single domain rather than a distributed system.

2 Literature review

Azam, M.,at el(2024). This article explores the integration of IoT technologies in smart cities, emphasizing enhanced urban management and quality of life improvements. Applications in infrastructure, transportation, and energy management are discussed, highlighting the importance of secure and efficient data handling. However, the article lacks discussion on integration challenges, autonomous systems, and user-centric design, which are crucial for a holistic approach to smart city development.

Azam, M.,at el (2024).The paper presents a smart healthcare model that combines IoT devices, data analytics, and real-time monitoring to enhance patient care and reduce hospital visits. It emphasizes early detection and intervention, aiming to improve patient outcomes and healthcare efficiency. However, the study does not explore integration with other smart city components, environmental sustainability, or autonomous decision-making, limiting its comprehensive applicability in smart cities.

Azam, M.,at el (2023).This research introduces a context-aware facial recognition system developed using VB.NET, designed to adapt to environmental changes and assess user activity for enhanced security. It utilizes real-time data to minimize false alarms and provide rapid response capabilities. While the system significantly advances security, it does not address broader smart city integration, environmental sustainability, or user-centric design, focusing primarily on security applications within smart cities.

Shenavarmasouleh, F. at el (2022) present the difference between AI in that it helps the internet with real-time examples by using the dataset SUNCG [77] dataset, Matterport3D, by using

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transfer learning methods. with the help of DFP algorithm. Proximal Policy Optimization algorithms. (PPO, instead of static time detection. Because in smart cities, the data is sometimes not static. So, to overcome these issues, we proposed the embodied AI driven in smart cities. The experimental results show that the policies used by the agent fulfill the requirements. By doing that, the agent will be able to understand the data and process it according to the situation. In future there should be a mechanism which reduces the biases in different situations to tackle in results.

Pratama I. at el (2022) present in this paper proposed the RPJMD method to overcome the problem, like features that are CCTV inaccurate Google Maps and half-full features such as health emergencies with the help of different AI algorithms. Sentiment analysis results show a good response from 55% of different users on the other hand the negative response from 45% users. The Jambi City appreciates peoples says that Sikoja is considered as easy. In the future, the integration of applications with different sectors will make them sustainable to support future policies.

Ahmad, K. at el (2022) In this paper, the author mainly depends on the AI attacks and how they will impact the real-time system and make it difficult in a large number of crowded. In which they used the GTSRB [74] and GTSDB self-collected dataset, the dataset consists of 1000 samples. They used the feature extraction data analysis technique. Manipulation methods were implanted in it and the SVM and NN algorithms were used in it. So, it's important how ai can reduce the number of threats in the form of attacks over the internet to pass the smart censoring or hack the iot based ai sensors. By using ai, we can secure smart cities. These results highlight the challenges and future of attacks and their link to each other by going through the literature from different areas and papers. Soon there will be some areas which still be a security theft in the near future, there will be some areas that will still be a security theft, which will be covered in future work.

Al-Marghilani, at el (2022) proposed the digitization digitizing the cyber bullying free online social networks in which they used the multi-platform dataset, a global dataset which contains large data with the help of the AICBF-ONS pre-processing technique. In order to checked the e cyber-aggression, cyber bullying, and cyberstalking. By implementing the SSO approach,td-idf, feature extraction technique were used. The CNN method was involved in it, and CSSO and MFO algorithms were implemented, too. This can detect social media-based content like comments on profiles and pictures, which can detect the different words and check the weighting of the words on behalf of the ai detection concept. The experimental results show that using dataset-1 with the mf-lr technique was effective for cyberbullying detection from data by archiving the accuracy/precision of 77.45% and recall at 78.35% with respect to the f1 score. In the near future, the performance measures of the AICBF-ONS technique can be improved by using different clustering techniques with big data.

Kim, S.,at el **(2022)** proposed the ai enabled digital devices for smart cities .in the smart cities the security and reliability are more concern .in. They used the chip-off and JTAG algorithm, so we need to use the ai enabled handheld devices to reduce the risk of security. Using the ai enabled devices will be helpful in understanding whether they used the chip-off, and JTAG algorithm, so we need to use the ai enable handheld devices to reduced the risk of the security by using the ai enabled devices it will be helpful into the dataset from the given data. Because ai enabled devices can be utilized into the smart (voices, videos, and audio) etc. The results show that this study contributes to the acquisition of key evidence for investigations. In future studies, the acquisition of artifacts will be done through a detailed analysis of the operating system.

Mohammadi, G., et al (2022), In this paper, discusses the several challenges regarding smart cities, such as how the data are collected and managed. Sometimes, the data can be lost. To overcome this we proposed the ML and DL techniques of ai by using the preprocessing technique (Artificial Bee colony) in order to collect the real time data like (crowed monitoring) and generate the results and make the decision. The dataset generated dataset was used in it. The Integrated Method (IM) was implanted into his data analytics, and data-analysis algorithms were used as well .Here, the concept of big data was introduced with the help of different algorithms like machine learning and deep learning to tackle the challenges and overcome them. These algorithms were helpful in decision-making and mobility for smart cities. In future scenarios, the data of smart cities will grow with the help of big data. The issue can be controlled with different AI-based algorithms for smart decision-making within scenarios, and the data of smart cities will grow with the help of big data. The issue can be controlled with different AI-based algorithms for smart decision-making within a short time.

Xu, C.,at el (2022) In this paper proposed the concept of 5g.V2X with the help of ai in order to detect the objects to reduce the number of accidents as well as detect the road to avoid the accident with the help of the Mask R-CNN feature extraction technique in the real time environment as compared to RNN method to avoid the loss of lives and vehicle a swell. The (TuSimple lane) test dataset was taken in it. The DL-based feature extraction lane-marker technique was used with the DL algorithms. The generated outcomes show that by using the 5g-v2x method, the processing is a bit faster as compared to other machine learning algorithms, and they make the best decision-making regarding road perception under complex circumstances. In the near future then we will work on the optimization problems in fitting algorithms for better utilization of methods to tackle the real time road perception.

Prematilake at el(2022) Proposed the AI-based framework. During Covid-19, the detection of COVID-19 patients is difficult to manage, and they know whose person has COVID-19 or not. We used the image filtering technique, machine learning technique for preprocessing to tackle it. To overcome this problem, we proposed the AI-based method ANN to detect the patient in a real-time environment with accurate results. The experimental results show that by using the (ten-data) with the help of the based technique, the patient's tracking system works perfectly with better results; this system has the capability to get the data and predict the medicine based on their symptoms. Soon this system will be upgraded for detection and prediction of medicine based on data generated by report the near future, this system will upgrade for the detection and prediction of medicine based on data generated by reports.

Chen, J.,at el (2021) (HDDI-AI) is proposed to secure the data over the internet to control the security threats from the different attacks at the management. Load Datasets were taken into this experiment. The adaptable interference method is used with the help of AI technology because the AI detects the suspect's things and makes the decision on behalf of data that are already collected and makes it more secure. The differential evolutionary algorithm was also used in it. The generated results show that the operational burden of users on a show that the operational burden of users on the system will be optimized by removing the over data from the system to make it available to users. Here is the detailed overview presented about the HBDIAIM approach. In future directions towards the security and privacy to cope the confidentiality of data for smart cities.

Kong, L.(**2021)** proposed In this paper, the author presents the ai AI-based triage model, which helps the Medicare department in order to give the basic level of treatments to patients. The classification technique is used for pre-processing. The INO world public datasets were taken for this experiment. To get treatment rather than going to hospital. That's why the model can be used in smart (hand phones and electronic devices.). Here, the people-centric medical

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selection was implemented with the lightweight encryption algorithm .The experimental results shows great improvements in accuracy and effiency in hierarchal diagnosis. In future directions is high depth research on general test of this model.

Sarker et al (2022) proposed AI-based modeling application. After many decades, ai has become a vital part of real life in human-centric application et al (2022) proposed AI-based modeling applications. After many decades, ai has become a vital part of real life in human-centric applications. Here the large number of labeled training dataset samples used. Today's world can be said as 4IR (industrial revolution), in which ai helps in smart automation to reduce the risk level of potential threats to make the system reliable and accurate. The based model nowadays can be used in any smart area like (smart cities, smart homes, smart automation, and surveillance). Weighted embaying and dnn methods and different k-means clustering methods were implemented. After reading through several kinds of literature, the results show that 4IR provides a basic way of modeling artificial intelligence. In future research directions the modeling ai can be used for helping in relevant applications domains.

Ziosi, M., et al (2022) proposed in this paper, the author gives a brief overview of the smart cities; one Dataset was taken. That is how ai plays a major role in smart monitoring, like street cameras, and needs to be used for ethical purposes rather than a bad impact on the audience because building smart cities is not an easy task. Imply objective Methods and black-box predictive algorithms were used in it. Here, the overview of different definitions and labels of smart cities were highly listed to deal with the four dimensions of smart cities that work present on the ground and create the hurdle towards the use of the smart cities concept. Future research will analyze in more depth and seek to resolve the identified ethical concerns. As far as this article is concerned, its goal is to provide some groundwork for more constructive investigations at the intersection of ethics, technology, and urban studies, which we hope to develop in future studies.

Zhang, Y.,at el **(**2021**)** proposed that In this paper the author presents big data and ai to detect the fire hazard with the help of dn-lstm base method to safe from the fire by using different sensors to avoid any deaths .so we used the different ardionos based sensors which detect it and make up to 98.4% accuracy .In the near future, the work will be done on real-time scenarios to check the accuracy of the system with generated results in particular scenarios.

Yigitcanlar, T.,at el **(**2021**)** proposed the green artificial for complex urbanization problems. They used artificial intelligence (AI)—defined as algorithms, to reduce the problems having an impact on the environment. The experimental results show that the quality-of-life changes can be improved by going towards smart cities. In future directions research can be done on smart cities to make them sustainable and self-based AI smart cities with the latest technologies.

3. Comparison of Existing Models with Our Model

To highlight the unique contributions of our model, we compared it against various existing models in the literature. The comparison table below summarizes the key aspects covered by each model and identifies the novel contributions of our model.

Paper	AI in Smart	Real-time Decision	Autonomous Systems	Novel Method	Integration Issues	Environmental and Sustainability Focus	User-centric Design and

	Cities	Making					Implementation
Shenavarmasouleh F. et al (2022)	✓	✓	✓	✓	✗	✗	✗
Pratama I. et al (2022)	✓	✓	✓	✗	✗	✗	✗
Luckey D. et al (2020)	✓	✓	✓	✓	✗	✓	✗
Şerban A. C. et al (2020)	✓	✓	✓	✗	✓	✗	✗
Allam Z. et al (2019)	✓	✓	✓	✗	✓	✓	✗
Englund C. et al (2021)	✓	✓	✓	✓	✓	✗	✗
Al-Marghilani et al (2022)	✓	✓	✓	✗	✗	✗	✗
Yigitcanlar T. et al (2021)	✓	✓	✓	✓	✓	✓	✗
Garg P. et al (2021)	✓	✓	✓	✓	✓	✓	✗
Ahmad K. et al (2022)	✓	✓	✓	✗	✓	✗	✗
Jha A. K. et al (2021)	✓	✓	✓	✓	✗	✗	✗
Chakrabarty S. et al (2020)	✓	✓	✓	✓	✓	✗	✗
Golubchikov O. et al (2020)	✓	✓	✓	✗	✓	✗	✗
Nikitas A. et al (2020)	✓	✓	✓	✓	✓	✗	✗
Zhang Y. et al (2021)	✓	✓	✓	✓	✓	✓	✗
Kim S. et al (2022)	✓	✓	✓	✓	✗	✗	✗

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Sarker I. H. et al (2022)	✓	✓	✓	✗	✗	✗	✗
Prematilake R. D. D. et al (2022)	✓	✓	✓	✗	✗	✗	✗
Chen J. et al (2021)	✓	✓	✓	✓	✓	✗	✗
Kong L. (2021)	✓	✓	✓	✗	✗	✗	✗
Verma R. (2022)	✓	✓	✓	✗	✗	✗	✗
Singh S. et al (2020)	✓	✓	✓	✓	✓	✗	✗
Srivastava S. et al (2017)	✓	✓	✓	✓	✓	✗	✗
Ma Y. et al (2019)	✓	✓	✓	✗	✓	✓	✗
Mohammadi G. et al (2022)	✓	✓	✓	✓	✓	✗	✗
Our Model	✓	✓	✓	✓	✓	✓	✓

Table 1

Table 1 provides a detailed comparison of various models in the context of smart cities, focusing on key aspects such as AI integration, real-time decision making, autonomous systems, novel methods, integration issues, environmental and sustainability focus, and user-centric design and implementation. The table highlights the unique contributions and limitations of each model, allowing for a comprehensive understanding of their respective strengths and weaknesses.

Key Findings from Table 1:

1. **AI Integration in Smart Cities:** All models demonstrate a strong emphasis on incorporating AI to enhance smart city functionalities. This includes aspects like real-time data analysis, decision-making capabilities, and system automation.
2. **Real-Time Decision Making:** Most models effectively utilize AI to enable real-time decision making, crucial for managing dynamic urban environments and ensuring timely responses to various challenges.
3. **Autonomous Systems:** Several models incorporate autonomous systems, enhancing the ability to perform tasks without human intervention. This is particularly important for applications like traffic management and environmental monitoring.

4. **Novel Methods:** Only a few models introduce truly novel methods, indicating a gap in innovation within the current literature. Our proposed model stands out by introducing a novel approach to smart city management.
5. **Integration Issues:** Many models lack a comprehensive approach to addressing integration issues, which is critical for the seamless operation of various smart city components.
6. **Environmental and Sustainability Focus:** While some models consider environmental sustainability, it is not universally addressed. Our model emphasizes sustainability as a core component, promoting long-term urban resilience.
7. **User-Centric Design:** User-centric design is often overlooked, yet it is essential for ensuring that smart city technologies meet the needs of residents and stakeholders effectively.

Aspect	Azam, Hussain, & Nasir, 2024	Azam, Hussain, & Nasir, 2024	Azam, Hussain, & Nasir, 2024	Covered in Paper
Integration Issues	✗	✗	✗	✓
Autonomous Systems	✗	✗	✗	✓
Environmental Sustainability	✗	✗	✗	✓
User-Centric Design	✗	✗	✗	✓
Real-Time Decision Making	✗	✗	✗	✓
Centralized AI System	✗	✗	✗	✓

Table 2

Table 2 elaborates on the specific aspects covered by our proposed model in comparison to other existing models. This table underscores the unique contributions of our model, particularly in areas where other models fall short.

Key Findings from Table 2:

1. **Integration Issues:** Our model uniquely addresses integration issues, ensuring seamless interaction between various smart city components. This is achieved through a centralized AI system that facilitates coordination and data sharing.
2. **Autonomous Systems:** Our model incorporates advanced autonomous systems, enhancing operational efficiency and reducing the need for human intervention in routine tasks.
3. **Environmental Sustainability:** We place a significant emphasis on environmental sustainability, integrating AI-driven solutions to manage resources efficiently and reduce the urban carbon footprint.
4. **User-Centric Design:** A major strength of our model is its focus on user-centric design, ensuring that smart city solutions are tailored to meet the needs of the residents, enhancing usability and satisfaction.

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5. **Real-Time Decision Making:** Our model excels in real-time decision-making capabilities, leveraging AI to provide timely responses to urban challenges, thereby improving overall city management.

   This comparison highlights that our model uniquely integrates user-centric design and implementation, addresses integration issues, and focuses on environmental and sustainability aspects, which are not comprehensively covered by existing models.

4. Proposed Model:

Proposed model:

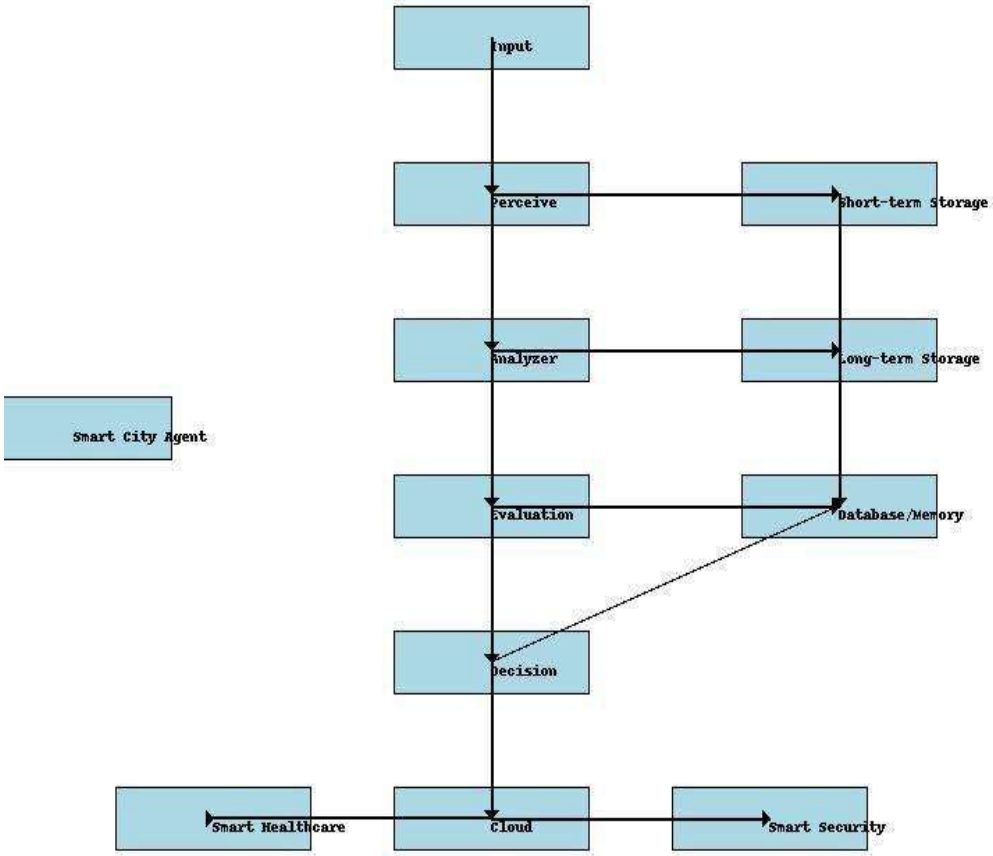

Figure 2

4. 1Working of model:

The proposed model operates through a structured sequence of processes, leveraging AI and IoT technologies to enhance the functionality and efficiency of smart city applications. Initially, sensors, including cameras and various other sensing devices, continuously collect data from their respective environments. In the context of smart healthcare, these sensors gather critical patient data, which is then forwarded to the analyzer for initial processing.

Once the sensors collect the data, the analyzer processes it by performing preliminary data cleansing and formatting. The processed data is subsequently stored in a short-term memory system, referred to as the database. This database acts as an intermediary storage before the data undergoes further analysis. The stored data is then subjected to a comprehensive analysis phase, where AI algorithms analyze and categorize the data or objects based on prior knowledge and information stored in memory. This ensures accurate and context-aware analysis.

Following the analysis, the evaluated data is stored back into the database. The evaluation module retrieves information from both the analyzer and the database (short-term memory) to perform a thorough assessment. This phase focuses on deriving actionable insights from the analyzed data. The evaluation phase culminates in the decision-making process. Based on the evaluated results, the system generates predictions and alerts. For instance, in a smart healthcare scenario, the system might trigger an alert if a patient's temperature exceeds a certain threshold, indicating potential health issues.

The final step involves generating actionable results based on the decisions made. These results are then communicated to relevant stakeholders or systems. In the context of smart cities, this could involve adjusting traffic signals, notifying healthcare providers, or initiating security protocols. The accompanying flowchart provides a visual representation of the model's operational workflow, illustrating the flow of data from acquisition to action execution.

4.2 flow Chart

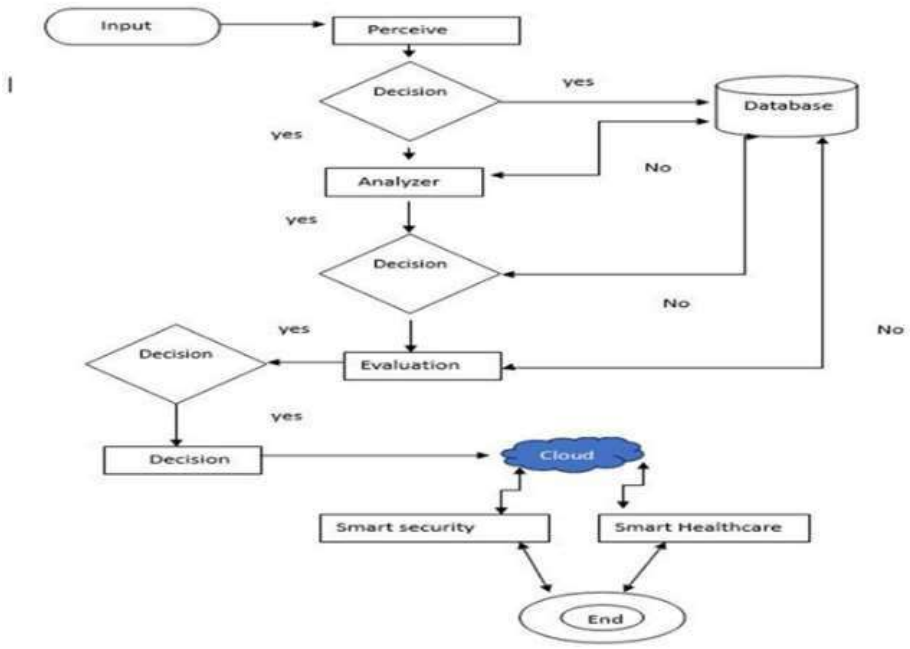

Figure 3

4.3 Results

In this research, we explored how artificial intelligence (AI) can enhance the functionality and efficiency of smart cities by addressing various urban challenges. The following section

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provides a detailed analysis of the smart city model developed using AI. The tools and languages employed include VB.NET for creating the user interface and Visual Studio 2013 for the development environment.

4.4 Simulation Tools and Environment

The simulation was conducted using VB.NET to develop user-friendly interfaces, while Visual Studio 2013 served as the primary integrated development environment (IDE). MySQL was used for database management, and Xampp was employed as the localhost web server. These tools were selected to address the complexities and challenges associated with smart city environments effectively.

5. Implementation and Results

The smart city model includes multiple domains, such as smart healthcare and smart security, each designed to demonstrate the integration of AI for improved decision-making and system efficiency. Additionally, the system provides a centralized view for administrators to manage data across these domains effectively.

5. 1 Smart Healthcare Implementation

The smart healthcare system fetches real-time data from sensors and displays it through an interface developed using VB.NET in Visual Studio 2013. This setup ensures that data is captured and presented to the users promptly. Patient data recorded from sensors is stored in a MySQL database, ensuring that all information is systematically organized and easily retrievable. The database interface allows for efficient management of patient records. To make the data accessible, it is displayed on a web server using localhost (Xampp). The web interface includes a login form for smart healthcare, providing secure access to the system. Once the admin successfully logs in, they can access and view patient records. This feature ensures that healthcare providers can monitor and manage patient data effectively, as highlighted in the interface.

5.1.1 Data Handling and Alerts

Algorithm for Temperature Alert:

1. **Data Acquisition**: Real-time data is read from the serial port.
2. **Parsing**: The data string is split into individual components (e.g., temperature, distance, object).
3. **Threshold Checking**: If the temperature exceeds a predefined threshold, an alert is generated.

    - **Mathematical Formulation**:

      Given the temperature reading T:

      $$\text{if } T \geq T_{\text{threshold}} \text{ then alert}$$

      where $T_{\text{threshold}}$ is the predefined temperature threshold.

Function for Temperature Alert:

```
Function Check Temperature Threshold(temperature,threshold):
    if temperature ≥ threshold:
        Generate Alert(temperature)
```

5.1.2 Feature Extraction and Monitoring

To make the data accessible, it is displayed on a web server using localhost (Xampp). The web interface includes a login form for smart healthcare, providing secure access to the system. Once the admin successfully logs in, they can access and view patient records.

Algorithm for Feature Extraction and Monitoring:

1. **Feature Extraction**: Extract key features from the data for monitoring purposes.
2. **Anomaly Detection**: Implement an anomaly detection algorithm to identify unusual patterns or outliers in the data.

Principal Component Analysis (PCA) for Anomaly Detection:

PCA can be used to reduce the dimensionality of the healthcare data and identify anomalies.

- **Mathematical Formulation**:

  Given a data matrix X:

  where W is the matrix of principal components.

- **Anomaly Score**:

  Compute the reconstruction error for each data point:

$$\text{Error} = \| X - \hat{X} \|$$

where $\hat{X}$ is the reconstructed data from the reduced components.

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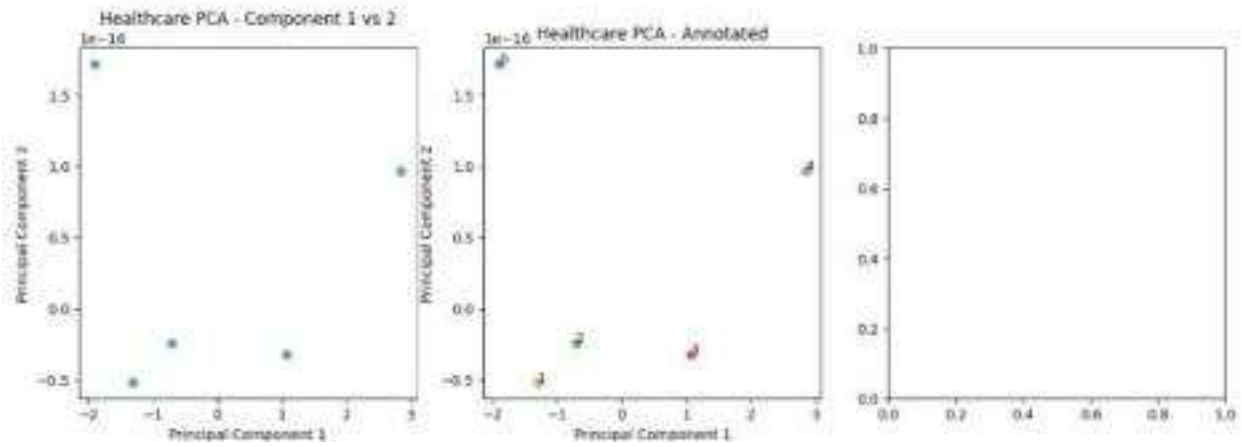

Figure 4

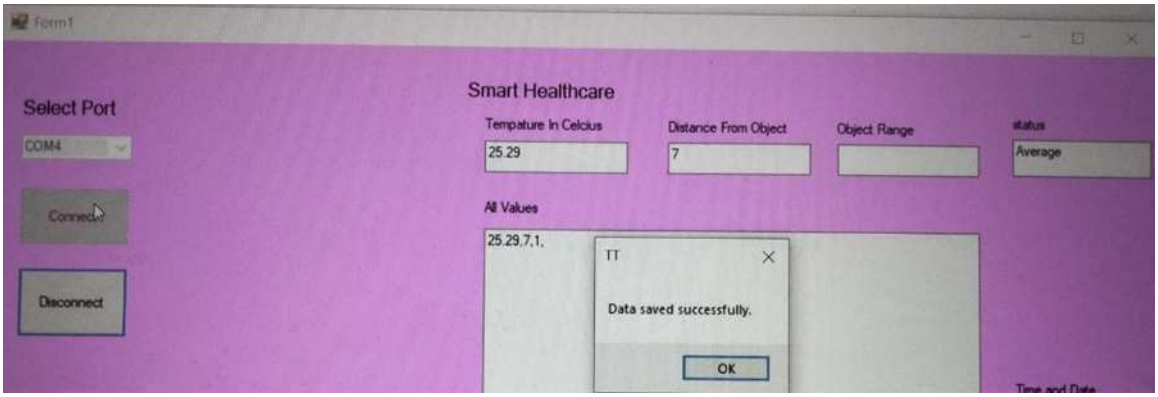

Figure 5

Figure 6

5.2 Smart Security Implementation

The smart security system captures images and saves them to the database using VB.NET. This approach ensures that the security system maintains up-to-date information on all activities. The data is then displayed on a web server, requiring admin login to access the information. This security measure ensures that only authorized personnel can view sensitive data. Upon successful login, the results are displayed on a PHP page, showcasing the smart security interface. This setup allows administrators to monitor security events and respond appropriately. To enhance the security system's capability, the Eigen object recognizer and Principal Component Analysis (PCA) algorithms are utilized. The Eigen object recognizer, combined with PCA, significantly improves the accuracy and reliability of object recognition by reducing the dimensionality of the data and focusing on the most important features.

5.2.1 Algorithm for Object Recognition Using Eigenfaces and PCA:

1. **Image Capture**: Capture images in real-time and convert them into vector form.
2. **Feature Extraction**: Apply PCA to reduce dimensionality and extract significant features.
3. **Object Recognition**: Use the Eigen object recognizer with the extracted features to identify and classify objects.

Mathematical Formulation:

1. **Principal Component Analysis (PCA)**:

Given a data matrix X of size n × p (where n is the number of samples and p is the number of features), PCA involves the following steps:

1. **Standardize the Data**: Center the data by subtracting the mean.

$$X_{centered} = X - \mu$$

2. **Compute the Covariance Matrix**:

$$C = \frac{1}{n-1} X_{centered}^{T} X_{centered}$$

Eigen Decomposition: Perform eigen decomposition on the covariance matrix C:

$$Cv = \lambda v$$

where λ and v are the eigenvalues and eigenvectors, respectively.

3. **Principal Components**: Select the top k eigenvectors corresponding to the largest k eigenvalues to form the principal components.

2. **Eigenfaces (Eigen Object Recognizer)**:

Given a set of training images, convert each image into a vector and form a matrix Γ

$\Gamma = [\Gamma 1, \Gamma 2, \ldots, \Gamma_N]$

Compute the mean image Ψ

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Subtract the mean image from each training image to get the difference matrix Φ

$$\Phi i = \Gamma i - \Psi$$

Compute the covariance matrix C:

$$C = N^{-1} \sum \Phi i \Phi i^{T}$$

Perform eigen decomposition on C to obtain eigenfaces (eigenvectors).

Project new images onto the eigenface space and classify based on the nearest neighbor in the reduced space.

5.3 **Implementation Workflow**:

1. **Image Capture**: Images are captured in real-time and converted into vector form.
2. **Feature Extraction**: PCA is applied to reduce the dimensionality and extract significant features.
3. **Object Recognition**: The Eigen object recognizer uses these features to identify and classify objects.
4. **Data Storage**: The recognized data is stored in a MySQL database.
5. **Data Display**: The data is displayed on a web server, requiring admin login to access the information. This security measure ensures that only authorized personnel can view sensitive data.
6. **Admin Monitoring**: Upon successful login, the results are displayed on a PHP page, showcasing the smart security interface. This setup allows administrators to monitor security events and respond appropriately.

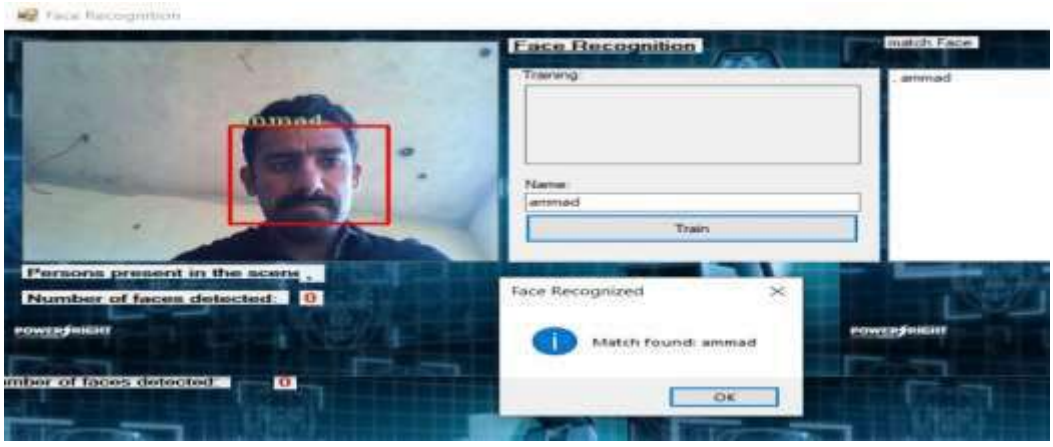

Figure 7

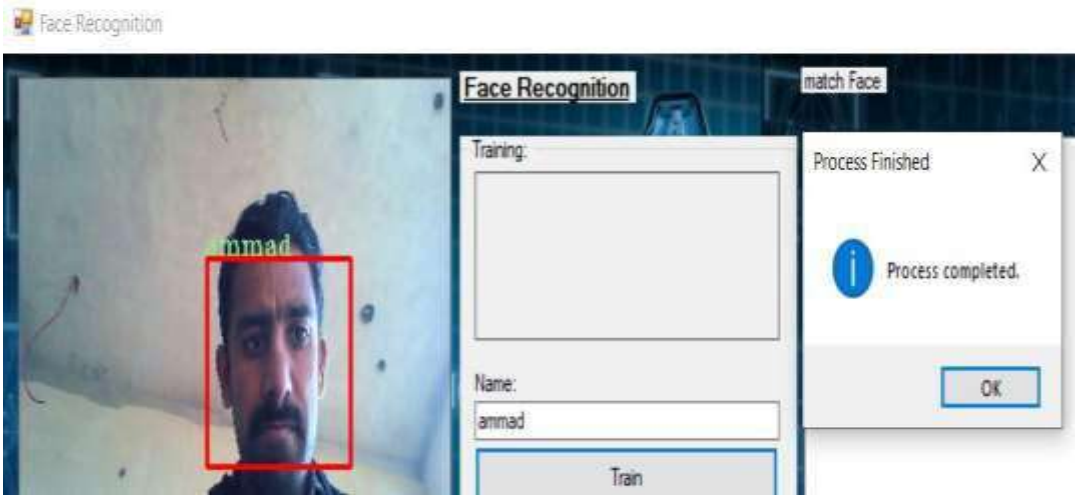

Figure 8

id	name	imageAddress 1
70	abcd	D:\facere\Face Recognition Software\Face Recogniti...
74	aads	D:\facere\Face Recognition Software\Face Recogniti...
6	ammad	D:\Face Recognition Software\Face Recognition\Face...
5	ammad	D:\Face Recognition Software\Face Recognition\Face...
11	akf	D:\Face Recognition Software\Face Recognition\Face...

Figure 9

5.4 Centralized Smart City Management

The smart city system provides a centralized view that integrates data from both the smart healthcare and smart security systems. This centralized view allows administrators to manage and monitor data across different domains efficiently.

- **Centralized Login**: Administrators can log in through a unified interface to access both smart healthcare and smart security data.
- **Integrated Data Management**: The system consolidates data from various sensors and databases into a single interface, providing a holistic view of the smart city's operations.
- **Enhanced Decision-Making**: By centralizing data, the system facilitates better decision-making and coordination between different city departments

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Figure 10

Figure 11

Figure 12

In this research enough idea about how the model should work in different environment by using the artificial intelligence in it as well already created in chapter 3. In chapter 4 the results will be displayed. to perform the simulation, the tools and languages which are used vb.net, which is used to make the interface for ease for the system, and the tools which are used by Visual Studio 2013.To tackle the issues of smart city. Here, the proposed solutions are provided. In this phase, the simulation for the smart city will be performed using artificial intelligence. In smart cities there is a lot of work that has been done by using the different methods and technique like (iot and network) based. In smart cities the complexities were almost reduced but still there is issues like urbanization, weather forecasting, smart grid, smart transportation, smart security and global warming issues that's means in smart cities still there is improvement needed. To overcome these limitations artificial intelligence can be the best solution to overcome these limitations by integration of artificial intelligence and smart cities to different levels. In smart cities there are limitations in decision making in real time environment which will impact on the smart cities. By implementing artificial intelligence in smart, the system will be autonomous and intelligent for decision making and take the perfect measures to predict the future outcomes and give better results. Here is the basic mechanism of artificial intelligence integration with smart cites to make it intelligent in decision making.

6. Discussion:

Smart city is a revolutionary concept which is based on the integration of different electronic modules to enhance the information from up to down for the easiness of customers. After going through the different literature there is a lot of work has been done on the smart cities by integration iot technology with machine learning technique for the betterment of system towards audience. But still, there are some issues regarding the complexity and integration issues within the smart cities domain, which play a vital role in smart cities that need to be addressed. In the literature review there are some key issues are highlighted that are That smart city still lack with abilities of decision making and which can be better if artificial intelligence technology integrates with the smart cities to tackle the problem of decision-making for the betterment of system and the future needs like sustainable environment, smart grid smart automation real time camera monitoring and healthcare sectors. Artificial intelligence reduces the risk of errors, which can affect the performance of any system, and these issues can lead in the wrong direction. So, artificial intelligence could be the best option for smart cities integration for the smart cities.

7. Conclusion:

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Smart cities concept is towards the digitalization in which the things are smart like smart healthcare, smart monitoring, smart security etc. In smart cities there are still some problems which make it inefficient and less intelligent by using iot and machine learning. These are the issues which are highlighted. In the proposed approach these issues will be overcome by implement the artificial intelligence with iot for smart cities to make the smart cities sustainable and environment friendly. The proposed approach will be beneficial in terms of results. In future work will do deeply in artificial intelligence to make the smart cities more secure and reliable towards urbanization.

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