VIDEO DATA ANALYTICS FOR SMART CITY APPLICATIONS: METHODS AND TRENDS

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IoT and Big Data Analytics

(Volume 1)

Video Data Analytics for Smart City Applications: *Methods and Trends*

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CONTENTS

FOREWORD

Data is everything and nowadays, Big Data and Big Data Analytics are given more attention in the field of research. The smart city paradigm completely relies on data and smart frameworks. This framework comprehends the physical infrastructure, networking system, centralized computing center, data storage, and higher-level domain use-cases. The physical infrastructure requires sensors, devices, and cameras to capture and generate data. In the smart city, also known as an innovative city, the devices and sensors involved in smart city applications generate a massive amount of multi-media data especially Video Data. The involvement of multimedia sensors enables to obtain precise and concrete information. This book titled “IoT and Big Data Analytics” Vol. 1 (Video Data Analytics for Smart City Applications: Methods and Trends) aims to explore the various applications and use cases of Big Data & Analytics and processing for smart city applications. The technologies like Machine Learning, Deep Learning, IoT, WSN, IoT, and AI have been contributing to the application and efficient processing of data. Object detection and tracking, intelligent processing, video compression, the performance of IoT & AI in business growth, key enabling technologies and video analytics need to be explored more. The information processing is both challenging and interesting. The researchers are working with passion, and dedication to develop new methods and algorithms for information analysis and to provide a solution to remain in the new direction. The book will provide a valuable window and wide-ranging exposure to concerned technologies and their architectural frameworks for smart city applications. How these technologies are serving themselves to fulfilling the needs of a smart city is also discussed, for the research and industry personnel. This book is a good step in that direction and will surely help researchers to find relevant information in one place.

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PREFACE

This book aims to explore the various applications and use cases of Video Data Analytics and processing for Smart City Applications. Everyday things are embedded together with the help of software, and sensors through the internet to collect and exchange data. Hence these devices generate a massive amount of data. The smart city paradigm entirely depends on data. In the context of video data, cameras capture huge data, and later these video recordings are effectively used in various smart city applications such as surveillance systems to counter potential threats. The generated data is heterogeneous and sparse in most cases. The processing of this Big Data in real-time is a matter of concern. With the participation of multimedia sensors, it is possible to obtain more precise and concrete information. Enormous challenges come in the data collection, analysis, and distribution.Various trending technologies like Machine Learning and Deep Learning are contributing to real-time data processing. Hence, these technologies should also be explored for efficient processing.

The video analytics field is continuously in evolution, because of speedy hardware and software progress that is making the technology more reachable and valued. To transform a large amount of video into actionable intelligence as complementary mechanisms, an effective algorithm and model are required. The book will provide comprehensive coverage of the latest and trending technologies like machine learning, deep learning, blockchain, AI, *etc*.

The book will highlight the advances and trends in various technologies by targeting the research and industry that are involved in video data analytics *via* addressing extensive themes. This book will surely demonstrate how technologies are serving their use-cases in the smart city. Interested researchers and academicians will get to know about the latest happenings and research, and more research possibilities can be explored. The industry professional may also benefit from this book by connecting the research with industry needs. This book will be proven as a useful resource for the target audience by outlining the promising future research and providing references to newcomers in the field of video data analytics.

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CHAPTER 1

Comprehensive Analysis of Video Surveillance System and Applications

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Abstract: In this growing age of technology, various sensors are used to capture data from their nearby environments. The captured data is multimedia in nature. For example, CCTV cameras are used in those places where security matters or where continuous monitoring is required. Hence object detection, object recognition, and face recognition became key elements of city surveillance applications. Manual surveillance seems time-consuming and requires huge space to store the data; hence video surveillance has a significant contribution to unstructured big data. All surveillance techniques and approaches are based on Object Tracking, Target Tracking, Object Recognition, and Object Mobile Tracking Systems (OMTS). The main difficulty, however, lies in effectively processing them in real time. Therefore, finding a solution still needs careful consideration. This paper mainly targeting to the smart city surveillance system and inspects all existing surveillance systems based on various tremendous technologies like a wireless sensor network, machine learning, and Deep Learning. The author discovered the problems in the existing methods and summarized them in the paper. The motive is to point out the various challenges and offer new research prospects for the multimedia-oriented surveillance system over the traditional surveillance system for the smart city network architecture. The thorough survey in this paper starts with object recognition and goes toward action recognition, image annotation, and scene understanding. This comprehensive survey summarizes the comparative analysis of algorithms, models, and datasets in addition to targeting the methodologies.

Keywords: Deep learning, Face-recognition , Image annotation, Multimedia, Machine learning, OMTS, Object detection, Smart city, Video surveillance.

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Abhishek Singh Rathore, Surendra Rahamatkar, Syed Imran Ali, Ramgopal Kashyap & Nand Kishore Sharma (Eds.)

INTRODUCTION

Surveillance may be outlined in a variety of ways, including vehicle monitoring at roadside traffic areas as an intelligent traffic management system, theft monitoring & identification, capturing abnormal happenings, monitoring of widely open critical areas, and crowd analysis. Apart from that, it is also important in the smart healthcare system to perform hospital surveillance, secure hospital facilities, detect patient emotion and sentiment, detect patient fraud, and analyze hospital traffic patterns.

The video surveillance system has progressed. Now it is not only aiming to capture and show the video but has upgraded towards an autonomous and intelligent system. Only cutting-edge algorithms have made this possible. Because the purpose of all these algorithms was not only to classify images or videos but also to enhance them. Thus, a modern surveillance system workflow is mentioned in Fig. (**1**). As a result, video surveillance makes a significant contribution to unstructured big data.

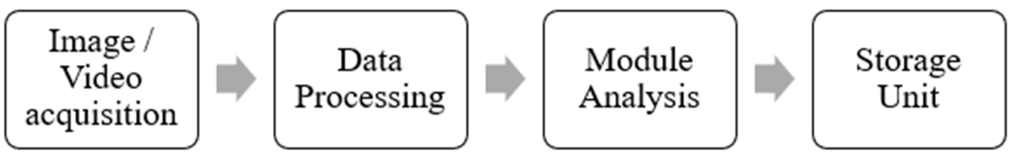

Fig. (1). Surveillance System workflow.

Intelligent surveillance is the main application of a Smart city, and the objective of the Smart city is to improve the quality of human lives. Smart environments contain sensors & devices that are network-connected and work together to perform operations. Though the last decade, the Internet of Things (IoT) with Machine Learning & Deep Learning has received so much attention. The cause for the accomplishment of this much attention is the services and capabilities offered by it.

The IoT is an interconnection between everyday objects and computing machines. It enables them to communicate in many smart city applications, where smart surveillance is one of them. Intelligent Transport Management Systems, Intelligent Traffic Management systems, Vehicular Ad-Hoc Networks, and Car-to-Car Communication are a few examples of IoT. Here, Intelligence indicates the best utilization of data. This data is generated by aggregating the knowledge and then converted into information through modeling. After that, this information is used for further processing.

In reality, all of this generated data is also known as multimedia data, such as audio and video. Their combination also makes the computation more energy efficient. Wireless Multimedia Sensors are used to collect multimedia data. However, Wireless Multimedia Sensors have exceptional issues such as high bandwidth and energy consumption. Other issues observed include quality of service (QoS), data processing, and compression at the node level. Object detection and recognition schemes have emerged in recent years as a solution for reducing the size of multimedia data at the node level.

The strategy used in it is based on motion detection. The camera only starts recording when it detects motion; otherwise, it does not record. As a result, unnecessary recording and storage are avoided. As a result, no overhead exists.

However, it is inefficient in some ways because it requires the user's involvement to process forwarded data, so that alert decisions can be made. A simple object classification with few details can work. It is based on a genetic algorithm-based classifier. The classifier used only two features of the objects:

1. Video frames: specifically, the shape of the minimum bounding box, also known as video annotation of the object.

2. The frame rate of the observed region.

This method was tested in a simulated environment on three types of objects: humans, animals, and vehicles. The observation was that as the audio was added, the noise count increased [1].

The evolution of IoT presents enormous challenges in data collection, data analysis, and distribution in the direction of more productive use of information [2].

According to the survey, video surveillance systems have advanced technically over three generations.

The survey said that the video surveillance systems have technically progressed as:

- The first generation was introduced in the 1960s with Analogue Close Circuit TV (CCTV). That was primarily for indoor surveillance applications. But the limitations were the recording and distribution process.
- Digital imaging began to expand surveillance systems in the 1980s. Advances in this area include compression and distribution as well as surveillance algorithms. The system included object tracking as well as an event alert system.

CHAPTER 2

Compressed Video-Based Classification for Efficient Video Analytics

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Abstract: Videos have become a crucial part of human life nowadays and share a large proportion of internet traffic. Various video-based platforms govern the mass consumption of videos through analytics-based filtering and recommendations. Various video-based platforms govern their mass consumption by analytics-based filtering and recommendations. Video analytics is used to provide the most relevant responses to our searches, block inappropriate content, and disseminate videos to the relevant community. Traditionally, for video content-based analytics, a video is first decoded to a large raw format on the server and then fed to an analytics engine for metadata generation. These metadata are then stored and used for analytic purposes. This requires the analytics server to perform both decoding and analytics computation. Hence, analytics will be fast and efficient, if performed over the compressed format of the videos as it reduces the decoding stress over the analytics server. This field of object and action detection from compressed formats is still emerging and needs further exploration for its applications in various practical domains. Deep learning has already emerged as a de facto for compression, classification, detection, and analytics. The proposed model comprises a lightweight deep learning-based video compression-cum-classification architecture, which classifies the objects from the compressed videos into 39 classes with an average accuracy of 0.67. The compression architecture comprises three sub-networks *i.e.* frame and flows autoencoders with motion extension network to reproduce the compressed frames. These compressed frames are then fed to the classification network. As the whole network is designed incrementally, the separate results of the compression network are also presented to illustrate the visual performance of the network as the classification results are directly dependent on the quality of frames reconstructed by the compression network. This model presents a potential network and results can be improved by the addition of various optimization networks.

Keywords: Compression, CNN, ConvGRU, Deep learning, PSNR, SSIM, Video.

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Abhishek Singh Rathore, Surendra Rahamatkar, Syed Imran Ali, Ramgopal Kashyap & Nand Kishore Sharma (Eds.)

INTRODUCTION

Videos take the maximum share of the internet content and it is growing exponentially day by day [1]. A lot of modern high-resolution formats of images and videos have been developed and used by cell phones to capture and store them. Various recent applications like autonomous drones, self-driving cars, and warehouse inventory systems are largely driven by video content. Videos store and convey a lot of information rather than still images convey. Emotions [2], predicting some future course of action [3], spatial awareness, and temporal context be better represented and conveyed by the videos [4]. These domains are less exploited and still emerging.

Several deep learning-based techniques for video analysis have been developed but they are quite simpler and primarily comprise CNNs. The techniques designed for image analysis are further extended for decomposing videos into consecutive still frames. But these techniques are not able to outperform the traditional hand-designed schemes [5, 6]. Deep Learning based object detection in images results in promising outputs but its transformative implication on video chores like action recognition is yet to be explored. Two arguments may support this concern. Firstly, the information density in the videos is low. A compression rate ranging from 1 GB to 222 GB can be achieved for a 720p video of one hour. Videos contain a lot of redundant information and this redundancy put some additional challenges before CNNs in extracting significant information from the videos. Moreover, it also results in slow training. Secondly, temporal feature learning is hard with RGB images only. A number of explorations have been made employing RNNs and 3D and 2D CNNs for video processing as RGB stills, but result in only marginal improvements [5, 7]. Further, the usage of pre-computed optical flow has enhanced the performance [8].

Action recognition plays an important role in video analytics. Here, the type of action is predicted based on the movements in the given video. As video accumulates rich information than still images, understanding or action recognition from videos stimulates new explorations in the field of vision and deep learning. Traditionally, for video content-based analytics, a video is first decoded to a large raw format on a server and then fed to an analytics engine for metadata generation. These metadata are then stored and used for analytics purposes. This requires the analytics server to perform both decoding and analytics computation. Fig. (**1**) illustrates the whole process.

The decoding of compressed videos for object/action detection increases the computation task of the analytics server. The efficient detection, directly from the compressed videos will surely enhance the whole process. This same concern has motivated us to propose this model. This model comprises an integrated network of compression and classification sub-networks. It exploits the compressed formats for classification tasks instead of decoding into raw format. The proposed scheme is presented in below Fig. (**2**).

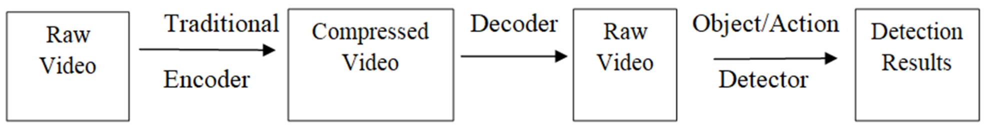

Fig. (1). Traditional scheme of object/action detection from videos.

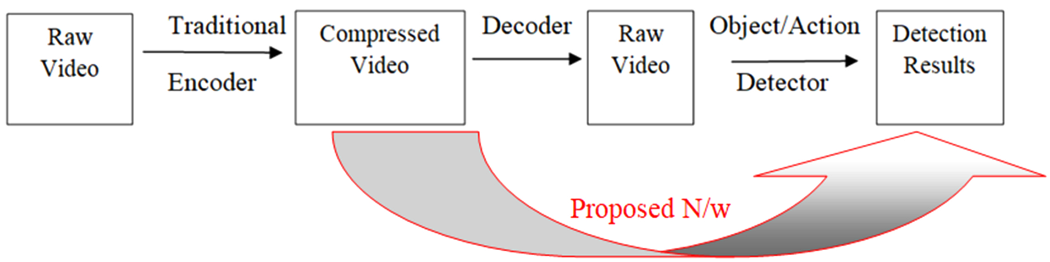

Fig. (2). Proposed scheme of object/action detection from videos.

The traditional compression codecs take into account the similarity between successive frames. They keep some of the important frames only and reproduce the remaining frames using residual error and motion vectors of the preserved frames. Our model comprises a flow autoencoder for efficient motion vector compression and processing. The frame autoencoder eradicates the redundancy and insignificant data and makes important signals prominent. The motion vectors provide better motion information than simple RGB frames. In addition, motion signals did not take into account the spatial differences, for example, if two persons are doing the same thing but in varied lighting and attires, they will generate the same motion signals. Hence, the generalization will get better and improves training efficiency due to lesser variation. The proposed model exploits some time-sensitive variations rather than i.i.d. frames in addition to the spatial features. This way of constraining information helps to address the dimensionality overhead. Avoiding continual processing of near duplicates and the use of only true signals also enhances the efficiency of the model. Lastly, as the classification operates directly on compressed formats of the videos, this saving of decompression overload also adds to the efficiency of the network. YouTube UGC data set is used to train the network. 600+ UGC content labels are used for studying the relationship between UGC content and perceptual quality. The model efficiently classifies the content into 39 labels with an accuracy of 0.67. The

CHAPTER 3

Object Detection and Tracking: Exploring a Deep Learning Approach and Other Techniques

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Abstract: Object detection and tracking have a wide range of uses, for example, in security and surveillance systems to deter and investigate crimes, for traffic monitoring, and for communication through video sharing. In a smart city, data is continuously being obtained through various means. In terms of video data, the data collected through cameras and other digital devices need to be analyzed to derive useful information from it. Hence, the concept of object detection and tracking comes into play. This chapter looks into developing various frameworks for object detection and tracking in the context of video data. We will be working with a database of 1,939 pencil images. These images will be used to train a neural network that performs image classification tasks. Various object detection methods are implemented such as Convolution Neural Network (CNN) image classification, Canny edge detection, object detection using the Haar Cascade classifier, and background subtraction. The experiments are carried out with Python programming language, TensorFlow, and OpenCV library.

Keywords: CNN , Canny edge , Haar cascade , Image processing , Neural network , Open CV , Object detection , Python .

INTRODUCTION

Video analytics is of high importance in today's world. By analyzing visual data, we attempt to detect, and track objects of particular interest, and interpret the action of the object. For instance, in the area of surveillance and security, video analytics can be used to monitor each person entering a store or designated area which can help in the prevention of crimes or criminal investigation. Visual analytics can also be applied in traffic management, automated parking systems [1], pedestrian detection, optical character recognition [2], vehicle counting [3], and several other areas. Video analytics brings about new visual data collection,

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Abhishek Singh Rathore, Surendra Rahamatkar, Syed Imran Ali, Ramgopal Kashyap & Nand Kishore Sharma (Eds.)

storage, and analysis methods. In large environments, capturing data and subsequently analyzing it can be a challenge. For instance, a camera can capture images of cars every second at a traffic light. Now imagine a human physically monitoring this data every second around the clock. This is not feasible, hence the need for modern techniques of video analysis.

Object detection and tracking is a field of computer vision that aims at detecting occurrences of a semantic object with a given label in digital videos or images, for example, detection of human's facial features such as eyes, nose, and mouth, detection of houses, cups, bridges, or road lanes. This field is ever-growing, and more technologies are being developed to help improve the accuracy by which objects are detected.

Object detection for visual data essentially works by initializing a tracking process which is then continually applied to each video frame. A common approach to object detection is using a deep-learning neural network. This concept will be explained in-depth further in the chapter, but basically, deep learning mimics the natural way by which humans assimilate and gain knowledge. The most common neural network used when dealing with visual data is the convolution neural network (CNN). This chapter discusses fundamental aspects of object detection using the convolutional neural network and other image processing techniques such as the Haar Cascade classifier, Canny edge detection as well as the background subtraction method of image tracking.

The objective of this chapter is to develop a framework for object detection and tracking using deep learning and various image-processing techniques. The specific aims are;

a. Developing a convolutional neural network to perform image classification tasks in a continuous stream of data.

b. Using Haar Cascade classifier to track various human facial features.

c. Using Canny edge detection algorithm for object recognition.

d. Image tracking using background subtraction techniques.

Porikli & Yilmaz [4], in 2012, provided research that discussed major developments in the detention and tracking of objects. In their research, several methods of object detection and tracking were discussed such as matrix decomposition where images were re-vectorized and used in background modeling. Karmakar *et al.* [5] developed a tracking system for dynamic objects that are based on vision guidance, using the guidance laws approach of the rendezvous cone. The system made use of a point estimator for localizing targets. The concept of background subtraction was explored by Wren *et al.* [6] who proposed to model each pixel with a single Gaussian distribution. However, using just one pixel was not effective for dynamic screens because multiple points may be seen as a pixel due to repeated object motions. In a study [7], a system was described by which a single human can be detected within a crowded environment. The method made use of local appearance structures with their geometrical relations using the top-down segmentation approach that is determined by the probability of each pixel occurring.

OBJECT DETECTION AND TRACKING WITH CONVOLUTIONAL NEURAL NETWORK (CNN) AND IMAGE PROCESSING

Building a deep learning model capable of analyzing picture input and classifying it into relevant classes can be used to discover objects. CNN is the most common neural network type used for image classification problems in deep learning. Convolutional neural networks (Fig. **1**) are examples of artificial neural networks that can take in an image as input and assign learnable weights and biases to distinct aspects/objects in the picture to distinguish one from the other.

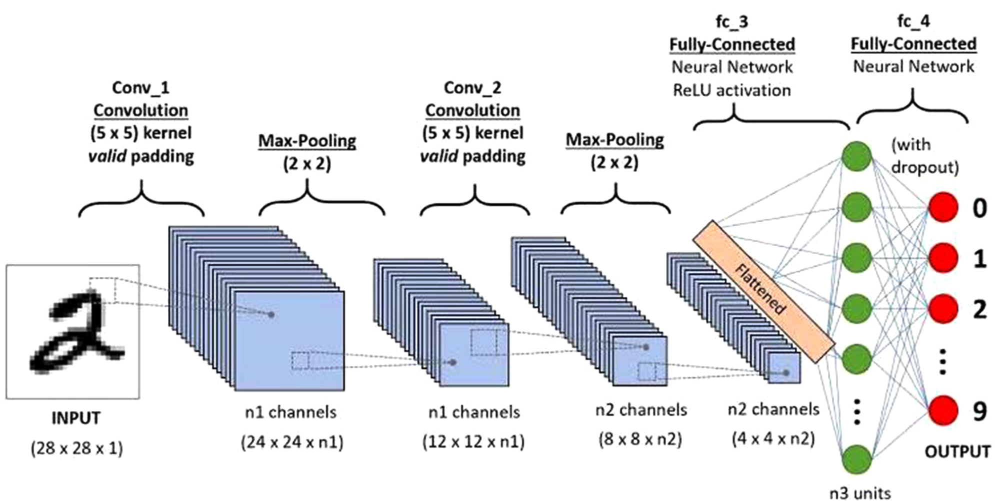

Fig. (1). CNN algorithm to classify handwritten digits [8].

CNN is highly efficient in dealing with image data than other neural network models. For example, trying to feed an image to an Artificial Neural Network can be very tasking for several reasons. ANN requires a large number of parameters (over 10,000 for very small images), you'll also end up losing all 2D information when you flatten out the image, therefore the model will be far less accurate than if done with a CNN. In other models to solve these issues with ANN, CNN makes

CHAPTER 4

Introduction and Overview of Key Enabling Technologies for Smart Cities and Homes

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Abstract: The Internet has come a long way in the previous three decades. It began as a content-sharing platform for early websites, portals, and search engines. With the globalization of Internet users, the importance and diversity of Internet material have increased; the Internet is increasingly connecting people rather than just connecting information. Other services, such as voice over Internet Protocol (VoIP) and video chat, as well as social networks, have enabled the social web. The end-user has changed as a result of the shift from information consumers to contributors and producers. This trend has accelerated with the introduction of smartphones and Internet of Things (IoT) devices. Smartphones have ushered in a new era of communication, in addition to data. End-users may access information from wherever they need to connect with their environment for basic everyday activities thanks to a new type of communication. Cabs may be summoned in large cities by pressing a button on a mobile device and using an app like Uber. The Internet connects things, dwellings, cities, and everything else that can be linked, with early information associated with individuals and later users engaging with other users *via* the social Web. As a result, a smart platform with a wide range of smart services emerges. This chapter examines the growing trend of connecting things and the issues they provide in the context of smart homes and cities, as well as a summary of key technological capabilities.

Keywords: Internet of things (IoT), ICT, Information and communications technology (ICT), SCDs (smart city departments), Smart homes, Smart cities, Smart governance, Smart economy, Smart obility, Smart grid, Security, Wireless power transfer (WPT).

INTRODUCTION

According to recent estimates, half of the world's population now lives in or near cities. These cities account for three-quarters of global energy consumption and greenhouse gas emissions. By 2050, the world's population will have increased by

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Abhishek Singh Rathore, Surendra Rahamatkar, Syed Imran Ali, Ramgopal Kashyap & Nand Kishore Sharma (Eds.)

30%, with cities accounting for 70% of the total population. Town planners and urban architects have sought to construct a vision for the future city based on the concept of a smart city [1]. Acceptance of these new concepts will be determined by the timely and successful delivery of a wide range of services. The way forward is to take advantage of the current surge in networked IT. Smart cities are aided in their expansion by technology breakthroughs such as the Internet of Things (IoT), public Wi-Fi access, all-around mobile coverage, 4G and 5G networks, and smartphones. Individuals and smart cities are bridging the digital divide using IoT and smartphones. These two ubiquitous and democratized technologies will make services available to everyone. Over the next ten years, smart cities will make significant investments. The development of technologies to assist smart cities is expected to cost roughly $100 billion. By 2020, most of these technologies will be commonplace. Aside from smart cities, the notion of smart housing is gaining traction. ICT is used in smart houses to take home and living to a new level. Intelligent dwellings make use of ICT as well. Clever gadgets link houses to the internet and digital services, which range from basic utility information like weather predictions to intelligent algorithms that manage and optimize residential energy usage [2].

There are no two intelligent grids that are the same. The first is that a significant effort must be made to build a smart grid environment in which utilities may participate without conflict; the second is that common features must be found for this sharing of common practices and standards to be practicable.

Although it is still in its infancy, the intelligent grid concept is evolving [1 - 4]. This immaturity is caused in part by a lack of “already there” strong corporate references, and in part by the fact that utility conditions change so quickly that, while consumption scenarios may appear to be the same, an implementation may differ substantially.

A reference to the modernization of the structure, as well as significant advances in electrical system sensors and controllers, may be identified as common components of all smart grid concepts. These components, which are constantly present in the grid, were built during network installation, monitoring, and local operation, as well as from remote, centralized control centers. Following that, these components were incorporated into automated systems capable of making difficult judgments based on large amounts of data. Even though smart grids require new infrastructure such as grids and algorithms (intelligence), ICTs [5 - 10] and this new infrastructure, telecommunications serve as the glue that holds it all together.

Telecommunication for utilities, on the other hand, is not a novel notion. Many telecommunication enterprises (traffic rights, pipelines, poles, fiber optics, telecommunications services, and so on) are now built on the essential infrastructure provided by these companies, and a few are even utility spin-offs. Telecommunication networks were built due to a lack of public transportation networks, or specially those that met critical commercial criteria.

Even though today's telecommunications networks are a valuable tool for utilities dealing with operations in hundreds of thousands of power distribution stations, earlier communication standards are unlikely to be cost-effective. The challenge becomes even more apparent when telecommunication coverage is not provided consistently and affordably by a single technology, but rather by a situational combination of commercial and governmental telecommunication solutions. In both cases, the challenge will be to seamlessly integrate a wide range of technologies over several important networks.

Global life expectancy is increasing at an alarming rate, especially in developed and newly industrialized countries, with most projections suggesting that this increase will approach 10 million people in the next ten years or so. Seniors are typically cared for in the hospitals or at home, where they are closely monitored. To satisfy the needs of this population, intelligent homes and cities might be employed efficiently and cost-effectively.

- Due to the following causes, there has been a boom in interest in intelligent homes and cities in recent years: increased global use of ICT devices and technology by consumers and businesses; green economy; growing interest in environmental conservation and cutting CO_2 emissions;
- Economic growth has been phenomenal in populous countries like China, India, and Brazil (China and India account for 40% of the world's population).
- The number of people over 65 who want intelligent houses and cities to live peacefully, healthily, and affordably is rapidly increasing in many countries, particularly in Japan, Europe, and China.

TRENDS IN SMART CITIES AND HOMES

Smart cities

Some characteristics distinguish a city as “intelligent.” Summary reports are provided [3]:

Immersive city services that leverage real-time data sensing and knowledge technologies to collect and analyze all data.

CHAPTER 5

Intelligent Processing: Scope and Application of Smart Agriculture in Smart City

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Abstract: By far, the Internet has been a major revolution in the field of communication technology as it allowed more and more devices and objects to get connected. The Internet of Things (IoT) has evolved rapidly as it can support intelligent data processing and can help in automation. IoT is gradually being used in various automation processes and also to make intelligent decisions. This paper analyses the various ways in which IoT can be used in agriculture. Intelligent system implementation in the field of agriculture can lead to a lot of advantages such as minimization of human intervention and resource wastage, maximization of profits, and efficient utilization of resources. This paper focuses on the model implementation and analysis of the implementation of intelligent systems in agriculture.

Keywords: App development, Artificial intelligence (AI), Communication, Dashboard, Intelligent processing, Internet of things (IoT), Networking, Robotics, Sensor, Smart farming, User interface.

INTRODUCTION

The Internet was a major revolution in the field of communication technology as it allowed people to get connected and share data easily. With the development of technology, more and more devices and objects are being connected to the Internet very rapidly. Nowadays, the Internet of Things (IoT) is gaining a lot of prominence in the technological world because it can support intelligent data processing with minimum human intervention. IoT is regarded as the next technological revolution in the information industry after the launch of the Internet. IoT is gradually being used to automate various processes, to analyze crucial parameters, and to take intelligent decisions. The volume of data generated

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Abhishek Singh Rathore, Surendra Rahamatkar, Syed Imran Ali, Ramgopal Kashyap & Nand Kishore Sharma (Eds.)

by the things connected through the Internet is increasing exponentially with every passing day. This has resulted in an increase in intelligent processing machines that can make real-time decisions based on sensor data. The major concern for the implementation of IoT is the storage, retrieval, and analysis of huge amounts of data that are being generated through these connected devices. Another major concern is regarding the security of the data. IoT has the caliber to completely change the present Internet scenario and hence it is important to understand the underlying technologies that support IoT.

INTERNET OF THINGS (IOT)

The IoT is a group of intelligent machines which connect objects or things to the Internet for swapping information and providing communication *via* sensing tools according to a set of protocols. It achieves the goal of intelligently identifying, tracking, locating, managing, and monitoring things. As depicted in Fig. (**1**), the IoT integrated technologies include Software Applications, Sensing Technology, Network systems, Data Analytics, Hardware and Software Systems, and Global Positioning Systems. The Internet of Things (IoT) is a network of virtual and physical things that may be utilized in several ways to innovate and facilitate a range of useful tasks. The Internet of Things is a calculative and processing concept that draws an idea of everyday observable things being associated with the Internet and being able to communicate with other devices. The term is closely identified with RFID as the process of communication, although it may also consider other wireless and sensor technologies or QR codes. The ability to provide real-time communication between objects or things makes IoT a very desirable technology. The scope of implementing IoT is also very vast as it can be integrated into a host of objects for communication, control, and automation.

The IoT is an important technological advancement because an object that can constitute itself digitally becomes more useful and important than the objects by itself. No longer does the object just relate to its user, but it gets associated with the surrounding objects, machines, and database. When so many objects or things behave in unison, they possess “ambient intelligence”. In an IoT-based environment, smart devices are used to enhance the existing processes and introduce new approaches to gather data and using it efficiently. It provides better decision-making and improved performance in the system. But, there is a major concern about the security and privacy of sensitive personal data. IoT provides a boundless imagination which put it on an edge of reshaping the current forms of the internet into an altered and integrated version. The types of communication we see nowadays are either human-human or human-device, but the IoT assures an extent future by enabling the internet technologies and the sensor networks where the type of communication is machine-machine (M2M). The usage of IoT in various applications is expected to increase rapidly in the coming era.

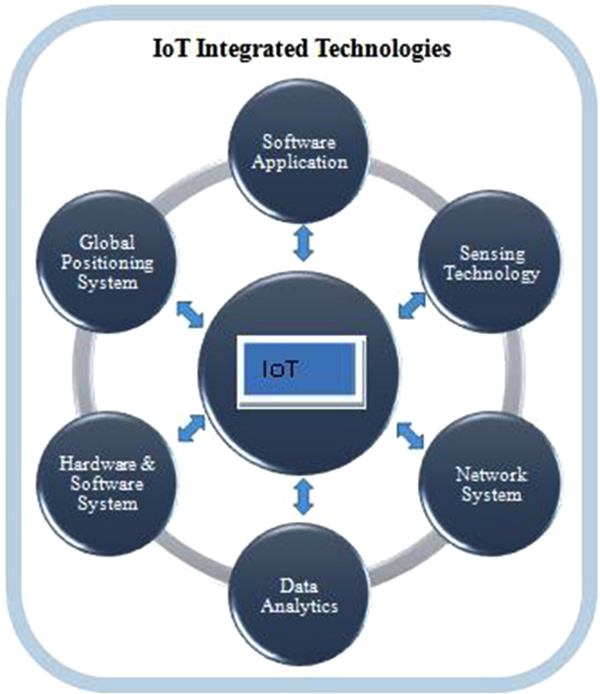

Fig. (1). IoT Integrated Technologies.

INTELLIGENT PROCESSING

The IoT has initiated to unite intelligence and autonomous control into its environment. It could build into a non-detected and open network of auto-organized structures. IoT is utilized for smart applications and innovative technologies by using intelligent processes. The data generated by sensors are being analyzed and intelligent decisions are being taken in real-time. With the use of intelligence processing, IoT bridges the space between the materialistic and digital world by providing connection and communication between things. Intelligent processing is gaining a lot of popularity as it facilitates automation and requires less human intervention. With a huge quantity of data being produced every second, demand for intelligent processing machines is increasing at a fast speed.

Intelligent Process Automation (IPA) is the application of new technologies related to Artificial Intelligence including Cognitive automation, Machine Learning, and Computer Vision to Robotic Process Automation. This union of

CHAPTER 6

Challenges and Security in Terahertz Band for Wireless Communication

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Abstract: As society generates, transmits, and consumes information, wireless data traffic has grown dramatically in recent years. As a result of this shift, there has been a surge in demand for even faster wireless networking that can be used anywhere and at any time. Over the last three decades, the amount of data sent wirelessly has tripled every eighteen months, reaching the capacity of wired networks. Wireless Terabit-per-second (Tbps) connections will be a reality in the next five to ten years, if current trends continue. Support for these extraordinarily high data speeds will need advanced physical layer technologies, notably present spectral bands. Terahertz Band networking is envisioned as a vital wireless technology to meet this need, alleviating bandwidth depletion and power limits in present wireless networks, and allowing a deluge of long-awaited applications across a variety of industries. THz is a spectral band with frequencies ranging from 0.1 to 10 GHz. Despite the fact that the frequency ranges immediately below and above this band (microwaves and far infrared, respectively) have attracted a lot of attention, this is still one of the least explored contact bands.

Keywords: Bandwidth, Cellular networks and 5G communication, Spectroscopy, Terahertz.

INTRODUCTION

The THz Band's very wide bandwidth allows for the development of a wide range of modern technologies in both traditional networking and new nanoscale connection paradigms. Any of these implementations may be predicted in advance, while others will undoubtedly arise as technology advances. THz Band networking is used by next-generation small cells, such as hierarchical and heterogeneous cellular networks. Small cells would be able to communicate at

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Abhishek Singh Rathore, Surendra Rahamatkar, Syed Imran Ali, Ramgopal Kashyap & Nand Kishore Sharma (Eds.)

ultra-high speeds with coverage ranges of up to 10 meters using the THz Band. In both indoor and outdoor contexts, the operating structure of these tiny cells incorporates static and smartphone involvement. THz Band networking allows ultra-high-speed wired networks, such as fibre optic cables, to communicate with personal wireless devices like laptops and tablet-like devices (no speed difference between wireless and wired links). This will make bandwidth-intensive apps more accessible to static and mobile users, particularly in indoor situations. Synchronization is a crucial activity in cooperative communication, both at the receiver and across several transmitters, and it becomes more difficult in ultra-broadband networks for the following reasons. To begin with, sampling at the Nyquist rate and performing complex signal processing operations at Tbps data rates are both very difficult. Second, various users' local oscillators create carrier frequencies in different ways, resulting in large frequency offsets across systems [1 - 5].

Short-range communication employing pulse-based modulation methods may be accomplished using low-complexity noncoherent analogue detectors like the energy detector and auto-correlation receiver. A more sophisticated non-coherent receiver is being developed using a Continuous-time Moving Average symbol identification algorithm in this approach. In terms of symbol error rate, this symbol detection approach outperforms previous detection systems for pulse-based modulations, lowering the synchronization need. For ultra-broadband communication in the THz Band, longer communication distances need robust and trustworthy synchronization mechanisms. In the near future, it is expected that the Terahertz Band (0.1–10 THz) will meet the need for Tbps wireless communication. THz Band connectivity can overcome the current spectrum shortages and power limitations in wireless systems, enabling a variety of applications such as ultra-fast massive data transfers between neighboring devices or high-definition videoconferencing across mobile personal devices in small cells [6 - 10]. In addition, the THz Band might allow new nanoscale networking paradigms like Wireless Nano Sensor Networks and the Internet of Nano-Things.

From a computer standpoint, this research examines the state of the art in THz Band technology, covering various system transceiver topologies as well as new ultra-broadband and exceptionally wide antenna array designs. In terms of channel modelling and at various levels of the protocol stack, from the physical to the transport layers, we've also uncovered connection difficulties and proposed viable solutions. Finally, we examined the current status of experimental and simulation platforms and highlighted the most major impediments to their implementation. Due to a paucity of good sources and detectors in this THz gap, the THz (1012 Hz) section of the electromagnetic spectrum from around 100 GHz to 10 THz was essentially inaccessible until recently [11 - 15]. Since the 1960s, astrophysics has been a driving force behind the development of detectors in this frequency range, since the rotational spectra of several gases of astrophysical and environmental relevance lie within this band. In millimeter and submillimeter wave astronomy, observational astronomers used cryogenic detectors to capture spectra (named after the wavelengths). The development of photoconductive and electro-optic methods for creating and monitoring radiation in the THz frequency range was sparked by a pioneering work on picosecond photoconductivity in silicon. As a result, there has been a boom in interest in this frequency range, and a lot of work has been done for developing efficient sources, sensitive detectors, and appropriate modulators in this range [16 - 18].

CHALLENGES IN TERAHERTZ BAND

Lower-frequency sources depend on electric generation regulated by classical electron transport, such as RFs for AM and FM radio and microwaves. At these wavelengths, most dielectric materials are transparent, enabling radio reception and wireless communication within. For example, radar imaging has a resolution in the order of the wavelength and is often restricted to a few centimeters. The optical domain, which encompasses IR emission, visible light, and UV, is indicated by higher frequencies in the spectrum. Light is created through quantum transitions, which may provide exceptionally high intensities when used by lasers. The rules of this regime govern how electromagnetic radiation propagates in free space. The phrase “THz communication” may refer to either successful data rates exceeding 1 terabit per second (usually on an optical carrier) or communication using a THz carrier wave, which is the subject of this article. THz frequencies are appealing for a number of reasons, including frequency band availability and communications bandwidth. Although larger bandwidths can be obtained at optical wavelengths through point-to-point optical communications, THz frequencies are appealing for a number of reasons, including frequency band availability and communications bandwidth. According to the United States Frequency Allocation table, the Federal Communications Commission has yet to award frequencies above 300 GHz.

THz networking is still in its infancy since the first data transmission in this frequency range was just recently validated. THz imaging is an interesting application that has spurred a great deal of THz research. The ability to image from dielectrics with a resolution of a few hundred of micrometers has several uses. Many systems, like the one at APL, use a photoconductive emitter to provide THz imaging with time-domain experimental setups by scanning an area *via* the focus of a single pixel. In the whole picture, each pixel possesses both a time domain and a spectrum waveform (with phase). The average time it takes to capture a photograph is in the tens of minutes. A full-field time-domain picture

CHAPTER 7

Empirical Impact of AI and IoT on Performance Management: A Review

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Abstract:

Purpose

In general, the role of AI and IoT in increasing the performance level of businesses has been discussed here to establish understandable data with several objectives regarding future potentials, business growth, and relevant challenges. Therefore, how different industrial businesses are using these two variables in their workplace cultures have been prioritized in the entire study.

Research Method

Secondary qualitative research method has been followed throughout the review work by aligning the systematic review and thematic analysis to get a clear overview of the topic. All the data have been collected between the published year- 2017- 2021 based on several inclusion criteria for numerous relevant measures. The researcher has counted on all essential methodological tools such as positivism philosophy, descriptive design, and deductive approach to make the study reliable.

Findings

The business sector units are focusing on their various departmental improvements such as Human Resources, supply chain, logistics, data transfer, *etc*. and others have been found to work efficiently with the help of AI and IoT automation sensors' productivity. Furthermore, it has been proved that the selection of topics has been beneficial to get expected findings by using various journals in similar regard.

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Conclusion

Hence, the conclusion section has illustrated how efficiently the researcher achieved the knowledge of the topic by focusing on its various relatable factors to improve the performances in businesses. Researching such a topic based on the current global scenario is found advantageous to move with the interest for further studies.

Keywords: AI, IoT, Industrial growth , Performance management , Technologies.

INTRODUCTION

Corporate performance management is adopting changes with the new technologies, especially to advance data analytics through Artificial Intelligence (AI). In previous times, it was not possible to create a correlation between the information and achieve a deeper insight which created challenges so many times to take effective decisions with potential development. This Industry 4.0 era has been found to depend on networks for being connected to the world, which has been possible due to the Internet of Things (IoT). Different IoT drivers to influence performance management can be seen in Fig. (**1**).

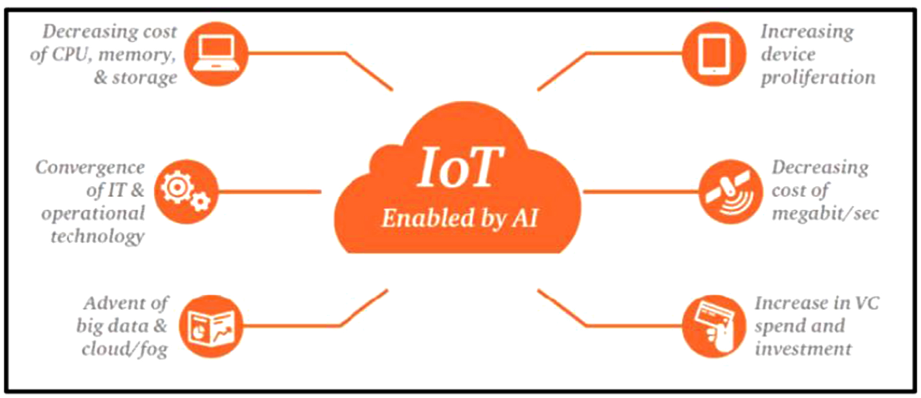

Fig. (1). IoT drivers to influence the performance management [1].

Intelligent communication across global networks has become possible with the help of IoT and the performance management of Human Resources has become efficient as well. Process automation works with high efficiency as it can work repetitively with a similar level of consistency by maintaining a standard that is not possible for humans [2]. With the help of computer software, the implementation of robotic process automation has made performances faster and errorless such as secure bank transactions, data transfer from one to another cloud, and others that play crucial roles in business performance betterment. There is no clear definition for the word IoT because it is so broad and extensively used. Several organizations and researchers have defined the Internet of Things. The

International Telecommunication Union (ITU) described it in 2012 as "a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies" [3]. There's no denying that AI has become one of the most influential issues in a variety of fields. The Merriam-Webster dictionary defines artificial intelligence as "the capability of a machine to imitate intelligent human behavior" [4]. The main goal of AI is to develop new models and ways that can perform intelligent tasks. In most cases, AI is based on experiments in which the researcher uses the computer system as a lab to validate and verify their assumptions [5]. Integrating the IoT with AI has the potential to create a powerful solution that can address a variety of IoT difficulties caused by the massive amount of data created by billions of IoT devices. Traditional analytical approaches will not be able to analyze these massive amounts of data; instead, adopting various AI and machine learning methods will be able to analyze and extract useful information, allowing you to reap the full benefits of IoT data [6]. With AI's tremendous analytic capabilities, many governments and businesses have begun to use AI technologies to uncover the value of massive amounts of IoT data. Although the discovery of fog/edge computing reduced response time, allowing real-time-based IoT applications to grow dramatically, AI-based techniques will be able to give a greater performance in a much shorter time frame. Furthermore, combining AI and IoT can improve security by not just combating external attacks but also providing an effective means to predict them. The Internet of Things (IoT) is a cutting-edge technology that has the potential to transform our lives, businesses, and economies. The Internet of Things generates a plethora of digitized services and applications that outperform traditional solutions in various ways. The following are some of the traits that these applications and services have in common [7 - 9]. Features of IoT systems include sensing capabilities, connectivity, large scale networks [10], dynamic system, intelligence capabilities, Big data, unique identity, autonomous decisions, and heterogeneity. The centralized IoT architecture, on the other hand, poses several difficulties (*i.e.*, Single Point of Failure, Security [11], Privacy [12], Inflexibility [13], Cost [14], Scalability [15], Access and Diversity [16]). It, for example, has scalability concerns since it can't keep up with the increasing influx of IoT devices. Furthermore, it raises a slew of security and privacy concerns [17].

Fig. (**2**) depicts the market revenue after adopting AI and IoT technologies. In comparison to other traditional technologies, AI is making machine learning procedures 20x faster. By promoting safer connectivity among devices through the internet and AI, pattern identification and fault detection during data collection are stimulated enough through advanced sensors. With the growing performance, the business market revenue is also increasing from $9.51 billion to $34.87 billion in 2021 and it is predicted that in 2025, it will cross $110 billion

CHAPTER 8

A Review of Progress Status in Achieving the Jal Jeevan Mission Goals in the State of Chhattisgarh

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Abstract: The water governance process is seen as a mechanism to solve both the deficiencies of the broader governance process and the Millennium Development Goals (MDGs). Millions of people in India rely on unstable, low-quality water supplies that are expensive and far from their homes. Water scarcity has a wide range of socioeconomic consequences. Women and girls are typically entrusted with the responsibility of collecting water for domestic purposes. Providing rural communities with piped water for drinking and domestic needs is an important and difficult endeavor. In light of the above Amity University Chhattisgarh partnering with UNICEF Chhattisgarh is entrusted with the responsibility of providing technical & monitoring support to the Mission Directorate, Jal Jeevan Mission (JJM), and Public Health & Engineering Department (PHED), Government of Chhattisgarh along with Institutional Capacity Building, planning, monitoring and reporting for effective implementation of safe rural drinking water facilities across the Chhattisgarh State.

Materials and Methods

In this perspective, the prime objective of the project was to strengthen the institutional capacity building, and program monitoring in 28 districts of Chhattisgarh through the establishment of the State Program Management Unit (SPMU) at the Directorate of Jal Jeevan Mission (JJM) and Project Management Unit (DPMU) at 14 district levels with light support to 14 additional districts. The method used for data collection was primary and secondary. The findings of the study are presented in suitable tables and graphs.

Results

Results of the study show the progress in solving drinking water problems in rural areas of Chhattisgarh since the inception of the monitoring project *i.e.* 1st June 2021.

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Abhishek Singh Rathore, Surendra Rahamatkar, Syed Imran Ali, Ramgopal Kashyap & Nand Kishore Sharma (Eds.)

Conclusion

In this paper, an attempt has been made to report the progress of the implementation of the JJM scheme in partnership with UNICEF Chhattisgarh.

Keywords: District planning, Jal jeevan mission, Rural drinking water, Sustainability.

INTRODUCTION

Sustainable rural drinking water is a common goal in India and around the world, ranging from individual households to village, district, state, and national levels. The Government of India launched the Jal Jeevan Mission in December 2019 intending to provide functional household tap connections (FHTP) to everyone by 2024 as a highly ambitious goal. As on 12th February 2022, only 46.59% of the rural household throughout India had tap connections although the number is increasing rapidly. It varies widely amongst states, ranging from 17.71% to 100%. Chhattisgarh state with its 28 districts had only 17.71% of the rural household had tap connections as shown in Fig. (**1**).

Although tap connections are significant, they are not the only indicator of safe drinking water availability. According to the Ministry of Housing and Urban Affairs, the benchmark for urban water supply is 135 liters per capita per day (lpcd). Under the Jal Jeevan Mission, the minimum service delivery of 55 lpcd has been set for rural regions, which states may increase to a higher level. Do rural households get the full 55 liters per capita per day (lpcd) that current national requirements require? Is this quantity received every year, or do they require tankers during dry months and drought years? Do different classes, castes, and tribal habitations receive the same level of service in villages? Do they collect enough fair water tariffs? Is it still necessary for women and girls to fetch water from faraway wells or ponds? Is the water safe to drink? 933 water samples were collected from National Hydrograph Stations across Chhattisgarh to test the chemical purity of groundwater. These samples were taken in May 2018, during the pre-monsoon season, when ion concentrations were at their highest. pH, EC, CO_3, HCO_3, CI, SO_4, F, TH, Ca, Mg, Na, K, PO_4, and Si were all determined in the water samples [1]. These are some of the most pressing issues facing India's rural drinking water sustainability today. It's worth noting that India is quickly urbanizing, and the lines between urban and rural are blurring. Rural areas are classified as those with fewer than 5000 persons, less than 75 percent of the male workforce engaged in nonagricultural occupations, and population densities of less than 400 people per square kilometer, according to the Indian Census. Rurban or peri-urban villages are becoming more common. Rural residential water service must meet a national level of 55 lpcd, whereas peri-urban regions must meet a standard of 70 lpcd, and urban areas must meet a standard of 135 lpcd.

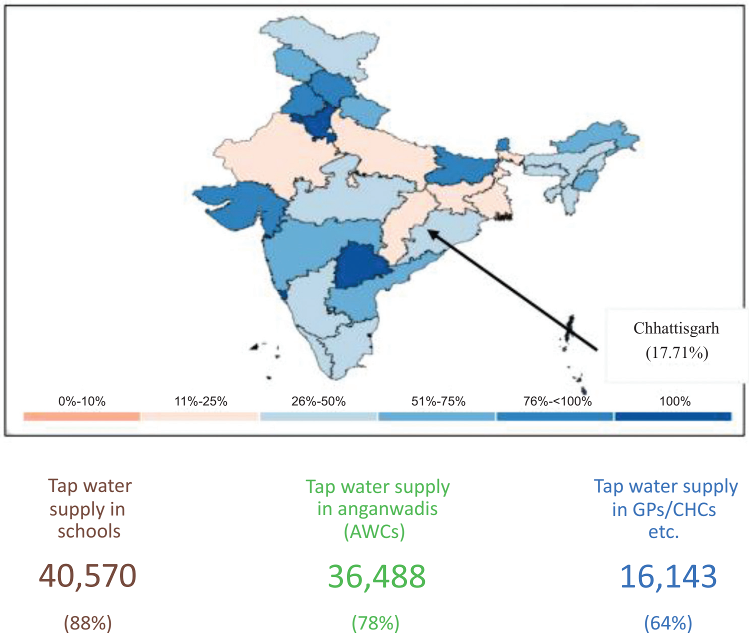

Fig. (1). Percent of households that have 100% household tap connection and data from the dashboard of Jal Jeevan Mission.

In Chhattisgarh, according to India's Integrated Management Information System (IMIS), 11,598 rural programs targeted 15,116 habitats. In the rural drinking water sector, sustainability is described as a scheme's ability to provide a planned level of water supply over the scheme's design life, which is influenced by financial, institutional, environmental, technological, and social issues. In the coming years, the millions of new Jal Jeevan Mission piped-water supplies and tap connections that are being built will need to address these sustainability issues.

Two broad lines of research have been conducted in India and states such as Chhattisgarh to address access to safe and sustainable rural drinking water supplies. On a bigger scale, national and international institutions have used aggregate statistics databases like the ones listed above to track drinking water access. These databases, which were created at significant expense and with great efforts, track progress toward drinking water goals and assist in identifying problem regions [2].

SUBJECT INDEX

A

B

C

Abhishek Singh Rathore, Surendra Rahamatkar, Syed Imran Ali, Ramgopal Kashyap & Nand Kishore Sharma (Eds.)

D

E

F

G

H

I

L

M

N

O

P

U

V

W

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