FUTURISTIC PROJECTS IN ENERGY AND AUTOMATION SECTORS:

A BRIEF REVIEW OF NEW TECHNOLOGIES DRIVING SUSTAINABLE DEVELOPMENT

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FOREWORD

Energy conservation and optimization are the prime mottoes of many industries and governments of the current time. Not only nations thriving hard to reduce the comprehensive usage of fossil fuel, but also there is an intense need to develop alternate energy sources to cater to the future generation world. On one hand, carbon credit is an accepted ticket to curb carbon emissions, while promoting carbon free energy sources like solar cells, wind mills, tidal turbines, biofuel, and hydel-turbo-generator are the center point of interest among the power merchants on the other hand. There have been huge incentives and promotions by governments and capitalists on utilizing renewable energy resources in recent years. This motivation has prompted the faculty and students of a range of colleges in India and around the world to work on the most recent experiments in these areas and publish the compiled work as a bible of real time projects that could better serve as a handbook of futuristic projects in energy systems and allied fields.

No doubt, the automation sector is an integral part of the recent development in the energy sector, be it automation, robotics, or artificial intelligence. So, the book is a conglomeration of advances in the energy sector and automation. The unique feature of this book lies in the fact that the theoretical coverage is either nominal or pertains to the need for the real time projects. So, the reader will encounter more of a practical situation in a given area of technology. The reader would encounter a wide variety of projects that would open a broad area of research in the field. This book would find its contribution to the consultancy firms who apply new ideas and sponsor such futuristic viable projects. This compilation would definitely invite the attention of the Sector Skills Councils of India and skill training programs worldwide which extend financial and technical support toward the field oriented technical enhancements in service industries. The projects presented in this work would probably develop an insight among the technocrats to determine an ecosystem that relates the apparently disparate areas of future interest, *viz*. energy systems, power systems, e-vehicles, soft solutions, automation, and artificial intelligence. I believe that this release would find itself as a harbinger in the series of editions in the future.

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PREFACE

In light of the present-day statistics of coal mines and petroleum bases off-shore, the globe will be devoid of core energy sources in a very short period. Thus, many countries mandate exploring renewable energy resources without any further delay. The present endeavor, namely, 'Futuristic Projects in Energy and Automation Sectors' is an initiative taken by Bentham Science, technocrats and researchers to expedite the mission of establishing new RERs and propose a support system for future developments in RERs through experiments and studies. This volume would be a handbook for scientists, technocrats, researchers, teachers, students, practitioners, law makers, and industry experts working in the disparate areas of energy conservation, global warming, green energy, conservation of earth, automating services, electrification, energy optimization, and what not.

However, limiting the focus of the stakeholders to a few specialized areas of evolution, the current volume is restricted to a classified set of topics, *viz*. 1) energy research that includes power systems, renewable energy, power storage, and power electronics, and 2) automation that involves robotics, control systems, and artificial intelligence. Thus, this text is a conglomeration of the specific areas of 1) Power Systems, 2) Renewable Energy, 3) Power Electronics, and 4) Energy Storage and Conversion, 5) Home automation, 6) Control Systems, 7) Robotics, 8) Artificial Intelligence, and 9) Technology to fight COVID-19. Thus, this handbook is an optimal compilation of the present-day issues and futuristic solutions to the problems in energy and allied topics by means of Electrical and Electronics Engineering. The chapters presented in this book are based on experiments in the laboratory or field to establish a hypothesis or retest a fact.

The book is technically classified into five units, *viz*. 1) Advances in Energy Systems, 2) Renewable Energy, 3) Advanced Approaches in Electric Vehicle Technology, 4) Control, Automation and Smart City, and 5) Artificial Intelligence.

Chapters 1, and 2, comprise the chapters in the diversified areas of sustainability of bioenergy during the pandemic and beyond, and green economy with blockchain.

Chapters 3,4 and 5 deal with the studies of solar energy for the future, optimization of the hybrid energy storage system, and wind turbine performance studies.

Chapter 6 deals with electric vehicle charging technologies and their harmonic studies.

Chapters 7,8,9,10, and 11 have brought forward the latest technologies in the applied areas of control, automation, and IoT devices. The topics are solid waste management, sanitized vehicle parking systems and their simulation results, performance analysis of induction motor drives, and Advanced Reconnaissance Rover.

Chapters 12,13,14,15 and 16 are the last but not least as it comprises energy optimization projects via artificial intelligence techniques. The topics are digitalized agricultural phenomena using disruptive technologies, image processing on resource-constrained devices, quantum computing in artificial intelligence, gesture-based ATM security, and big data.

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It was obvious since the inception of the idea of producing this experimental book on energy systems that we need participation of experts with exposure to the diversified subject areas. As a matter of serendipity, specialists from different specializations participated in mentoring this book at different stages. We are thankful to the editors from ARTC-ASTAR, Singapore, National Institute of Technology Jamshedpur, India, India, and Dr. Akhilesh Das Gupta Institute of Technology & Management, New Delhi, India.

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CHAPTER 1

Biomass: A Sustainable Foundation for Bioenergy and Bioremediation - It's Confronts and Scenarios in the COVID-19 Era: A Review

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Abstract: Various nations have distinct visions/missions and energy implementation strategies. Energy sources are essential to a nation's economic development and a necessity for all inhabitants. Several nations face varying degrees of energy catastrophe as a result of insufficient natural resources today mixed with the COVID-19 outbreak. This emergency led to the shutdown of numerous industrialized divisions exacerbated unemployment, constrained energy access, and associated societal shocks. A fundamental reason for these conflicts is the widening chasm between energy delivery and orders, financial issues, logistics, and irrelevant strategic planning considerations. The use of bioresources as a novel source of waste biomass was identified as a crucial criterion for bridging the gap and creating a vast outlook for an environmentally friendly biorefinery and bioremediation process. This presents a potential obstacle, as it suggests a replacement for fossil fuels in the production of specialty compounds and energy carriers. As a carbon-neutral mode/s, this reduces market anxiety and negative environmental repercussions. This ecological bioremediation with the use of biomass (phytoremediation), less expensive sorbents (for bioaccumulation and biosorption), and

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microorganisms (mainly agricultural byproducts) is more favorable than conventional ones.

Keywords: Bioenergy, Biomass, Biorefinery, Bioremediation, Biosorption, COVID-19, Phytoremediation.

INTRODUCTION

Energy, according to author Pratap *et al.*, is the aptitude and vigour to assume responsibility for one's actions. Energy is essential to human existence. It helps the growth of numerous industries, including agriculture, shipping, and communications [1]. There are various forms of energy, including gravitational, nuclear, thermal, chemical, electrical, acoustic, and radiant. There are renewable and nonrenewable categories of energy sources. Nonrenewable resources include fossil fuels including petroleum, coal, and natural gas. The transformation of renewable resources into solar energy, biomass, wind turbines, hydroelectricity, and geothermal energy [2]. The majority of nations' energy consumption rises over time due to socioeconomic and lifestyle changes, non-ecological urban planning and architecture, and population expansion [3 - 5]. Pratap *et al.* [6]. also demonstrated that customer actions invariably affect energy consumption. The city's way of life is energy-intensive, and its residents are appealing and costly [7]. Changing lifestyle norms have increased consumer demands; as a result, the rising demand for rapid energy has led to an increase in carbon emissions [8]. The efficiency of energy use is virtually reflected in the fuel(s) used, and the widespread cultivars are more resilient than conventionally normal. According to BP's testimony [9], Universal critical energy climbed by 3.5% in 2019, the largest increase since 2012. These occurrences occur in the context of sluggish Gross Domestic Product (GDP) growth and rising energy prices. In the chorus, carbon emissions related to energy grew by 5%.

Numerous environmental, political, social, technological, and economic issues can impact the global production and consumption of energy. The COVID-19 outbreak disrupted the worldwide energy industry by creating a rapid spike in oil prices and insurance claims, a fall in international CO_2 emissions, unemployment, and heightened energy supply panic. These issues induce the worldwide energy catastrophe. A fluctuation in energy indicates that it is not in equilibrium with its production, followed by a significant increase in energy charges and discharges, resulting in an ambiguous energy visualisation. To achieve the stated goals, the administration of universal energy reserves should be led by objective scrutiny. The global energy amount is a statistic used to monitor the growth of global energy expertise. International Energy Agency [10]. stated that until 2035, the primary target is to cut energy consumption by 3% annually. In comparison, the

rate of global energy intensity growth is just 2% in 2018, and a 3% yearly rise is required until 2035. In 2019, the global energy increase was only 1.5%, indicating that between 2020 and 2035, the global energy strength must expand by 3% per year to meet the sustainable development. goals and objectives. To attain this purpose, it is necessary to establish and implement energy competency policies and innovations. The tactical supervision course for global energy outlines where and why the evolution of global energy must proceed. People must simultaneously decide how to depart and acquire the thing. Legislators must include a map that incorporates supervisory procedures at all levels, including global, provincial, national, state, city, district, and zone, in terms of liability. This enduring drawing illustrates a way for creating planned supervision for worldwide power, although existing attempts are primarily focused on planned administration for a single nation. Several states have diverse perspectives, obligations, and techniques for power management with their aid. To promote sustainability, governments must assess the sustainability component of their proposed administration. In terms of truthfulness, the insertion of sustainability into the global power administration's strategic administration is composed yet awkward. Attendance is essential for global-echelon strategic administration that integrates the vision, mission, and strategy of each nation so that the production and expenditure of all energy foundations can be sustainable and satisfy all social needs [11 - 16]. Biomass (BM) refers to animal/plant matter used to produce energy and food, as well as a natural resource for a wide range of substances in various engineering processes, with an added emphasis on ecological fortification. BM is a synthetic substance produced from C, H, and O. Global biomass production is predicted to reach 121 billion tonnes (C-equivalent/year) by the end of the 21st century, with approximately half of that coming from soil and the other half from water [17]. BM was the most significant energetic foundation that contributed significantly to the evolution of humans during the invention of combustion [18]. In contrast, the extensive use of BM has contributed to singular environmental disasters that have recurred throughout history due to deforestation, soil depletion, and catastrophic global warming.

After the medieval ages, human history developed to rely on a new source of energy. A few other energy resources and artifacts remain to be uncovered, even the fossil fuel in custody is superior. A few of them were ancient biomass workout pedestals [19].

The current global COVID-19 outbreak, which could result in an epidemic, is a source of concern for many. It is disastrous for a variety of livelihoods in low-, middle-, and high-revenue countries, irrespective of the background and socioeconomic class of the persons afflicted. Even though the majority of the world's population lives in prosperous regions, catastrophic disasters are

CHAPTER 2

Green Economy with Blockchain and Microgrid

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Abstract: 100 % Green economy is a dream to be realized by every economy in the world. Every economy is firm in its motives in terms of investing in Green Technology and enhancing its contribution to the Green Economy, strategically any nation that masters the art of maximizing its Green Energy productivity is going to be a crucial player in the world order. In this scenario, Blockchain comes in as a tool that can be positively exploited for mankind's betterment, especially in the field of Energy Conservation. Microgrid system in this context is a revolutionary mechanism for opening up the market of energy exchange to the public and reducing energy wastage/consumption.

Keywords: Blockchain, Green Economy, Microgrid.

INTRODUCTION

What does Block Chain involve? The four pillars that permit more precise and speedy data sharing for business transactions are Consensus, Security, Provenance, and Trust. It lets and tries to simultaneously record transactions and track assets on any corporate network. Any tangible (a home, car, cash, or property) or intangible (intellectual property, patents, copyrights, or brand) item is an asset. A block consists of data plus a linking part, also known as a Chain. This chain is effectively a cryptographic signature based on a hash function that ensures the blocks cannot be altered under any circumstances.

Let us try to understand the evolution of blockchain over time. In 2008, Satoshi Nakamoto uploaded the first Bitcoin block to create a shared (P2P) currency for people developing Blockchain technology. Because of the subsequent increase in Bitcoin's value, the media began to release more information on Bitcoin. The underlying Blockchain innovation's revolutionary concept has been extensively covered by the media [1, 2], including its exploitation by criminals to shift crypto-bitcoins without leaving actual evidence. The Bitcoin address connected with an

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exchange does not correspond to a specific character. In May 2017, NSA-created ransomware escaped and exploited a weakness in older versions of Windows to attack machines worldwide. Erebus was able to get a rollback/key for $1,000,000 USD, however the ransomware was only capable of obtaining 50 Bitcoins as of the end of May 2017, rendering it fatal. Although its criminal uses are unmatched, the underlying Blockchain technology has attracted the interest of the financial sector, which believes that Blockchain will significantly transform banking, security, and resource management. Long has the medical services industry desired to utilise Blockchains for safe, coordinated data utilisation. Various Blockchain arrangements for the stock exchange board are currently in development, and governments around the world are researching Blockchains for electronic voting. Let's study the many Blockchain types:

TYPES OF BLOCKCHAINS

Public Blockchain

Public Blockchains are typically considered to be “simple” and “decentralised” accordingly. A person who can research the data stored in the Blockchain, doing transactions and exchanging data during the time spent studying it. It is important to utilise an open Blockchain [3] and set up devices. These Blockchains are more responsive and trustworthy than earlier Blockchains.

Blockchain Consortium

Blockchain Consortium is essential for social gatherings where only a clearly identified centre is permitted to share information throughout the planning process. In general, they are considered decentralised. Approval for social events may be obtained in a public or private context. The benefits are that they can be performed faster and provide wider coverage. In general, they are employed in the financial industry [3].

Private Blockchain

Private Blockchains are managed by a single individual or entity that has authorised the transactions and scrutinises the trades. The Blockchain may be entirely open or completely closed. The Blockchain is modifiable (for instance, trades can be reversed), the validators are known, there is no risk of a 51 percent attack, trades are cheaper, faster understanding estimations are possible, and a higher level of protection is provided if the read approvals are bound.

When it comes to large-scale energy creation, superlattices have been associated with various types of frameworks; some of these frameworks are exchanged as a

solution to long-distance storage problems, whereas microgrids [4] are regarded as "the" solution for the combination of various decentralised energy frameworks. Even though this section is concerned with microgrid-beneficial methods, a portion of the tasks also involve a big number of superlattice issues. While microgrids offer numerous practical benefits, like as a dependable and cost-effective architecture, any modifications should be handled and evaluated with care. The cycles associated with microgrids have been governed by a variety of techniques, and these methodologies are continually being enhanced. One ingenious and generally accurate method of utilising the Blockchain has been discovered. As an illustration, the decentralised design of a Blockchain, such as the multi-specialist framework (MAS), is well suited for the execution of energy framework cycles [5]. This section provides a concise introduction to the development and improvement of various microgrid variants, including the internal operations of Blockchains, before introducing a specialised understanding of the best-in-class review being conducted on current Blockchain projects for the energy sector, which could potentially advance and expand the possibility of microgrids powered by Blockchain technology.

FEATURES OF BLOCKCHAIN

Work Proof

Excavators may struggle to overcome a structure of work that is exceedingly difficult to settle, and the check will be easier overall. This necessitates the guarantee of an excavator, which is substantially less stringent than the specified limit when the hash of the square information is calculated. Occasionally, beast power is used to determine the issue, which is known as Information mining. The disadvantage of PoW is the need for a large number of resources; for instance, Bitcoin transactions [6] will need as much energy as all of Denmark in 2020.

Stake Evidence

For stake evidence, diggers are not concerned with the verification of stake structure; instead, a validator assortment is maintained. Whoever claims cryptocurrencies from the Blockchain will enter this collection by securing all of his coins in a store known as the stake. In the square arrangement measure, which employs two primary types of agreement calculations, the validators then take part [7]. In chain-based PoS, the validator, who has the privilege to build the square, is occasionally selected pseudo-randomly.

Authority Verification

In the confirmation of the authority plot, only approved hubs are eligible to

CHAPTER 3

Conservation of Solar Energy for Future Needs

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Abstract: Day by day, because of the increase in the population, energy use also increases, leading this generation towards the end of Non-Renewable sources. A free quotation which is completely unutilized, is available, but very few people are interested in using it, which is Solar Energy. In Solar Energy, this generation can have one-time investments and utilize a free energy source for a long time. The main problem is trust and past investments, which few governments support by giving multiple subsidies and benefits to those who want to use them. In this chapter, the author enlightens the technical know-how of Solar energy systems and their advantages and disadvantages from a technical perspective.

Keywords: Energy Conversion, Optoelectronics, Solar Power, Solar Cells.

INTRODUCTION

Global power outages and the potential for environmental disasters have surfaced as major global concerns. The need for electricity is constantly increasing. Traditional energy sources, such as thermal and hydroelectric, are facing significant challenges in obtaining limited reservoirs, which may be depleted in the following years. Carbon emissions from power plants and traditional energy sources seriously threaten the environment. Also, other energy sources, such as nuclear, pose a significant threat to human safety [1 - 3].

For members of society, fuel shortages may appear in different ways, but in each case, it will lead to more expensive fuel supplies and the need to find alternative energy sources [4]. Fuel constraints include the restriction of fuel and increase in fuel costs, and we observe that it restricts power in several identifiable forms:

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1. By nature of being *physically inaccessible* from supply chain disruptions or regional resource depletion,

2. Being of *limited access* due to an exceptionally high demand for fuel that outstrips supply,

3. From socially restraining policies, regulations, and laws,

4. Or being accessible but only at *high risk*.

To triumph over the above issues and amongst all renewable strength sources, sun strength is the most suitable answer as it's far from being ample and freed from fees worldwide. Solar energy conversion describes technology dedicated to transforming solar energy to other (proper) varieties of strength, consisting of electricity, gasoline, and heat. It covers light-harvesting technology consisting of conventional semiconductor photovoltaic devices (PVs), emerging photovoltaic, solar fuel generation *via* electrolysis, and associated varieties of photo-catalysis directed on the technology of strength wealthy molecules [5 - 8] as shown in Fig. (**1**).

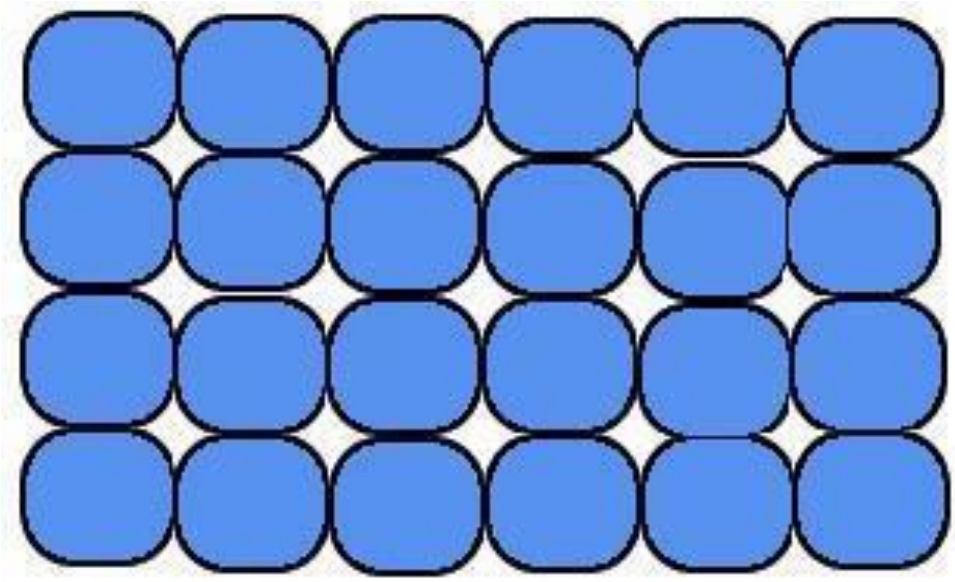

Fig. (1). Solar Panel.

In the past, solar energy systems mainly came from three fields: one with experience in mechanical engineering (solar thermal), another with expertise in electrical engineering (photovoltaic), and the third in architecture (house planning

based on passive solar energy). Regardless of external climatic variables or solar resource measurement limits, the photovoltaic field focused on device physics and component optimization. This scenario persists, and we wish to modify this tradition. Those with mechanical or architectural expertise tended to distinguish between active and passive solar conversion devices. On the other hand, dynamic systems require pumps and motors for agriculture and household use [9], as well as heavy fluids and heat transfer. In contrast, passive systems rely on fields and pressure differentials inherent to the entire collection.

FOUR LAWS OF LIGHT

In addition to the Inverse Square law, that the light intensity decreases nonlinearly with distance, we have four basic light laws that affect our rules for considering the energy transmitted by radiation.

Kirchhoff's Law

When it comes to energy balance, this radiative transfer law is crucial. It asserts that when a body or surface is in thermal equilibrium, its emissivity (ϵ) matches its absorptivity (α).

Kirchhoff's law can be expressed mathematically as

$$E/E_b = \epsilon = \alpha \quad \textbf{(1)}$$

E (W/m^2) is the radiant energy released by an actual surface, while EB (W/m^2) is the radiant energy emitted by a blackbody (a theoretical state).

As explained, a surface at steady state temperature absorbs and emits light in equal amounts. Characters exchange photons in both directions, even though the light is directional.

Planck's Law

This concept can be expanded to indicate that all objects have an internal temperature and shine at that temperature. Max Planck established the dependency of a blackbody's spectral emissive energy for all wavelengths of light. ($E_{\lambda,b}$), if the blackbody's equilibrium temperature is known

$$E_{\lambda,b} = 2\pi hc^2 / \lambda^5[e^{hc/\lambda KT} - 1] \quad \textbf{(2)}$$

CHAPTER 4

Hybrid Energy Storage System

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Abstract: Presently, the role of renewable energy sources (RES) in the energy continuity of a power system is emphasized. Since renewable energy sources are unreliable and intermittent, a smart energy management system is recommended for hybrid energy storage systems (HESS). This study introduces two storage technologies for RES. a battery and a supercapacitor. The generation process in which solar panels, also known as PV panels, are integrated into an array in a grid-connected or off-grid PV system. A dc link is connected to two storage devices and two bidirectional DC/DC converters in the proposed model. The generation from photovoltaic panels is supplied to the load via a converter system. Both supercapacitors and batteries are utilized as storage devices in the proposed system. The voltage of the supercapacitor reached 32V, whereas the value of the capacitor varied slightly between 25V and 25V. The voltage of the supercapacitor in the proposed hybrid paradigm is significantly higher than the voltage of the capacitor.

Keywords: Battery, Converter, Hybrid Energy Storage System (HESS), Supercapacitor.

INTRODUCTION

Rapid use of fossil fuels causes depletion of the ozone layer, pollution concerns, and greenhouse gases emission occur more in the environment. Hence, the contribution of renewable sources has increased in past decades, such as wind, solar, micro-hydro, tidal, geothermal, *etc*. From low to medium voltage limits, Photovoltaic systems and some other renewable energy systems are commending options because of the easy scaling of the input power source. PV systems produce the generation without harming the environment by the configuration of utility grid (on-grid), stand-alone (off-grid), *etc*. for supplying continuous power to the load. In the remote section, a stand-alone system is used because of the generation of an excessive amount of power which is stored in batteries and fed

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the generated energy to the required load, as shown in Fig. (**1**) [1]. The primary advantage of stand-alone is to supply without the need for a high-voltage transmission and distribution system. Fig. (**2**) shows the installed KW capacity of the solar power plant under the off-grid Programmed. The challenging task for a standalone system is the intermittent nature of renewable energy resources and small capacity limits. To enhance power quality and reliability, tremendously improved techniques have been involved in recent times, such as Energy storage systems (ESS), the hybrid energy storage system (HESS), *etc*. Various types of energy storage technologies are utilized in grids nowadays. The benefits of energy storage systems include superior power quality, frequency and voltage regulation in grids, *etc* [2 - 4]. The hybrid energy storage system is a combination of supercapacitors (SCs) and batteries since this system extends battery life [5]. Due to the better lifespan of the battery, the main application of HESS is e-vehicle [6]. According to Tiezhou Wu *et al.*, the quality of power is improved in the renewable energy-based grid system [7]. ESS system has failed to respond optimally in both high and low-frequency power exchange, which is shown in Table **1**. This limitation can be overcome by the HESS shown in Fig. (**3**) [8] *i.e* Hybrid Energy storage system has the quality of power-sharing between battery and supercapacitors [9].

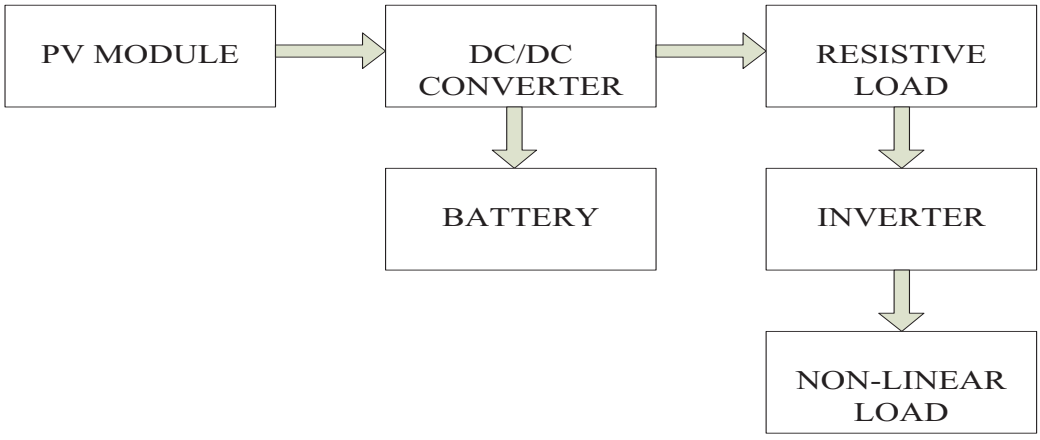

Fig. (1). Standalone PV System under different Load conditions [1].

S. No.	Agencies	Solar Home Light (Nos)	Solar lamp (Nos)	Solar Street Light (Nos)	Solar Pump (Nos)	Solar Power Plant (kW)
1	AP	22972	77803	15468	34045	3815.595
2	Arunachal Pradesh	35065	76401	13741	22	963.2
3	Assam	46879	647761	16338	45	1605
4	Bihar	12303	17352	46032	2813	6800
5	Chhattisgarh	42232	3311	2792	61970	31372.9
6	Delhi	0	4807	301	90	1269
7	Goa	393	1093	707	15	32.7
8	Gujarat	9253	31603	5004	11522	13576
9	Haryana	56727	93853	34652	5014	2321.25
10	HP	22592	33909	92500	15	1905.5
11	J& K	144316	51224	22900	39	8129.85
12	Jharkhand	9450	79051	13572	4800	3769.9
13	Karnataka	52638	7781	5069	7435	7854.01
14	Kerala	41912	54367	1735	818	160438.39
15	MP	7920	52910	13611	23156	3654
16	Maharashtra	3497	23929	10420	1131	3857.7
17	Manipur	24583	9058	22217	10	1580.5
18	Meghalaya	14874	40750	5800	19	2004
19	Mizoram	12060	91201	10117	37	3885.6
20	Nagaland	1045	6766	11107	3	1506
21	Odisha	5274	99843	17815	9599	2191.515
22	Punjab	8626	1749	43448	4663	2066
23	Rajasthan	18796	22585	7114	5342	30449
24	Sikkim	15059	23300	504	0	850
25	TN	29864	16818	39908	6289	13052.6
26	Telangana	0	0	1958	424	7450
27	Tripura	32723	25344	6284	151	867
28	UP	23590	23463	28935	2960	10638.31
29	Uttarakhand	91595	16338	31535	26	4059.53
30	WB	14533	17662	11530	653	1730
31	A & N islands	468	6296	920	5	167
32	Chandigarh	275	1675	901	12	730
33	Lakshadweep	600	5289	4465	0	2190
34	Puducherry	25	1637	417	21	121
35	Others	24047	12579	9150	609	23885
36	NABARD (2015 onwards)	11622	0	0	4012	0
	Total	**1723479**	**7830685**	**813132**	**272700**	**216398.7**

Fig. (2). State-wise Cumulative Capacity installed under Off-grid SPV Programmed [2].

CHAPTER 5

Performance Comparison of Equilibrium Optimization Algorithm, Particle Swarm Optimization, and Gravitational Search Algorithm to the Design Optimization of Wind Turbine PMSG

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Abstract: This research optimises the design of a permanent magnet synchronous generator to meet the output power needs of a small direct-drive wind turbine. Extra care has been taken to reduce the generator's total volume to reduce expenses. The proposed method aims to reduce the cost of PMSG by reducing its volume. In this study, the optimal values of PMSG parameters for minimising the overall volume of the PMSG generator while maintaining its output power at the rated value are determined. To estimate the optimal values of design parameters, three algorithms have been considered. Equilibrium Optimization Algorithm (EOA) as the proposed algorithm, Gravitational Search Algorithm (GSA) as the first existing algorithm, and Particle Swarm Optimization as the second existing algorithm. Comparing the results of the Equilibrium Optimization algorithm (EOA) with those of the Gravitational Search Algorithm (GSA) and the Particle Swarm Optimization algorithm (PSO) (PSO). Simulation results demonstrate that the Equilibrium Optimization algorithm (EOA) outperforms both the Gravitational Search Algorithm (GSA) and the Particle Swarm Optimization algorithm (PSO). When simulated and statistical results of EOA were compared to those of other optimization methods, it was found that EOA is more effective and superior, resulting in the lowest volume value for wind turbine PMSG.

Keywords: Permanent magnet synchronous generator, PSO, Renewable energy, Wind power, Wind turbine.

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INTRODUCTION TO COMPUTATIONAL INTELLIGENCE

In the field of computer science, known as artificial intelligence, machines demonstrate intelligence. The definition of artificial intelligence is "the study, design, and development of intelligent agents." An intelligent agent is viewed as a system that analyses its environment and acts to maximise its chances of success. Artificial Intelligence (AI) has become pervasive in today's society. It refers to the simulation of human intelligence in computer systems that have been programmed to learn and imitate human behaviour. Machines can learn from their mistakes and perform tasks comparable to those performed by humans. Research in artificial intelligence is highly technical and specialised, and it is divided into numerous subfields that rarely communicate with one another. Currently, prevalent AI methodologies include traditional statistical methodologies, traditional symbolic AI, and computational intelligence (CI). The field of study known as Computational Intelligence (CI) is relatively new. It is a set of computational techniques and methodologies inspired by nature that is used to solve complex real-world problems for which conventional solutions are inadequate or ineffective. Computing intelligence refers to the theory, design, implementation, and development of biologically and linguistically inspired computational paradigms (CI). Fuzzy Systems, Artificial Neural Networks (ANN), and Evolutionary Computation have been the three main pillars of Computational Intelligence (CI) historically (EC). However, several computing models inspired by nature have emerged over time. CI plays a crucial role in the development of effective intelligent systems, such as games and cognitive developmental systems. Recent years have witnessed a surge in Deep Learning research, specifically deep convolutional neural networks. Deep learning is currently the most popular artificial intelligence technique. In reality, some of the most effective AI systems employ CI [1]. In recent years, researchers have paid close attention to algorithms for computational intelligence because of their ability to produce near-optimal solutions. Modeling the human mind and nature-inspired intelligence were the two categories used to classify the algorithms. Models of the human mind are inspired by how humans receive and process information. Similarly, algorithms in the nature-inspired intelligence domain are based on common natural phenomena. SI is a subset of Computational Intelligence (CI) inspired by animal or insect groups such as bird flocks, fish schools, ant colonies, and bee swarms. SI-based algorithms have a wide range of applications in virtually all scientific disciplines, and they are especially effective at addressing complex problems for which conventional methods are ineffective. SI techniques search through generations with a fixed population size, and individual discoveries are evaluated in each generation to adapt the search strategy in the next generation without individual selection processes. Self-organizational strategies and each individual's independent problem-solving work

are two major components of SI approaches. The self-organizing strategy results in the formation of a system of individuals who individually respond to local stimuli and may collaborate to complete a global task, while the independent working state eliminates the need for centralised supervision. These characteristics enable researchers to simulate the collective behaviour of animal herds or insect swarms in nature.

In recent years, algorithms simulating the behaviour of various animals have been developed, including the Firefly algorithm (FA), Particle swarm optimization (PSO), krill herd algorithm (KHA), honey bee algorithm (HBA), cuckoo search algorithm (CSA), Lion optimization algorithm (LOA), cat algorithm (CA), Bat algorithm (BA), Ant colony optimization (ACO), and flower pollination algorithm (FPA). Notably, selecting the appropriate algorithm is a crucial step in the problem-solving process. Optimization, which is an interdisciplinary field, is used to solve nonlinear, stochastic, combinatorial, and multi-objective issues. Optimization is the process of determining the optimal values for decision variables to arrive at the optimal solution. The optimal solution consists of a group of design variables that maximise or minimise the objective function while satisfying the specified constraints. In most instances, the optimal solution is found when the values of the decision variables generate an objective function with the highest value and satisfy all model-related constraints.

OPTIMIZATION

Optimization is a numerical procedure for determining the selection variables that minimise or maximise an objective function while adhering to the linear and/or non-linear constraints imposed on the decision space. Numerous real-world problems involve non-linear objective functions and constraints with multiple local optima and a restricted feasible region. Due to the presence of multiple local optima and a small feasible region, it is difficult and time-consuming to solve these problems with conventional algorithms. Traditional optimization techniques can be applied to both continuous and differentiable functions to identify the optimal solution. These conventional methods are analytical and utilise differential calculus to determine the optimal solutions.

Numerous problems in the real world, such as CFD issues, necessitate the formulation and solution of optimization problems that are frequently non-differentiable, multi-dimensional, non-linear, stochastic, multi-modal, and time-consuming to solve. In response to the increasing complexity of real-world problems, researchers have sought problem-solving algorithms based on biological or natural processes. Traditional classical optimizers fail to improve their performance in the face of such obstacles. This has prompted researchers to

CHAPTER 6

Modeling and Parametric Study of Electric Vehicle Charging *via* WiTricity. A Multiple Harmonic Analysis

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Abstract: Technological challenges to the widespread adoption of battery-powered devices contain substantial weight with a high cost and low power density. To bring an improvement in over-dependency on batteries, wireless power transfer is a ray of hope in energizing electric-driven devices. Moreover, for high voltage transmission lines, optimization of natural frequency plays an important role in efficient wireless power transfer (WPT) considering dc to load supply. In consideration of different aspects of wireless power transfer technology, a completely optimized method should be adapted for monitoring. In the present work, a model of an electric car vehicle has been developed based on WiTricity. This concept of wireless power transfer has been realized in this work as a small-scale simulated model, which can be used to charge batteries, mobile, door locks, and propeller clocks, Further, the evolving wireless power transfer technologies often face difficulty in asymmetrical variable-frequency pulse-width-modulated (WPT) systems. To deal with these multiple harmonics as inherently generated by variable frequency amplitude pulse width modulation (VFAPWM), a multiple harmonics analysis technique has been adopted in this work. Different parameters like loads and duty cycle have been varied with varying frequencies, to study the charging current harmonic distortion and voltage harmonic distortions. The difference in voltage observed was essentially nonexistent, with a 1.8 to 3 times variation in switching frequency. Moreover, the pattern of deviation has been noticed for output voltage when the load was varied from 20% to 100%. Additionally, a comparative study has also been performed in evaluating the charging current distortion pattern by the implementation of both MHA techniques and conventional first harmonic approximation (FMA).

Keywords: EV, Multiple harmonic analyses, WiTricity.

INTRODUCTION

To provide power without any physical contact to different applications, wireless power transfer (WPT) has become the most promising and emerging technology.

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This crucial and ground-breaking technique of energy transfer is quite incredibly "cordless" [1, 2]. WPT has the potential to fundamentally alter the utilization patterns of energy in multitudes of applications such as portable electronics, biomedical implants, solar-powered satellites, unmanned aerial vehicles (UAVs), and electric vehicles (EVs). Although battery-powered devices generally have a limitation of high initial cost and short battery life, they still gain huge acceptance and approvals in various applications.

In this regard, electric vehicles (EVs) are the most emerging technology which provides a clean environment apart from saving conventional fuel costs [3]. Despite manufacturer claims of EVs with a 120 km plus range per charge, in practice, EVs often fail to run beyond 100 km. To overcome such problems, a larger number of batteries can be installed in EVs, which again results in an unaffordable initial price. Besides the energy storage technology, the WPT technique is attracting intense research activity as a new energization approach for battery-driven devices.

A. Wireless Technology

EVWC, commonly known as electric vehicle wireless charging, generally operates on the concept of resonance along with magnetic inductance and is reminiscent of the more familiar transformer technology. The help of sending current within a wire winded in a form of a coil induces a magnetic flux in the surrounding nearby areas. Further, a current will be induced by the magnetic field when a second coil is placed in the near vicinity, thereby producing a wireless power transfer method. However, inductive power transfer can be made with high efficiency by spacing the coils closely with an appropriate alignment [4, 5]. The advantages of magnetic resonance can be taken into account for a larger distance between the source and wrongly aligned receiver to enhance the efficiency of WPT [6 - 8]. The basic idea of magnetic resonance is to tune the source and receiver circuits to the same resonant frequency. Tuning significantly enhances the efficiency of WPT. Optimization of the shape, number of turns, and prearrangement of the receiver and transmitter coils to enhance the WPT efficiency is the subject of intense ongoing research [9].

The new wireless energy transfer method comprises both -near-field and far-field components. Optical waves, microwaves, and acoustic waves are adopted as the components used for the realization of far-field components. The near-field component is based on the inductive coupling effect and is realized by non-radiative electromagnetic fields.

A model for the IPT system has been depicted in Fig. (**1**) [10, 11] where two inductive coils correspond to both the receiving and transmitting coil, which directly interface with the power source and the load impedances, respectively. A mutual inductance and equivalent AC resistance of coils are also present.

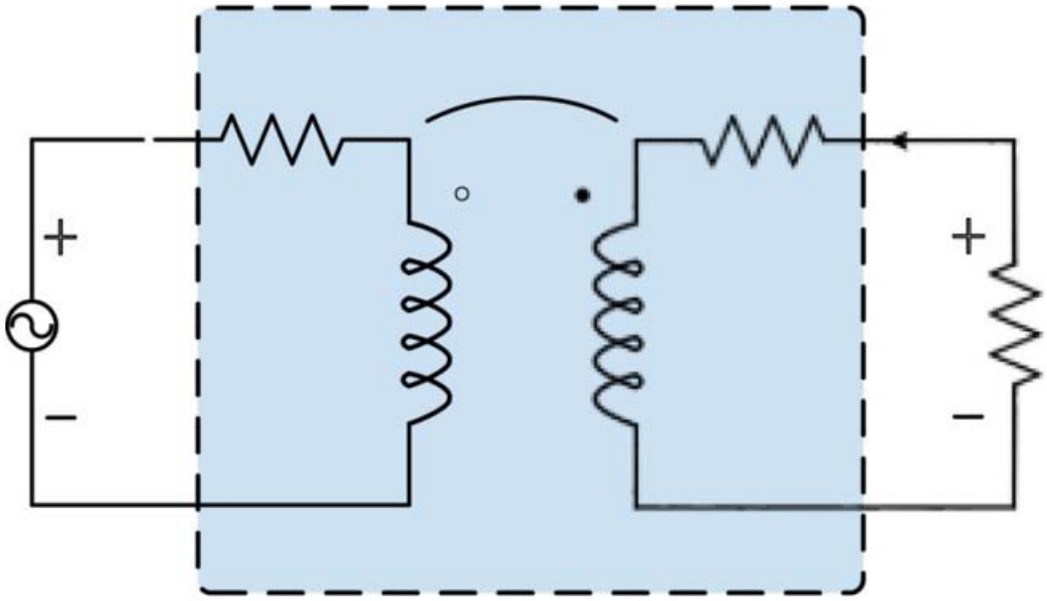

Fig. (1). Circuit model of IPT systems.

Moreover, certain special circuits are additionally required for converting AC power to DC and thereby charging the battery. These circuits often control the values of voltage and current, and depending on the configuration of coils [12] the current level may fluctuate. In focus on the awareness of the polluting environment, electric vehicles (EVs) have gained huge popularity towards greener energy [13]. Despite environment-friendly attributes, plug-in EVs face certain problems in charging. This involves remembering the pattern of plug-ins and the infrastructures or charging stations. The charging stations suffer from both vulnerability and vandalism, where the weather (snow, rain, *etc.*) and stealing (cord blocking, outlets, *etc.*) condition causes a negative impact. Moreover, a tripping fault can be caused by the cord, followed by an electrocution hazard due to a large flow of power [14].

CHAPTER 7

A Sustainable Approach to Solid Waste Management. A Review

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Abstract: Achieving long-term solutions to today's waste challenges necessitates long-term strategy and effort. Population, urbanization, development, and industry all contribute to the increase in trash. Energy use is also strongly related to waste management, which is also a strong component for achieving an effective solution. The waste energy conversion processes have technological limits, called thermodynamic limits. Energy and entropy are variables that may be used to evaluate energy systems and technologies. People's non-segregation tendencies, as well as their consumerism inclinations, make waste management tasks difficult. Landfilling, combustion, pyrolysis, gasification, incineration, *etc.* are insufficient to deal with such a large volume of waste. Recently developed plasma base waste technology mimics nature's waste management through matter-energy conversion with a scope of waste-to-energy (WtE) conversion. This study shows that plasma-based technology has a high waste volume handling capacity in a short span and also minimises waste exposure to nature and society. Despite its high installation and maintenance costs, the income generated from Syn-Gas and slag makes it financially viable. It is a sustainable way to manage waste because it can handle large amounts of waste, takes the least amount of time to process, and has the least amount of social and environmental impact.

Keywords: Plasma waste technology, Waste Management, Waste to Energy (WtE), Waste Treatment, Waste to Wealth.

INTRODUCTION

Various energy resources are used for technological product development. It escalates daily as the population's desire for luxury intensifies. Thermodynamic inefficiency of technological processes results in undesired output in the form of waste production. The waste can either be in the physical form or the form of heat energy. This is a non-essential component of industrial production and also affects mechanical conversion. The mass-energy conversion ratio also controls develop-

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ment as well as ecological coexistence. Several pieces of research have shown that effective waste management technology not only controls the environment but also gets rid of any negative effects on human health [1 - 3]. According to the waste production study, urban areas are creating more waste due to their growing need for energy. That is why waste disposal and management are considered key factors for sustainable development. In response to a growing demand for energy, urban areas are experiencing an increase in the production of waste. This need for energy also uses up more of our natural resources and makes more waste [4, 5].

Municipal garbage is often deposited on the edges of cities and towns. Such a simple waste management system has created overflowing landfills, and it has negative consequences in terms of water contamination, land degradation, and air pollution, contributing to global warming. Such huge waste landfill space also disturbs local geographical parameters and affects the surrounding ecology. Such a simple waste disposal method is unmanageable for any natural or human activity [6, 7]. The problem of waste is, to some extent, due to the waste disposal policy's failure and less focus on waste market utilization. One of the primary issues that governments confront is the effective, sustainable, and long-term disposal of their waste.

Nature also tackles such environmental waste issues through the energy-mass conversion process. Synthesis, respiration, water, biomass, nitrogen, and other cycles are important components of natural waste management. All living and non-living organisms contribute directly or indirectly to such a process. These dynamic and static processes can be understood in terms of the various conservation laws and energy dynamics. The laws of thermodynamics predict and put restrictions on such conversion processes. Several studies [8 - 10] show that the main reasons for this kind of waste increase are the push for energy and the overuse of natural resources. This shows a new and important element of waste generation and management.

Despite all these, waste management needs to address a sustainable society. The studies show that waste production varies with factors like social energy use, income group, energy culture, energy consumption, energy consumption economics, and people's geography conditions. Population, industrialization, and technological adoption are all important factors in waste creation. Form waste types are to be considered before their management. Rapid waste volume increases have made waste disposal challenging for nature as well as for any specific technical process. Various kinds of treatment—gasification, pyrolysis, incineration, etc.—are developed to tackle this issue. Most of them use heat energy in different environments for waste transformations and volume reductions. The research also proposed recycling, rejecting, and reducing ideas as

a feasible alternative for waste volume reduction and management. The most recent in this series are plasma-based gasification and others. This is waste treatment technology at higher temperatures [11 - 13].

This paper explores how the notion of matter-energy may aid in the management of sustainable waste. Section 2 discusses waste volume and its link to population and industrialization. Nature has a significant impact on waste management. An essential component of waste management, waste-to-energy conversion (WtE), is introduced in the Third Section. The natural capabilities in waste management are remarkable but have limitations. Such limitations are also discussed in section 4. Section 5 discusses the various processes used for waste management and their technical analysis based on certain parameters like cost of the technology, environmental impact assessment, life cycle, *etc.* This work also shows how plasma-based waste technology is better than other existing technologies. It also emphasises waste-to-energy conversion and helps in volume reduction as well as environmental damage. Nature-inspired plasma-based technology has been discovered to be a superior choice for waste management owing to its high conversion and sustainability.

WASTE PRODUCTION SCENARIO

Most countries in the world have dense populations and rapid economic growth. You are experiencing unprecedented industrial growth and rapid urbanization. Since human evolution, the population has undergone tremendous changes. Only the 20th century witnessed a population of 1.65 people on the planet. Fig. (**1**) reflects this pattern of change. The use of new products grows in lockstep with population growth. Because of this, the amount of waste being made is going up. Every year, about 2.01 billion tonnes of municipal waste are made around the world.

In the past decade, global waste generation has increased significantly, and there is no evidence that it is slowing down. On average, between 0.11 and 4.54 kg of waste per person per day is generated in the world. Globally, the average consumption is 0.74 kilograms per person. Studies have shown that waste generation has increased at a faster rate due to a large number of manufacturers. As of 2050, the global waste volume is expected to reach 3.4 billion metric tonnes of waste. Depending on the size and type of city, the amount of waste produced per capita varies dramatically. Gross domestic product is positively correlated with waste generation, and regional variations exist. As part of waste management, waste collection is essential, and this indicator is affected by income level, as shown in Fig. (**2**). In high-income counties, there is almost a universal garbage collector [14 - 18].

CHAPTER 8

Sanitized Vehicle Parking System

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Abstract: Automated parking systems have been revolutionized exponentially in recent times but configuring an automated parking system capable of incorporating the ability to perform total sanitization is the result of a novel approach, as presented in this chapter. This parking system sanitizes the vehicle as soon as it approaches the parking lot with the help of Infrared sensors coupled with a servo motor. The fundamental objective behind this approach is to suppress the spread of contagious infections like COVID-19, which is more prominent in the present age and has been hugely impacting the world. The proposed design includes Arduino UNO, Infrared sensors, servo motor, Water level sensors, LCD screen, and LEDs as its components. Arduino IDE plays a significant role in controlling the whole setup associated with Proteus-8 Software. This model is divided into three segments, the sanitization chamber, parking entry and parking exit, which also count and display the number of vehicles entering and exiting the parking lot on the LCD screen. In the sanitization chamber, the working of infrared sensors and servo motors are interlinked and configured by the code logic. When the vehicle arrives, the IR sensor senses it and allows the servo motor to eject the liquid from the dispenser vessel to sanitize the vehicle completely. An LCD screen is also employed to display the various percentage stages left in the sanitizing dispenser vessel. In parking entry and exit, the Infrared sensors operate the entry and exit points. LCD screens, along with LEDs of different colours, are also incorporated to indicate the functioning of the whole process.

Keywords: Arduino UNO, Automated parking system, Proteus-8 Software, Sanitization, Sensors.

INTRODUCTION

Coronavirus disease (COVID-19) is a contagious syndrome. This virus is more grievous for the older age group, and those with untreated past medical complications like cardiovascular problems, diabetes, chronic respiratory syndrome, and various malignancy issues are at higher risk of developing critical health problems. The best way to slow down the transmission and protect oneself and others from this destructive virus is by washing hands with soap or using an

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isopropyl alcohol sanitizer regularly and by not touching our face and nose before handwash. COVID-19 multiplies mainly through droplets from the nose while sneezing or coughing. Therefore, practising respiratory etiquettes like coughing/sneezing into a flexed elbow. COVID-19 affects various people in numerous ways based on their immune systems. Commonly infected people develop mild to moderate weakness and recover instantly without hospitalization. These people fall under the asymptomatic category. Common symptoms for this category of patients are fever, dry cough, tiredness, etc. Acute symptoms include breathing difficulty or shortness of breath, pain or pressure on the chest, and loss of movement or speech. Immediate medical attention is necessary if severe and alarming symptoms show up. People having mild and moderate symptoms should manage their symptoms on their own by following home quarantine.

It takes around 5-6 days for someone affected with the virus to show signs of being infected; however, 14 days is the minimum period to get adequately cured.

The covid situation is more than a threat to health. It is also an unconventional and unexpected socio-economic crisis. This virus can give rise to devastating political, social and economic effects.

NEED OF SANITIZATION

Sanitization has always been an important aspect to consider. Everyone around the globe is facing a health crisis of such a high magnitude. COVID-19 (coronavirus) has shocked the nation, and it has become the sole reason responsible for threatening the health of people all over the world. Schools and businesses have been shut down due to fear-mongering around the globe. Healthcare workers have faced a remarkable absence of livelihood supplies while coping with the incredible number of covid patients during the pandemic. Therefore, proper sanitization is vital from the overall health point of view but also has an essential role in our individual and social life.

The Internet consists of information regarding how to proceed as far as staying safe and sound is the key objective. The perfect data hub is the Centre for Disease Control (CDC). CDC keeps an updated index of COVID-19 regularly, along with the latest news and advice regarding the current pandemic times. Sanitization is the only alternative left to keep ourselves away and free from this life-threatening infection.

Sanitization saves us from coronavirus and protects us from numerous contagious infections around the globe. This sanitized vehicle parking system involves a design that can sanitize the metal surfaces of the vehicles to get rid of the coronavirus, which can stay on such surfaces for a very long time.

OBJECTIVES

• The fundamental objective of this project is to provide a Modern and Intelligent Solution to the COVID-19 pandemic, which has been hugely affecting the world.

• This pandemic became havoc in such a short time, and in this model, we have configured the Sanitized Vehicle Parking System.

• It is capable of sanitizing vehicles the moment they enter the parking lot, and for this purpose, we have also assembled a Smart Sanitizing Dispenser System.

• This model displays the Sanitizer Level volume in the dispenser vessel via the LCD.

• Sanitization is the only prevention in the current scenario.

CHRONOLOGY

The primary driving force behind this project was to understand how vital sanitization is due to the prevailing pandemic conditions. Novel coronavirus being the only culprit is essential to understand so that we can fight it and eventually eliminate this deadly virus responsible for the havoc it has created in the world. Analysis of this outbreak explained that the research describes the COVID-19 pandemic in detail, which revolves around the COVID-19 epidemic in India. Coronavirus or COVID-19 is a Respiratory contagious syndrome that can pose a significant threat to humans, which is described in this paper. The reproduction count in China ranges between 2-2.5, varying across regions. In India, the situation has been adverse as there have been 70767 confirmed cases, according to the records of the Government of India. Due to insufficient testing, inaccurate data of confirmed cases and death counts are highlighted based on a mathematical formula that is used to establish a correlation between Death Counts and the count of infected people. SIR Epidemic Model (SIRD) emphasized the need for optimal parameters to elucidate this outbreak's intensity. It also diminished the inaccuracy between the actual death count and the maximum number of confirmed active cases of this pandemic [1].

Another unavoidable aspect responsible for designing this project is the engineering and maintenance of a modern and futuristic parking system that is well-equipped with all the modern features and requirements. As a result of continuous research and exploration in the domain of sanitization and parking systems, we got valuable insights into the need and importance of incorporating sanitization along with an efficient and intelligent parking system. Recently a paper proposed an autonomous hand sanitizer in which the motor ejects sanitizing

CHAPTER 9

Simulation Results of Sanitized Vehicle Parking System

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Abstract: Simulating a futuristic idea for the implementation of an innovative, efficient and economic sanitization-based parking system is the fulcrum of this paper. This paper depicts the simulation results of the previous chapter, "Sanitized Vehicle Parking System", designed to solve parking problems and ensure customers' safety. Proteus 8 is the simulating software that has the ability to depict all the components used and their functionality in real-time. Arduino IDE is the coding platform incorporated with the Proteus 8 software. Arduino IDE has a lot of advantages over other platforms; one of them is extremely simple and flexible. This model will visualize the simulation results in detail which have been achieved and can be implemented in all the parking compartments with an upper hand over other parking systems by being completely automatic. Sanitization is the most crucial aspect responsible for the design of this system, as this parking system will sanitize all the automobiles entering the parking lot. This model has been divided into three compartments. The 1st section is responsible for sanitizing the vehicles entering the parking area. The 2nd section operates as the entry point of the parking area, automated through infrared sensors. Simultaneously the count gets incremented by 1, which gets displayed on the LCD Screen. The 3rd section operates as the exit point of the parking area. Each vehicle exiting from the parking area decrements the count by 1. Water-Level sensors are also employed to detect and measure the sanitizing fluid left in the vessel at different stages. The detailed simulation results for the sanitizing dispenser system are displayed on the LCD screen, indicating the next course of action in case of emptying the sanitizing liquid. The infrared sensors entirely handle the entry and exit points.

Keywords: Arduino IDE, Automatic, Automobiles, Economical, Efficient, LCD Screen, Parking Entry, Parking Exit, Sanitization, Sensors, Simulation.

INTRODUCTION

The previous chapter described the model's idea, approach and work. We also defined a detailed explanation of the model along with the simulation results and

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the outcomes of the model. The previous chapter explained the working at the front end and the fulcrum of this model. This chapter is a continuation of the previous chapter. It will focus on the working of the model at the backend. This chapter will give a detailed description of the working of the components in unison.

In this chapter, we have explained the components' working, and the programming IDEs are also described in detail. This chapter also emphasizes the code logic used for the model's functioning. Applications of this idea in numerous domains are also taught to express the commercial viability of this model. Proteus 8 Professional is the simulating software used for simulation as it provides a highly dynamic and open-source environment. The coding Algorithm of this model is also elucidated with figures. Arduino-IDE is also explained, which is a highly efficient and easy-to-use software.

CHRONOLOGY

The primary factor behind this chapter is to imbibe and inculcate innovations worldwide in this domain. One such innovation is proposed in a paper that deals with the design and development results of a hand hygiene reminder system. The system is designed to accompany a dispenser equipped with a power-efficient technology which, when incorporated systematically with a Bluetooth module and an IoT mobile application, provides location awareness necessary to track the proximity of healthcare workers to the dispenser system. The hygiene-centric model offers a unique and valuable feature of selectively operating the dispenser action only when a user is in its proximity. This feature plays a vital role as it is crucial for installing hand sanitizer dispensers in medical services. Furthermore, the mobile application is configured uniquely to maintain an online platform for hand hygiene records in the database. The database records are stored and supervised through an internet-based dashboard to improve overall compliance levels for monitoring hand hygiene. Preliminary results are demonstrated that depict the efficiency and effectiveness of the model to serve as a prime source of motivation and encouragement for healthcare workers to improve their hygiene parameters, as cited by J. Wen Loong *et al.* [1].

Simulation and designing an efficient parking system is not an easy task. It should be done with complete precision and knowledge of the current technology standards and innovations done in the past. One such creation is proposed in a paper that concentrates on the evolution of the Internet of things which increased the efficiency and productivity of the urban area infrastructure by locating the void spaces in parking areas along with delivering the necessary information to customers and gazillion researchers significantly elaborated the issues faced while

implementing reliable parking assistance and directions to build Smart Parking Systems, as cited by G. Shanmugasundaram *et al.* [2]. A research paper depicts the prototype of an automatic vehicle parking system capable of automatically sensing the movement of cars and displaying the count of vehicles present in the parking lot. This system saves time spent on checking empty spaces left in the parking lot by displaying available spaces on an LCD Screen using Infrared sensors and an 89c52 microcontroller, as cited by Ahmed *et al.* [3]. Interesting concepts always pave the way for new possibilities. One such idea was proposed in a paper that emphasises the need for improvement in current parking systems and traffic congestion according to the city's modernisation level. This paper proposes the concept of the ZigBee network, which sends pressure information to a personal computer via the Internet and makes good use of web services altogether to accumulate all the scattered information related to parking space so that it provides an ease to their customers in finding an available parking space, as cited by Cui Shiyao [4]. A parking system is efficient if it also considers the customers' economic aspect. Minimal cost is a significant and crucial factor that can attract a good customer base. Research-based on this aspect proposed an innovative parking prototype designed for a metropolitan city. It reserves a parking space based on the driver's cost function. The cost function combines proximity to the destination and the cost of parking. This model reduces the time to search for an empty parking space and the cost of parking. This system effectively utilises the overall parking capacity, which provides an economic system compared to uncontrolled parking processes, as cited by Yanfeng Geng *et al.* [5].

SOFTWARE TOOLS

Proteus 8 Professional

Proteus Virtual System Modelling combines mixed-mode simulation with industry-oriented rapid microcontroller simulation. It helps the user to perform reliable prototyping of both firmware and hardware designs in software format.

This VSM diminishes the gap between the PCB layout and schematic capture. Furthermore, it empowers the user to design and implement suitable software for an integrated microcontroller to co-simulate the program limited within the MCU peripherals circuit simulation. It also allows us to visualize and interconnect with the dynamic design using on-display indicators like LEDs, Liquid Crystal Display, and actuators involving buttons and switches.

Proteus virtual system modelling software also provides substantial and innumerable debugging characteristics, including variable display, breakpoints and single-stepping for assembly code and high-level language sources. In

CHAPTER 10

Performance Analysis of DTC-IM Drive Using Various Control Algorithms

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Abstract: Direct Torque Control (DTC) is the dominant strategy used in three-phase induction motor control, thanks to its excellent and vibrant characteristics, consistent operation, fewer mathematical calculations, and rigidity in adjustable velocity drives. However, torque ripple is the main drawback of DTC, and it is challenging to reduce it. While DTC based conventional PID controller is utilized, it gets pretentious by lengthy settling time, maximum peak overshoot, and torque and speed curve oscillations. The current research aims to diminish the torque ripple and augment the DTC-enabled induction motor drive performance. Various control methods, such as Fuzzy Logic Control (FLC), Artificial Neural Network (ANN), and Adaptive Neuro-Fuzzy Inference System (ANFIS), were used in the chapter to enhance the DTC-enabled induction motor drive performance. These control methods were carefully verified and simulated under MATLAB/Simulink 2017. The effectiveness of the projected work was confirmed through simulation, which achieved promising results, thus establishing the supremacy of the proposed model.

Keywords: Adaptive Neuro Fuzzy Inference System, Direct Torque Control, Fuzzy Logic Controller, Neural Network Controller, PID controller.

INTRODUCTION

The introduction of induction motor drives in industries drastically changed their functioning methods. Approximately 90% of sectors currently use IM drives for motion control, thanks to their simplicity of development, maximum efficacy, excellent performance, and reliable operations. A variable frequency strategy is used to manage the induction motor, partitioned into two approaches: scalar control and vector control.

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Scalar control works well in a consistent state, while in the event of transient circumstances, the space vector position faces a challenge. On the contrary, vector control works in unpredictable and quick cases; Field Oriented Control (FOC) is the frequently used strategy in a transient state and was introduced [1]. Next to the FOC, Direct Torque Control (DTC) was submitted [2]. According to a study [3], the motor equation in FOC is changed into a coordinate configuration that revolves in synchronization with rotor flux control. This remains the primary issue with FOC. However, DTC overcomes this issue by maintaining constant stator flux amplitude and eliminating electromagnetic transient.

According to a study [4], the DTC mechanism comprises two hysteresis comparators, a voltage vector selection table, and two estimators, one for electromagnetic torque and another for stator flux. DTC directly controls the change and torque utilizing a Voltage Source Inverter (VSI), stator flux, and space vector orientation, during which the oblique speed is also controlled. The main challenges faced in DTC at the beginning are maximum torque, flux ripples, and changeable switching frequency because of the hysteresis band in flux and speed controller, which creates blast and worst concert at minimum velocity. The lookup table selected for the voltage vector generates a changeable switching frequency which can be removed with the help of different control techniques.

The problems discussed have been handled earlier in the literature, and different approaches were proposed, such as Space Vector Pulse Width Modulation (SVPWM) strategy, Adaptive manage strategy, Predictive management algorithm, enhanced switching table approach, superior PID controller, intelligent control algorithm, multilevel inverter and hybrid methodologies [5, 6]. The literature review broadly describes the research works that proposed these approaches.

In the studies [7, 8], dynamic and steady-state torque manage with constant switching occurrence were offered. Torque swell was reduced by space vector modulation with the help of flux error. Torque swell is varied using torque hysteresis band, velocity, and the changeover frequency. In this work, the torque ripple depends only on speed, whereas the switching frequency is stable. Though, this configuration produced six times of torque ripple higher than the stator incidence.

SVPWM was introduced [9] to lessen flux and torque swells at stable switching incidence to improve the VSI-fed IM drive performance by using a sliding-stage revolving-flux viewer. A Sliding stage DTC-SVM-based adaptive control of consignment torque was projected [10] for three sorts of loads stable, linear, and quadratic load torque to dispense the impact of load instability on IM beneath

sliding. This methodology accomplished the most excellent performance with no load disturbance impacts.

The selection strategy of voltage-vector utilizing a switching table is broadly investigated and popularized. It is simple in conception and can easily be carried out [11]. The traditional PI and PID controllers are generally utilized in DTC, as indicated [12], because of their easy configuration and excellent performance in working conditions. But, it is slowly adapting to speed and load variations.

IMD has not had many disadvantages, for example, multi-variable, sturdy coupling, nonlinear, and time-changing attributes. These disadvantages make it exceptionally hard to accomplish the ideal exhibition under consistent and transient circumstances. Henceforth, a GA-tuned PID was utilized in the study conducted [13] for the best results from IMD. The study aimed to minimize the torque ripples, providing the best MSE value in comparisons with regulators like PI and fuzzy-PI.

In their research study [14], DTC with PID controller is used to progress the performances of the asynchronous motor, such as dynamic and starting performances. This is because it produces excellent flux and torque outcomes and the finest speed control and minimizes undesirable torque ripple.

Predictive torque control was proposed [15] for a 3-level neutral point capacitor inverter fed IM. This research work concentrated on reducing the torque ripples, THD, and the number of commutation of switches. Unlike the conventional DTC, the predictive torque management approach is a simple-to-implement algorithm and is flexible. This approach does not involve any predefined switching tables. However, the drawback of this approach is that it needs lengthy processing time and is sensitive to parameters. A study [16] proposed a Predictive Torque Control (PTC) algorithm for induction motors based on Discrete Space Vector Modulation (DSVM) strategy. During this study, the number of voltage vectors was increased by the DSVM system and was valued in the PTC technique. The projected PTC-DSVM technique provides the most negligible sampling incidence. However, the utmost extent of implicit vectors considerably enhances the mathematical issues. To overcome this problem, a DTC switching table was presented to reduce the number of admissible voltage vectors.

PTC-DSVM exhibited the same performance as traditional PTC at any switching frequency, but the sampling frequency was three times lesser than its counterpart. A low sampling frequency procedure is feasible for industries to employ minimum expensive hardware or execute a complicated mathematical computation. The main problem with traditional controllers is the value of the gain. Hence, the controllers are tuned to achieve the best performance. In addition,

CHAPTER 11

Mesoscopic Station Controlled Advanced Reconnaissance Rover

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Abstract: S.C.A.R.R or 'Station Controlled Advance Reconnaissance Rover' presents a modern approach for surveillance at desired areas, remote border locations, buffer zones, or strategic military deployment areas using a multifunctional robot based on the Arduino development board. The purpose of designing and constructing a surveillance robot is simple; it is to adapt to the advancements in technology in the field of modern warfare as well as to have a pragmatic and reliable solution to ever-increasing surveillance demands due to hostile activities. This robotic vehicle can potentially substitute human deployment in concerned areas to provide surveillance and perform desired tasks. The robotic vehicle works as a manually controlled vehicle through Dual Tone Multi-Frequency (DTMF) technology and is equipped with a Radio AV Night Vision camera which can work both day and night to provide real-time video feed. This robot can be used to detect the presence of the enemy in both friendly territory and buffer zones and capture through the camera to give live streaming to authorized personnel. Surveillance is major and active field role while working in the border area and for the same, there is a need for a robot for surveillance purposes. A smart surveillance robot for military and counter-threat applications is presented in this paper. A well-rounded approach to testing, of all the physical and technical factors, was considered and taken into action in the form of improving the rover.

Keywords: Arduino, DC motor, Dual Tone Multi Frequency Decoder, Radio Night Vision Camera, S.C.A.R.R, Station Controlled Advance Reconnaissance Rover.

INTRODUCTION

Robots are no more just programmable machines that sit in laboratories of engineers and tech enthusiasts, but rather are becoming more mainstream and have become an integral part of our lives. Nowadays, more and more robots are attaining higher computational capabilities and better efficiency. This can be cred-

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ited to a lot many factors, including performance-driven industry, and advances in the field of Artificial Intelligence and Machine Learning, but the biggest factor of all, in my opinion, remains to be the persistent efforts of all the people who desperately and rightfully so want robot and machines to become an indispensable part of human lives.

In today's developing world, where more than ever, technology is being driven and developed at higher rates, it is finding its uses in places never thought of before. With continued efforts in the advancement of technology, machine and intelligent robots are being developed and employed to take the place of humans in fields where human life faces an imminent threat. One such field is military surveillance. With an increased threat of terrorism and hostile border situations, India can aptly look forward to employing machines at work.

The main idea of constructing a military surveillance robot is to provide active surveillance and, if needed, spy on hostile and buffer zones, create a threat map and perform maneuvers in the field or in inaccessible areas to lessen the probability of hostile situations and/or enemy takeovers by reducing human exposure. This rover presents a sound approach with wireless communication since wireless control is perhaps the most in-demand need for most of the applications across the globe, for performing various tasks. Hence, using mobile phones for control purposes is one of the greater advantages of this rover since they are simple, everyday devices and they can be operated in plain sight without any suspicion [1].

The robot will be driven by high-speed, geared DC motors such that they have enough torque to drive the rover with ample load. Here the building material used for the frame is aluminum rails/pipes but similarly, PVC pipes can also be used for a lighter frame [2]. A motor driver is used to drive all the motors in conjunction. Along with this, the rover will use Omni wheel drive, which is very effective for performing intricate maneuvers in suitable terrains. Programming is done on the Arduino platform to provide an autonomous capability to the rover. Along with the Arduino microcontroller, a DTMF (Dual Tone Multi-Frequency Signaling) module is used to provide wireless communication over a long range. One of the key blocks of this rover is its communication system viz. DTMF protocol. By using DTMF technology, we eliminate the need for having a specific controller or remote since DTMF can be connected and operated by any mobile device [3]. Other communication protocols, including Bluetooth, are a better option in economic terms but due to its low operating range, it’s not a practical option here [4]. In itself, the rover is already a great utility but other numerous advancements can be made; adding additional sensors like PIR, to detect human intervention, temperature sensors to sense the environmental conditions, and

vibration sensors to sense vibrations in an unidentified object. Data from all these can be sent to the human operator or stored locally [5]. The use of a microcontroller is a common approach. But more advanced and reliable alternatives like Robotic Operating System is also a great option, alongside AI algorithms for developing advanced autonomous robots like UAVs [6].

Looking at its core objectives, it is clear that it finds most of its use case scenarios in military applications [7] but if taken in a larger context, this robot can also assist in rescue operations and/or task-oriented applications such as defusing a bomb or act as a 'sacrificial' unit [8]. Robots have been used in similar applications before. Sydney Siege is one good example where a robot equipped with a laser and bomb disposal kit was sent into a room before the human intervention to reduce the risk of loss of human life [9].

But certain limitations do exist; Since most of the communication is done through radio frequencies, there are various issues regarding the operation of the robot such as less efficient operation, lower frequency range, and limited controls [10]. Also, a cell phone should be connected to the DTMF module at all times, which will get discharged over time. Hence there is a need to recharge not only rover batteries but also cell phone batteries [11].

TECHNOLOGIES EMPLOYED

Arduino Development Board

Arduino is the heart of the rover. It takes particular input from the DTMF decoder's output and gives a distinct set of instructions to the motor driver circuit. It can also operate the servo motor, which controls the wireless camera onboard the rover. The Arduino is an open-source microcontroller board that essentially employs a Microchip, ATmega2560, Microcontroller. The board has a set of numerous digital and analog input/output (I/O) pins that may be interfaced with various multi-utility boards and other devices. The board has 54 digital I/O pins, out of which 15 can be used as Pulse Width Modulation pins and 16 analog pins. The Mega board is the extensive board (heavy usage) in the series of USB-based Arduino boards.

DTMF DECODER

DTMF (Dual Tone Multiple Frequency) is an old technology that is essentially a signaling system purposed for identifying/recording a push button on a DTMF keypad. Here, a cell phone is always connected with a decoder which receives input in the form of push buttons on the DTMF keypad. This is correspondingly decoded and given as input to the Arduino microcontroller. DTMF technology in

CHAPTER 12

Farming 4.0 – Review of the Digitalized Agricultural Phenomenon using Disruptive Technologies, its Implementation, and Major Challenges

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Abstract: Farming has been a traditional, manual and labor-intensive industry, and it will continue to be so in the future. Agriculture is one of humanity's oldest businesses and practices. Extrinsic elements, comprising climatic parameters and general environmental variables, have strongly dictated crop yield and productivity. Disruptive technologies such as the Internet of Things (IoT), Big Data Insights, Artificial Intelligence (AI), Machine Learning (ML), *etc*., have significantly affected most every enumerated industry area. Farming based on the implementation of the above advancements leads to "Smart Farming", also known as the "Green Revolution 4.0" in agriculture, which combines agricultural methodologies with technologies to accomplish desired processing efficiencies at manageable costs. The entire development is software-based and sensor-monitored from farm to hand-held devices, lowering overall costs, and increasing aggregate yield and ubiquity level, thereby enhancing user engagement. Predictive analytics for crops may certainly contribute to data-driven decision-making with the help of "failure prediction systems." Climate conditions can be tracked and forecasted to help with forecasting, from seeding to development and delivery of the final crop to the consumer. An increase in global concerns about food safety, as a result of large-scale flood disasters, puts more pressure on smart farming methodologies. The study discusses more of the latest avenues of research and future trends in smart farming with case studies about Indian states. The work also examines major disruptive technologies that govern agricultural phenomena in the twenty-first century.

Keywords: Crop yield, Data-Driven, Decision Making, Disruptive Technologies, Failure Prediction Systems.

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INTRODUCTION

Agriculture is critical to the global economy; the whole world's future is dependent on agriculture. Demand for agricultural production has grown due to population expansion and to address global food security concerns. Smart farming is a phenomenal breakthrough that refers to a philosophy of farm management that prioritises the use of new technology to optimise the type and effectiveness of agricultural products. This strategy incorporates some significant features of IoT, including techniques to scan and process soil data with embedded GPS technology and other intelligent systems. Over time, smart farming has benefited both small and large farmers by providing access to technological systems that aid in the maximisation of commodity quality and quantity, thus lowering farming costs. Maybe you're worried about the critical nature of smart agriculture and agricultural technologies. At the moment, farmers are not required to spread chemicals, fertilizers, or water evenly throughout their whole field. The integration of technology into agriculture, specifically in smart farming, enables farmers to make use of the least number of these elements possible and to target certain areas of their farm or also implement them selectively.

Smart farming minimises agriculture's biological footprint. In precision cultivation systems, the application that is restricted or site-specific use of inputs, which includes fertilisers, can help counter leaching issues along with greenhouse gas emissions [1]. With the rise of ICT, it is imperative to generate a sensor network capable of observing the farm in real time. Using ICT, the scientific and tactical processes relating to the state of the plants, animals, and soils, as well as the requirements for input variables such as water, fertilizer, and medicine, are all within reach internationally. Agriculture can be more lucrative for farmers through smart farming. Reduced resource inputs safe capital and labour for farmers, while improved efficiency of spatially clear data mitigates risk. Crop cultivation may be configure by the use of streamlined, site-specific forecasts, yield projections, and disease and hazard risk maps using them as a foundation, which is composed of meteorological data. Additionally, site-specific data enables the discovery of new crop health coverage [2] and market possibilities throughout the supply chain network, which encompasses infrastructure and input suppliers to manufacturers, producers, and retailers [3] in evolving and established economies alike. When all farming-related data is collected by automatic sensors, the time required for resource prioritisation and administrative surveillance is reduced. Additionally, smart farming can increase market adoption. In general, improving management often enables improved product efficiency (*e.g.*, increased antioxidant and other secondary metabolite levels in orchards due to optimum fruiting densities; or physiologically more amenable milk products due to individualised livestock feeding rations). These goods are not only better but

much more profitable, which is a critical tactic for more productive land use [4]. Additionally, transparency in manufacturing and processing would improve along supply chains as a result of ICT's ability to track which farm generated a particular commodity under what conditions. This creates the possibility for fresh, more direct interactions between farmers and customers.

Several advantages are anticipated by the adoption of smart farming in agriculture, which includes: High crop productivity: the use of improved technology in farming as a result of the introduction of smart farming guarantees an improvement in crop production as the focus is on optimising inputs and minimising waste. Reduced reliance on pesticides, fertilizers, and power: Historically, farmers supplemented the soil with water, fertilizers, and insecticides without regard to the location of these factors on the field. However, with smart, you add water and other chemicals precisely when and where they are required. Reduced use of these pesticides leads to reduced food prices due to reductions in agricultural expenses. Smart farming has adopted more efficient methods for improving production while minimising waste of pesticides, water, and other elements used on the field. The point is that you should not have to subject the world too toxic substances in excess because they can be used sparingly and just when they are appropriate. Increased protection for farmers and employees: Since smart farming incorporates the usage of robots and improved technology, it reduces the number of time farmers and workers spend in the field. As a result, there is no longer a need to think about farmers' and workers' safety. Chemicals are disposed of in a manner that would not pollute groundwater and rivers. Smart cultivation encourages the usage of chemicals sparingly and the introduction of environmentally sustainable farming methods. This means the toxins can be deposited into rivers and the atmosphere in general in negligible amounts.

MARKET TRENDS

Using the full capacity of farm technology offers a powerful tool for battling nature's adverse influences on crops, such as land, animals, and plants, as well as measurement knowledge Precision cultivation often eliminates inputs of fertilizer, chemicals, and water waste, allowing land to be used more effectively. Process automation, which helps businesses save money and increase profits, and decrease costs associated with farming, is essential in increasing the use of smart tools in agriculture. Using advanced precision farming techniques, farmers can find a new avenue to benefit. Precision farming and smart agriculture-oriented businesses have therefore started using different technologies to improve crop yield and profitability Agriculture has yet to expand because of the large initial investment needed. For now, agricultural technology has been more costly and thus not accessible to farmers in the industrialised world and farmers in the developing

CHAPTER 13

Image Processing on Resource-Constrained Devices

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Abstract: The chapter portrays a new development in the field of embedded systems. It showcases the combination of Machine Learning algorithms and low-memory microcontrollers (ESP32-CAM). The uniqueness of this idea lies in the fact that Machine Learning is generally perceived as a processor-intensive task that requires high memory and storage. However, as seen in this chapter, one may soon realize how wrong this notion is with emerging technologies that are taking over the globe. This project portrays the successful implementation of a binary colour classification model on the ESP32-CAM with 68% accuracy post-training result with a mere 15 images of each colour. Machine learning has increased over the years. Some applications include image classification, object detection, and question-answering. This work merely puts out awareness in this domain and is hopeful that dedicated efforts towards it can solve many industrial problems.

Keywords: Arduino IDE, Arduino Language, Artificial Neural Network, Cloud Computing, MicroML, Object Detection, Python, Random Forest, Servo Motors.

INTRODUCTION

The merits of digital image processing have been well-documented in the hallways of scientific journals. Its subset, image classification, has also been in prime fascination among researchers with the rise of machine learning (ML) algorithms. Image classification [1] has a crucial role to play in successfully recognizing distant images such as microscopic images [2] and is used for varied functions such as urban planning, area-use/area planning, environmental change, disaster control, agriculture, geographic mapping, surveillance, and object detect-

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ion [3]. It also seems to have become popular among the remote sensing diaspora in research matters. The image data for remote sensing [4] is procured through various sources like airplanes, aerial vehicles, or satellites. Previously, low-resolution spatial satellite images were used with crude pixel sizes. For remote sensing images, the picture processing techniques deriving from pixel-based or subpixel analysis were used. In such a scenario, occasional problems related to the segregation of scene images occur, generally at segregating pixel-level distinct. Many applications inside the discipline employ ML to run reasoning. Specifically deep learning (DL) techniques with ML models that utilize Graphics Processing Units (GPUs). The long-term confrontation will be to procure ML models that require GPU power to execute optimally on portable devices having reduced processing power and storage. But today, this work shall look into tools that facilitate ML models to be capable enough and enhanced to be inside such devices.

MOTIVATION

ML models have become popular in the developer community to solve everyday tasks and make the Internet of Things (IoT) more efficient [5]. But it has been observed that such models require high processing power and memory to function correctly. Thus, making it impossible for edge IoT devices like microcontrollers to run them.

Generally, for enabling ML facilities on portable devices like an embedded system, ML models are needed to be put on a remote server and be used through services like Restful API. One notices that this method does not solve the problem when observed closely. Instead, it bypasses it since ML models are still not running on the microcontrollers and need to be accessed remotely. And would also render our device useless in case of Internet failure.

The initial approach was targeted toward implementing cloud computing alongside microcontrollers. The prediction was to borrow the processing power of remote cloud computers to process the image data sent through the ESP32-CAM over the Internet. Now, this would look like the solution at first, but on closer inspection, one may observe that the core objective was to process ML algorithms on the microcontroller and not outsource it. In this regard, this approach seems like cheating one's way around the problem rather than solving it head-on correctly.

LITERATURE REVIEW

As no papers have been written that exactly mimic the workings of this project, some were still inspirational towards the proceeding of this initiative. They are mentioned below:

Most embedded systems employed micro-computers (e.g. Raspberry Pi) for their endeavors. A plan was made that helped blind people recognize members of their family through a face recognition algorithm (k- nearest neighbour (KNN) / Tensor Flow) processed by a Raspberry Pi and output provided by audio [6]. Real-time Emotion Recognition is another fad that hit the electronics market by storm. Again facial image recognition is employed, algorithms like Active Shape Model (ASM) are used for feature extraction, and emotions are classified through the AdaBoost classifier. And all processing was hosted on Raspberry Pi II [7]. The Hidden Dot Pattern recognition is a less talked about Artificial Intelligence (AI) application. It's trained on infrared images through Convolutional Neural Networks (CNNs), which run on Raspberry Pi Zero W. The system's accuracy is commendable, and it has a quick response worthy of a real-time commercial product. The system is trained to recognize other patterns effortlessly [8].

Iris Recognition has applications in medical science and security. Embedded systems achieve this by implementing the Daugman algorithm on Raspberry Pi. Since this activity requires high processing power, the results are not up to the mark [9]. Image processing to detect defects on printed circuit board (PCB) seemed unique, but the minimal use of a microcontroller and actual processing done on the desktop was a showstopper. Although, missing holes and paths on the PCB could be detected and classified accordingly [10]. The rise in face recognition on mobile devices has led to increased device spoofing and unauthorized access. Anti-spoofing through face recognition was the need of the hour, which is solved through Arduino, but image processing was conducted on a desktop [11]. With many machine learning models available in the field, it became pretty difficult to decide which one would best fit the project's application. A study by De Leonardis *et al.* compared all popular ML algorithms and helped solve this query [12].

ML has also found applications in preventing traffic accidents. And is achieved by integrating face detection through OpenCV on Raspberry Pi to control the traffic lights or warn pedestrians about jaywalking [13]. The automation of the Swedish Transmission Research Institute (STRI) hydrophobicity classification arrangement, which has assisted applications, looked promising. But limited use of microcontrollers in just capturing the silicone rubber-coated surface’s image posterior to sprinkling water on it was dissatisfying. The image processing was,

CHAPTER 14

Role of Quantum Computing in Transformation of Artificial Intelligence - A Review

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Abstract: It is anticipated that the capabilities of quantum computers will substantially advance the field of Artificial Intelligence (AI). Quantum computing is similar to conventional computing, which encodes data using bits of 0s and 1s. Quantum computing, however, has its variant of data encoding known as quantum or qubit. AI processes complex datasets and is useful in the development of algorithms to create better learning and understanding environments. Researchers are working on employing quantum computing techniques to achieve the goals of AI. This chapter reviews the correlation between quantum computers and artificial intelligence and its future scope.

Keywords: Artificial Intelligence, Analysis, Computing, Quantum Computers, Qubit, Quantum Algorithms.

INTRODUCTION

Computer technology will enter a new era with the development of quantum computers [1]. These computers will be able to solve many computational problems like the factorization of large numbers much faster than the existing classical computers [2]. Moreover, they will be capable of performing rapid searches of complicated database. Quantum simulation [3] by providing new insight into proteins, will reform medicines. Quantum computers will thus have numerous applications [4] by solving the intractable problems which were not possible to solve by the existing classical computers. Artificial Intelligence is one of the promising technologies that have affected every aspect of our lives. It comprises creating algorithms [5] so that the computers can imitate the human brains. It has immense applications in various sectors, for example, gaming, medicines, robotics, smart appliances, education, natural language processing, and many more. Here we can expect the need for quantum computing to enhance the field of AI and help in solving intractable problems in a fraction of the time.

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Artificial Intelligence and Quantum Computing [6] have great potential to change the future of technology [7].

Researchers are working on bringing these two technologies together to revolutionize the world around us. In this chapter, an attempt has been made to show the interaction between Artificial Intelligence and Quantum Computing. Also, the scope of enhancement in various areas of AI using quantum computers has been discussed.

QUANTUM COMPUTERS

Classic computers are machines that utilise transistors to store and process data in the various sequences of zeros and combinations known as binary language [8]. A special circuit composed of a group of transistors known as logic gates enables the computer to perform computation operations and make decisions based on computer programmes written by programmers. The quantity of transistors utilised determined the rate at which computer processes ran. However, such machines are valuable and without a doubt contribute to the advancement of science and innovation, but there are a few more pressing matters that must be resolved. Some problems could not be resolved in an ideal amount of time by even the most advanced classical computers. Using the qubits as input, quantum computers execute the transformation operation [9]. Quantum computers can perform various computations significantly faster than conventional computers. Any conventional solution or upgrade cannot compete with the infinite possibilities offered by quantum computing.

Qubit and Quantum Superposition. In quantum computing, a qubit serves as the fundamental unit of information for measuring quantum states and is also known as a quantum bit. A computer only comprehends binary language and encodes data as bits that are either 0 or 1. In contrast, in quantum computing, information is encoded as qubits. In quantum computing [11], a qubit [10] has two states, 0 and 1, or it can be the group of both states in a linear order. Fig. (**1**) depicts the classical bit *vs.* qubit. The collection of two-qubit states is also referred to as a superposition. The superposition feature of quantum computing is based on the quantum mechanical principle that superimposes two valid states to produce a third valid state. A classical computer with n bits will only output n bits of information, whereas a quantum computer with n qubits will output 2n qubits of information due to quantum superposition. From 2015 to 2020, Fig. (**2**) depicts the growth of quantum computers in terms of qubits. With 200 qubits, Harvard-MIT is the winner of the race until 2020, followed by Google and others. In the future, quantum computer executions will be larger and much faster.

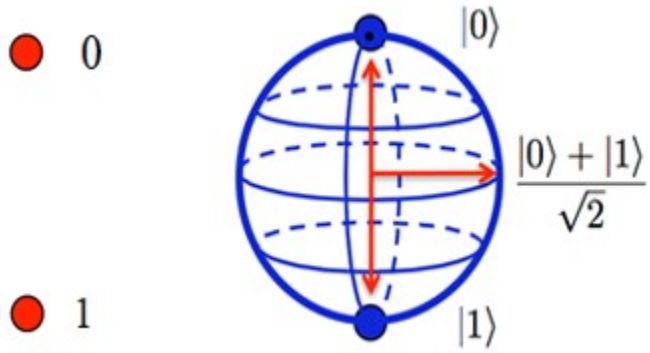

Fig. (1). Bit *vs.* qubit [12].

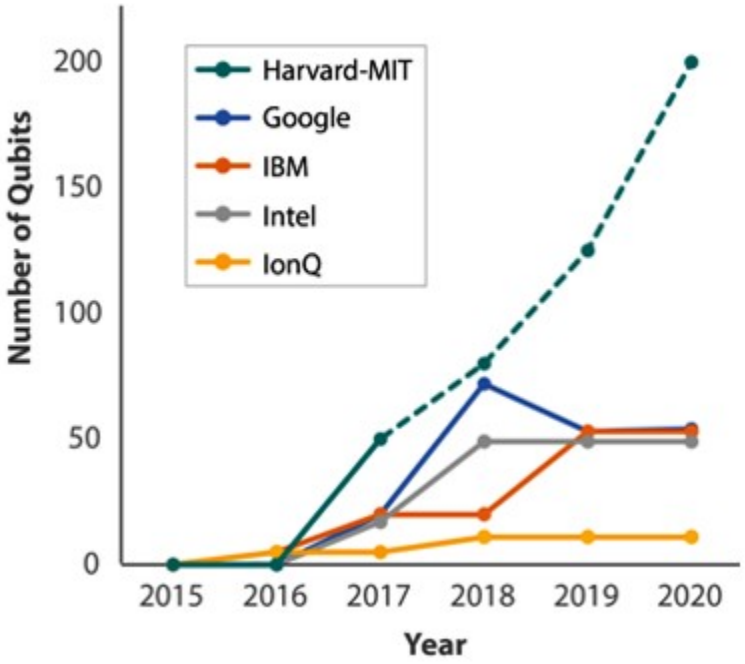

Fig. (2). Growth of quantum computers [13].

QUANTUM ALGORITHMS AND GATES

Deutsch (1985) presented the first quantum algorithm that demonstrated the processing speed comparison between classical and quantum algorithms [14]. Since then, a number of quantum algorithms that are faster than traditional algorithms have been proposed to solve a variety of computational problems. The algorithm developed by Grover [15] to sort data in unsorted data sets is a significant one. Shor's algorithm [16] is capable of breaking advanced encryption key cryptosystems such as RSA. If quantum computers are able to effectively

CHAPTER 15

Gesture-Based Secure Pin Entry in ATM

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Abstract: At present, ATMs (Automated Teller Machines) are one of the essential services for our daily life. It is also true that the thefts of false transactions and pin thefts are increasing yearly. A significant amount of theft at ATMs is due to pin overlooking and card skimming. Biometrics provide promising security but have high implementation costs. Also, Indian laws discourage using BiometricsBiometrics in all places. So, can AI be the solution to this problem? Instead of using keypad-based inputs for pins, gesture detection with AI can be used for secure inputs. A trained deep neural network can detect count from the hand symbols/gestures. The gesture input is given by inserting the hand inside a safe box with a high-resolution camera attached. The camera takes images and sends them to Raspberry Pi or any other embedded system. The Raspberry Pi executes the lightweight ML model to detect the count. The detected count is then encrypted and passed to the ATM. Using a gesture identification system removes the problem of pin theft and can be developed and implemented with the slightest modification in ATMs. In the current COVID period, execution of ATM works with minimum contact to public surfaces has increased immensely. In this system, a keypad is also removed and can further be incorporated to read a variety of inputs from gestures instead of just hands. This chapter explores how lightweight neural networks can be trained to detect sensors and run on low-processing systems like Raspberry Pi. We achieved an accuracy of 94%-97% in detecting gestures and pins where accuracy varies for each motion.

Keywords: ATM Security, CNN, Computer Vision, Deep Learning with Embedded System, Gesture Detection, Mobile Net, Raspberry Pi, Transfer Learning, Tensor Flow, VGG model.

INTRODUCTION

In India, in the fiscal year 2018-19, 22 crores were lost in ATM frauds in the single state of Maharashtra. The total loss for whole theft in India would be ten-

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fold more significant than this. All these amounts pertain to fraud through card skimming and pin theft alone at the ATMs. This theft has been carried out on a larger scale in poorer states like Bihar. So, to reduce these problems, in this chapter, we propose a system with a Machine Learning model implemented by us for secure pin authentication using the help of Artificial Intelligence.

In past years, many solutions have been proposed for ATM security using BiometricsBiometrics [1]. Most solutions include using a fingerprint scanning system instead of a pin-based system for user authentication. N. Ratha and his team from IBM laid out the current biometrics systems employed in various security-critical systems [2]. They also pointed out the weak links and the systems in use and proposed various solutions to overcome them. The overall analysis displayed the usage and drawbacks of biometrics-based authentication systems in various tech systems.

A few solutions proposed for user authentication have also been for Bank based OTP systems, but they were hugely discarded due to the limitation of interbank ATM usage. Even though BiometricsBiometrics promise security solutions, they have been avoided in ATMs for many years due to various legal restrictions, including Indian privacy laws, which don't allow using biometric data. In India, we can find fingerprint scanners besides keypads in most modern ATMs. Still, they are disabled as authenticating with fingerprints in public places for financial transactions is not permitted (the only exception is Aadhar Enabled Payment System - AePS). This is the point where Artificial Intelligence comes to help. Instead of only taking inputs through a keypad, we developed a box with a camera and Raspberry Pi. This box recognized the pin inputs through the detection and analysis of the hand gestures of the user. Now, the box was a closed and secured container, due to which no one could look at or record what pin was entered by the end user.

This secure box was wired to the ATM server. And this system was installed such that it boots up on signal/interrupt from ATM, records the pin, and sends the encrypted pin back to ATM through the wire. The encryption was the same as that used by ATMs [3]. So this encrypted pin was then used directly to verify the user's identity and card. This proposed system can be installed at a minimum cost and without much modification to existing ATMs, making it a cheap and promising solution for a country like India.

CURRENT ATM SYSTEM

ATM is the most popular transaction method for withdrawing money in India. The ATM is a device banks provide at different places allowing users to process their account transactions. The users require a chip-based card provided by the

banks to access their accounts. The card contains the information related to the user, which the machine fetches after the user inserts it in the ATM. After this, the four-digit user's pin is verified by the Bank for authentication by transmitting it in encrypted form. On successful authentication, all banking operations are permitted.

The way we enter our PIN through a keypad isn't fully secure. The keypad used to enter the numeric data is generally open (Fig. **1**). So, there is always a chance of phishing through a fake keypad or a camera being installed to look over the PIN we enter. This is prevalent in India in most tier-3 cities.

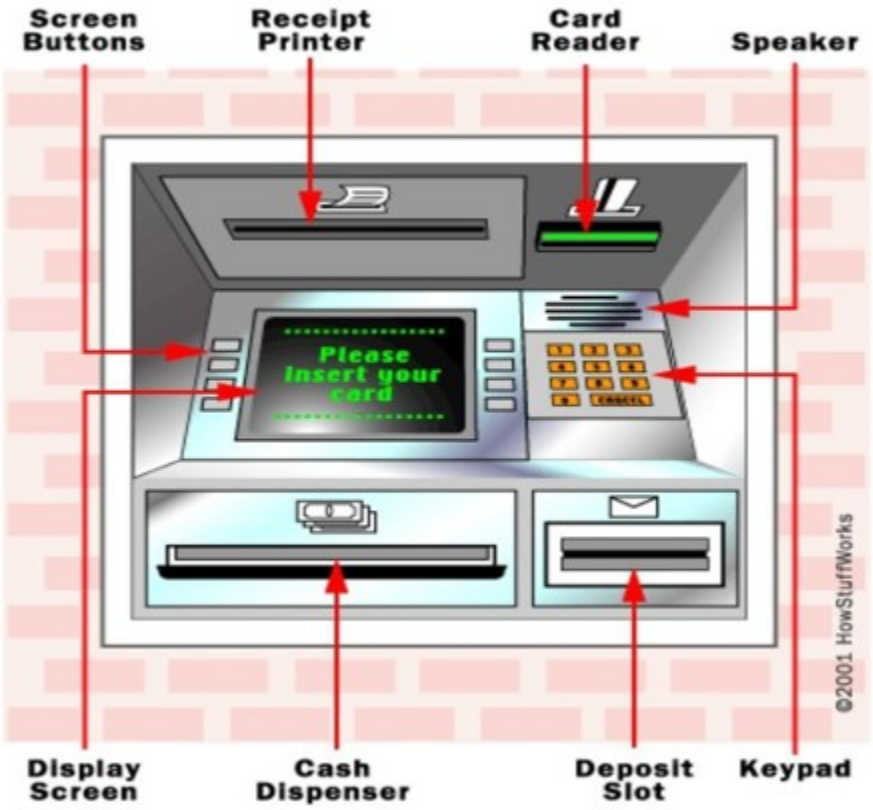

Fig. (1). General ATM Diagram. Source: Adapted from [4].

GESTURE-BASED INPUT SYSTEM

As discussed in the previous section, the current ATM uses input based on the keypad system. The keypad contains digits 0-9 and some other keys for functionalities such as cancel, clear, exit, *etc*., as it is known that the keypad-based system is prone to card skimming and pin overlooking. The authors in [2],

CHAPTER 16

Dimensions and Hadoop of Big Data. A Review

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Abstract: Big Data is a massive collection of data that continues to grow dramatically over time. It is a data set that is so huge and complicated that no standard data management technologies can effectively store or process it. Big data is similar to regular data, but it is much larger. "There's no doubt that the volumes of data presently available are vast, but that's not the essential element of this new data ecosystem," says one expert. The term "big data" is now commonly used to refer to the application of predictive analytics. New correlations can be discovered by analyzing data sets to "identify economic trends, prevent diseases, combat crime, and so on." In sectors such as Internet searches, financial technology, healthcare analytics, geographic information systems, urban informatics, and business informatics, scientists, corporate executives, medical practitioners, advertising, and governments all face challenges with enormous data sets.

Keywords: Big Data, Dimensions, IoT Devices, Technology.

INTRODUCTION

Big Data is a phrase for a collection of data sets that are so large and complex that traditional data processing software or on-hand database management solutions cannot store or analyze them. It is also used to describe data collections that are too large for standard software tools to acquire, manage, and in a reasonable period, complete the process. On the farm, we utilize an IoT gadget to track environmental information using a sensor. This device generates data to control various operations, such as farm protection, automatic transportation system tracking, *etc.*

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With today's technology and IoT devices, real-time monitoring can be increased with high precision, speed, and reliability. In examining BIG Data, IoT devices play a critical role, as shown in Fig. (**1**) [1 - 6].

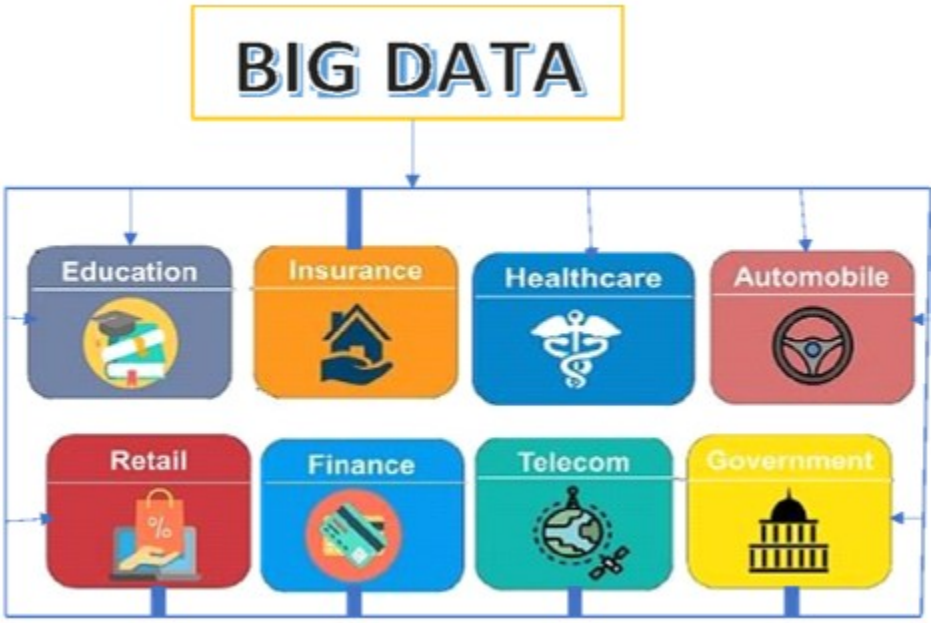

Fig. (1). Different sources of Big Data.

Dimensions of BIG Data

In this part, we'll start with an overview of the 4 V's, which are the dimensions of big data.

Volume. Measure of information

Variety. A mixture of structured & unstructured data

Velocity. Motion of data

Veracity. Correctness of the data

Researchers proposed that alternative dimensions of large data be defined by deleting some aspects, such as value, or by introducing other issues, such as validity. Mudholkar [7] considered 3V’s, whereas Shivanjali Khare and Michael Totaro [4] considered 4 V’s as shown in Fig. (**2**), whereas [5] Ishwarappa and Anuradha regarded 5Vs, but Khan deemed 10Vs to be Big Data problems [8].

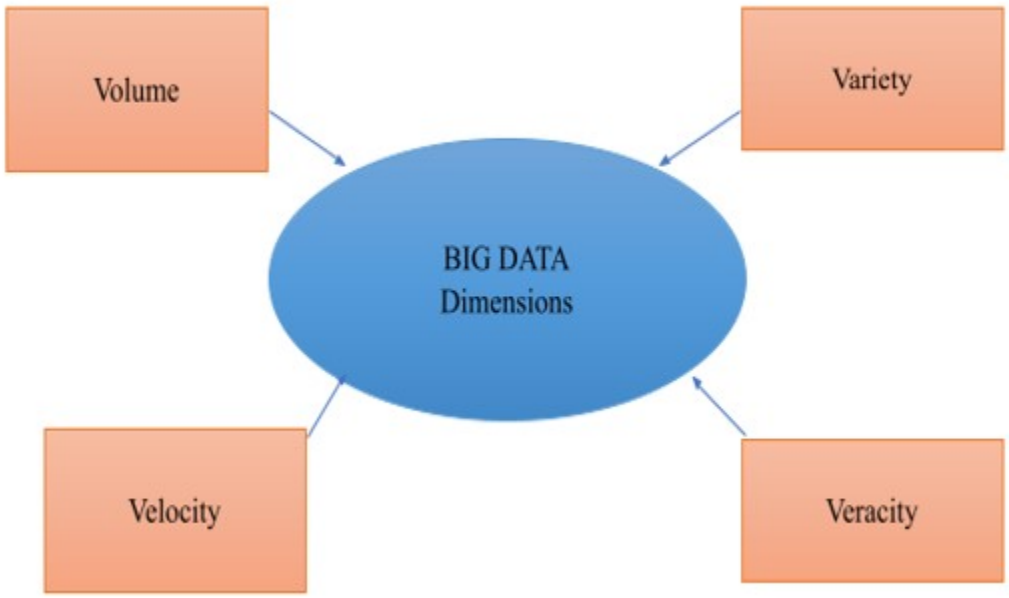

Fig. (2). Big Data's 4 V Dimensions.

Volume

This dimension relates to the amount of data or information measured. Metadata refers to the information generated by networks, machines, and human activity on a system such as social media. The amount of data that needs to be examined is enormous [9]. The size of this data is growing by the day; single data sets are currently ranging in size from a few hundred terabytes (TB) to several petabytes (PB). We collect data from IoT devices and store or transport it to other nodes. If the data is too huge, traditional database technology is no longer helpful [10].

Research from IDC shows that the volume of digital data will have reached 40,000 Exabytes (EB) or 40 Zettabytes (ZB), as shown in Fig. (**3**). Day by day, it is observed that the coming generations are leading towards faster internet, which requires more data rate shortly [11, 12].

SUBJECT INDEX

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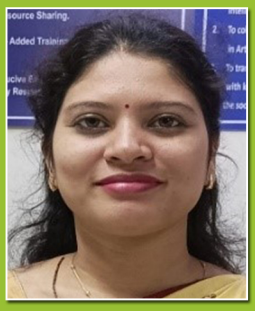

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