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CUTTING EDGE IOT TECHNOLOGY FOR SMART INDIAN PHARMA

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***Abstract*— The primary objective is to delve into the possibilities and benefits of implementing IoT in the pharmaceutical sector. This involves understanding how IoT technology can be strategically employed to enhance various facets of smart pharma operations in India. The project aims to contribute to the advancement of the Indian pharmaceutical industry by focusing on smart pharma operations. Through the integration of IoT technology and sensors, the goal is to identify and implement innovative solutions that can improve efficiency, traceability, and overall performance within the sector. The project focuses on different levels integral to establishing a robust IoT-based pharmaceutical system. It aims to provide valuable insights into the integration of IoT at various levels of the pharmaceutical industry, laying the groundwork for a comprehensive and effective IoT ecosystem. The project incorporates machine learning algorithms to predict patient health conditions and identify disease trends. By leveraging data acquired through IoT and sensors, the objective is to develop accurate and proactive models that can contribute to early detection and management of health issues. The project is organized into distinct phases to ensure a systematic approach. This includes the acquisition of data and information through IoT devices and sensors, as well as the effective management of IoT systems within the specific context of smart pharma. These structured phases aim to facilitate a seamless integration process and optimize the overall effectiveness of the IoT-based system.**

Keywords*— *IoT, digital innovations, healthcare, pharma industry, Make in India.

I. INTRODUCTION

India underwrites the second major portion of medicinal and biotech labour force in the world. Thus, pharma companies must look forward to strategies the manufacturing process well, following the best industrial practices. In order to lead in manufacturing processes and strengthen the supply chain management across globe it must adopt recent trends in technology such as artificial intelligence, machine learning and internet of things. India leads as the second foremost stakeholder of medicinal and biotechnology labour force in the globe. [9,11,12] India's inhouse pharma marketplace revenue touched Rs 1.4 lakh crore (US$ 20.03 billion) in 2019, up 9.8 % year to year from Rs 1.29 lakh crore (US$ 18.12 billion) in 2018. In May 2020, pharmaceutical sales grew 9% to Rs 10,342 crore (US$ 1.47 billion) all through COVID-19 pandemic. While discussing about pharma production sub-optimal environmental situations seems to be fatal. Any how this obstacle could be tackled easily with the help of internet of things (IoT). Pharma IoT generates transparency in drug manufacturing and storage environment accompanied by several sensors to monitor environmental parameters like photons, humidity, temperature and radiations [1]. Also, this can be helpful to create a health database or to diagnose ailments at early stages with the use of wearable devices implanted within human bodies. Along with this it can also capture data of the users of wearable devices where sensors are implanted. This could help to collect and store health data of any individual which might be useful to detect any disease at initial stages. Also there exist a scope of personalization of health care products as based on the health of individual thus making medications possible well on time.

Pharma industry face a chronic need to endure competitive in a market where product ranges are diversified, innovative start-ups stimulating the status-quo, logistical allies fetching more cohesive and patients more intricated in decisions around their upkeep. It's just because of lack of transparency and adaptation of latest trends in technology such as IoT [5,9,12] and sensors to ensure safe and secure medicine manufacturing and proper supply / distribution at time [2]. The thought of IoT commences with entities denoted as distinct interactive digital devices. Radio frequency identification device (RFID) [3] is a specimen of such system [3]. The usage of IoT and sensors could help avoiding critical situations by minimizing production downtime and ensure workplace safekeeping. Additionally, the assimilated data could generate a complete scenario of the paraphernalia consumption. In combination with artificial intelligence and predictive analytics the industry makes a flawless groundwork for predictive conservation of equipment [4].

II. LITERATURE SURVEY

Today, in an Industry 4.0 factory, machines are connected as a collaborative community. Such evolution requires the utilization of advance- prediction tools, so that data can be

systematically processed into information to explain uncertainties, and thereby make more "informed" decisions. Cyber-Physical System-based manufacturing and service innovations are two inevitable trends and challenges for manufacturing industries. This paper [1] addresses the trends of manufacturing service transformation in big data [1,11] environment, as well as the readiness of smart predictive informatics tools to manage big data, thereby achieving transparency and productivity.

Internet of Things (IoT) is a buzzword in the area of information technology. The Internet of Things is an interconnected computer system with unique identifiers (UIDs) that are capable of transmitting information over a network. This review [2] article highlights the potential applications of IoT [5,9,12] in pharmaceutical manufacturing, warehousing, and supply chain management to enhance product quality, increase productivity, and reduction in errors during different stages of a pharmaceutical product. During the manufacturing of the pharmaceutical product, IoT may be useful in supervising and optimizing different unit operations for real-time monitoring and control to enhance production efficiency. In warehousing and supply chain management of pharmaceutical products, IoT is applicable in monitoring the real-time storage conditions of the drug product and improving visibility to enhance operational effectiveness.

The Internet of Things (IoT) becomes a popular research area in the present technology world [9]. The combination of sensors and actuators makes a strong structure for cloud computing which may be utilized as networks of self-governing objects in real time system. IoT is growing day by day in smart cities, domestic life, and industries in different aspects. According to Gartner Inc., "IoT will include 26 billion units installed by 2020". IoT helps in making Smart environment such as home automation, smart wearable, security solutions, smart health care etc. The upcoming research areas of IoT [5,9,12] are in making smart transport mechanisms for cities and making smart power grids. This manuscript presents an overview of recent trends of the IoT and its effects in the daily life of human being. The significance of artificial intelligence, autonomous control, cloud computing in IoT is also discussed. There is a necessity to synchronize technologies like wireless sensors, actuators, internet, distributed computing etc. for effectively activate the new technologies for IoT.

Industrie 4.0 (I40), i.e. the implementation of cyber-physical systems along the entire value chain and a far reaching digitalization of products and processes, is regarded as a significant agent of change in our current industrial system. While the previous discussion of I40 has been centered on technologies and standards, our focus is on business models (BM) for and enabled by I40. Having the right I40 BM will ultimately decide about companies' market positions and profitability. This calls for a systematic process for business model innovation (BMI) [10]. The previous academic literature has offered mostly conceptual reviews to date. Empirical analyses of management approaches and processes applied for BMI are scarce. Based on an exploratory research design, we present the results of a comparative interview study with large companies and industry associations. [10] We analyze I40 business model characteristics, provide an in-depth perspective of companies' processes, structures and tools for BMI and derive upcoming practices as well as key compe-tencies for BMI in the course of I40. Our results indicate a diverse picture. While some companies have dedicated BMI structures in place and lead I40 BMI, others could benefit from complementing existing product and service development with a systematic approach to BMI, building the fundamental capability to exploit the opportunities of I40.

A number of technologies can reduce overall costs for the prevention or management of chronic illnesses. These include devices that constantly monitor health indicators, devices that auto-administer therapies, or devices that track real-time health data when a patient self-administers a therapy [11]. Because they have increased access to high-speed Internet and smartphones, many patients have started to use mobile applications (apps) to manage various health needs. These devices and mobile apps are now increasingly used and integrated with telemedicine and telehealth via the medical Internet of Things (mIoT). This paper reviews mIoT and big data in healthcare fields.

The pharmaceuticals and life sciences industries are generally require quite advanced technology to compete with the worldwide market share. Pharmaceutical and life science companies invest more time, effort and money into digitalization of their business [5,9]. It is estimated that by 2020, there will be 50 billion connected devices, and in five years, 80% of companies are expected to utilize IoT in their digitized firms. IoT revolutionizes the pharmaceutical sector by providing and automating pharmaceutical manufacturing, discovery of drugs and remote monitoring of patients and more. Digitization holds tremendous potential to help pharma companies address various challenges. This chapter [12] intends to provide an insight of Internet of Things in Pharmaceutical sectors.

III. MATERIALS AND METHODS

i. Proposed Work:

The proposed system incorporates IoT for real-time monitoring in pharmaceutical manufacturing and wearable sensors for continuous patient health data. It employs advanced data analysis and machine learning for predictive healthcare and introduces data compression to enhance the efficiency of the Indian pharmaceutical industry and healthcare response. Explore the potential of implementing the Internet of Things (IoT) in the context of smart pharma within India [5,9,12]. Investigate and enhance the Indian pharmaceutical sector by incorporating IoT technology and sensors into smart pharma operations. Focus on different levels to establish the foundation of an IoT-based pharmaceutical system, providing insights for effective IoT integration in the pharmaceutical industry. Utilize machine learning algorithms to predict patient health conditions and identify disease trends within the smart pharma framework. Structure the project into distinct phases, including the acquisition of data and information through IoT and sensors, as well as the management of IoT systems within the context of smart pharma.

ii. System Architecture:

IoT acts as a catalyst for paperless manufacturing, as equipment and recipe parameters turn out to be additionally close connected and available, which needs fewer labor-intensive involvements. As the health care industry grows to diagnostic based therapies which necessitates individualized production of medicine for smaller scale manufacturing using IoT [7]. IoT able to acquire the data from various processes and connect complex equipment which visualizes the insight of the process beyond performance and efficiency. Connects

various equipment working on various plant floors, communicates with each other and disseminate information crosswise the pharma manufacturing plant and till top level management. These offers opportunity to standardize the process easily. IoT enabled smarter plant offers solution to manufacturers, they could access the real time stream of data for better monitoring of the manufacturing process and advance perceptibility for the point of production to market reach. Manufacturers pull the data as and when necessary to track and trace process when an issue occurs which cautions and speedy recall of the products from the market quickly and efficiently [5].

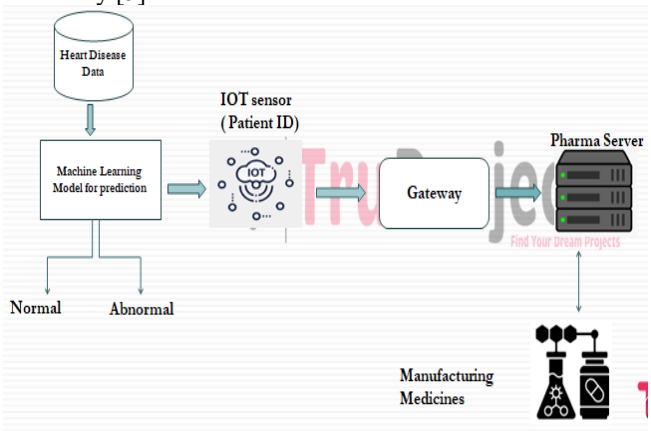

Fig. 1. System Architecture

iii. Algorithms:

Machine learning is a branch of artificial intelligence (AI) and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy. Over the last couple of decades, the technological advances in storage and processing power have enabled some innovative products based on machine learning, such as Netflix's recommendation engine and self-driving cars.

Machine learning is an important component of the growing field of data science. Through the use of statistical methods, algorithms are trained to make classifications or predictions, and to uncover key insights in data mining projects. These insights subsequently drive decision making within applications and businesses, ideally impacting key growth metrics. [1] As big data continues to expand and grow, the market demand for data scientists will increase. They will be required to help identify the most relevant business questions and the data to answer them. Machine learning algorithms are typically created using frameworks that accelerate solution development, such as TensorFlow and PyTorch.

```
>>> from sklearn.cluster import KMeans
>>> import numpy as np
>>> X = np.array([[1, 2], [1, 4], [1, 0],
...               [10, 2], [10, 4], [10, 0]])
>>> kmeans = KMeans(n_clusters=2, random_state=0).fit(X)
>>> kmeans.labels_
array([1, 1, 1, 0, 0, 0], dtype=int32)
>>> kmeans.predict([[0, 0], [12, 3]])
array([1, 0], dtype=int32)
>>> kmeans.cluster_centers_
array([[10.,  2.],
       [ 1.,  2.]])
```

Fig. 2 Machine learning Algorithm

vi. Modules:

1. Heart Disease Data : The system begins with the collection of heart disease data, which is used for training a machine learning model. This data serves as the foundation for the predictive capability of the system.

2. Machine Learning Model for Prediction (Normal or Abnormal): The trained machine learning model is responsible for predicting whether a patient's health condition is normal or abnormal based on the input data. It acts as the core component for health assessment.

3. IoT Sensor (Patient ID): Patient health is continuously monitored using IoT sensors, and each patient is assigned a unique IoT ID for data tracking. These sensors collect vital health information.

4. Gateway: The data from IoT sensors is transmitted to a gateway, which serves as a communication intermediary. The gateway plays a crucial role in routing data to the appropriate destination.

5. Pharma Server: The data from the gateway is directed to Pharma Servers, where the machine learning model processes the incoming health data. The machine learning model assesses whether a patient's health condition is normal or abnormal.

6. Manufacturing Medicines: Based on the results from the machine learning model, the Pharma Server provides manufacturing instructions to pharmaceutical companies. If the data indicates a need for specific medicines due to abnormal health conditions, pharmaceutical companies can take prompt action to produce the required medications.

IV. EXPERIMENTAL RESULTS

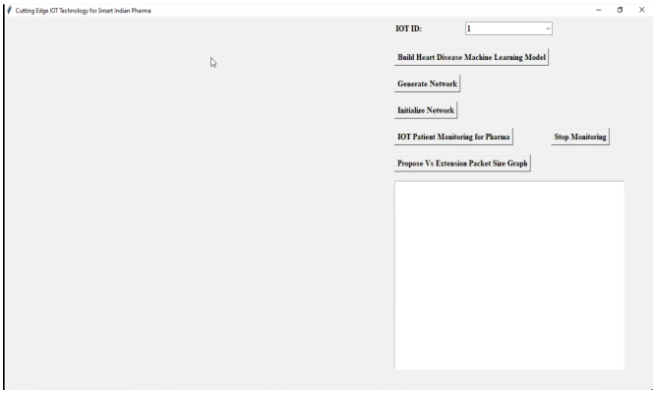

Fig 3 Home screen

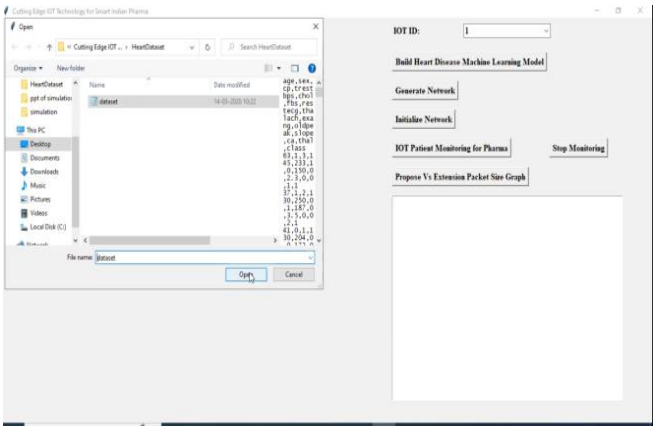

Fig 4 Build heart disease machine learning model

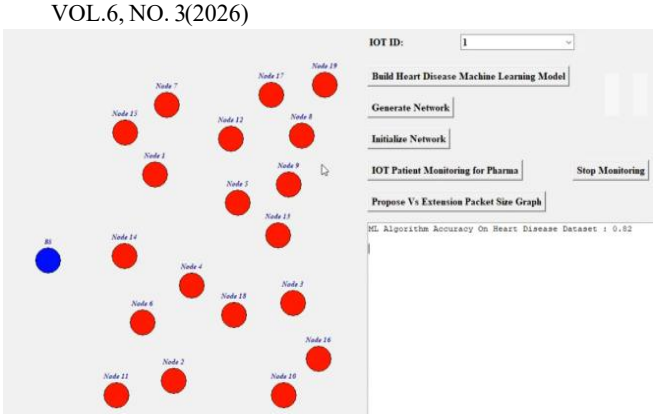

Fig 5 Generate network

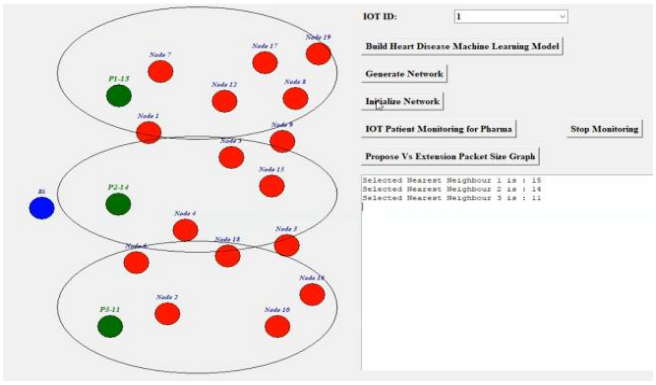

Fig 6 Initialize network

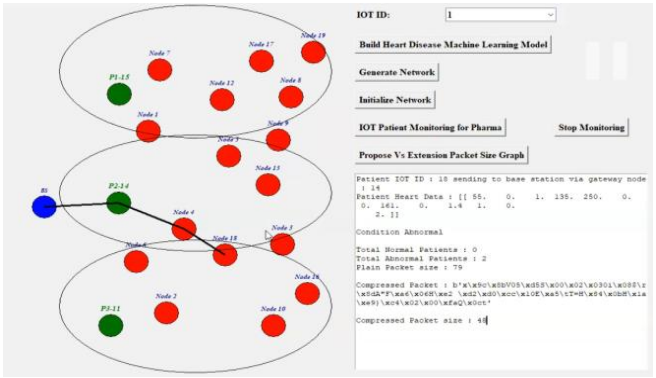

Fig 7 IOT patient monitoring for pharma

Fig 8 Packet size graph

V. CONCLUSION

This project offers a comprehensive solution to transform the pharmaceutical industry in India into a Smart Pharma ecosystem, bridging the gap between manufacturing and patient healthcare. By integrating IoT [5,9,12] technology for real-time monitoring and wearable sensors for continuous health data collection, the proposed system enhances the responsiveness and efficiency of pharmaceutical companies. Advanced machine learning and big data analysis empower predictive healthcare, enabling timely production of medicines and proactive interventions for patients. Data compression techniques mitigate the risk of internet congestion, ensuring seamless data transmission. Focusing on the Indian pharmaceutical industry, this project not only modernizes manufacturing processes but also contributes to the country's public health goals by addressing the timely supply of medicines and healthcare management needs.

VI. FUTURE SCOPE

The integration of IoT technology in the pharmaceutical sector holds substantial potential for driving advancements and enhancements in multiple domains. Combining IoT and sensors can elevate the efficiency and precision of smart pharma practices within India. [5] IoT offers the capability for real-time monitoring of pharmaceutical processes, resulting in improved quality control and error reduction. The incorporation of IoT in the pharmaceutical field can lead to superior management of the supply chain, providing enhanced drug tracking and traceability. [12] IoT has the potential to enable remote patient monitoring and the delivery of personalized medical solutions, leading to improved healthcare outcome.

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