A Review on Artificial Intelligence Enabled – Pandemic and Endemic Monitor and Regulator Applications

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ABSTRACT

A pandemic refers to world wild spread of an illness that spreads extensively, affecting people across broad geographic regions, often crossing international borders and impacting a large population. This phrase is commonly linked with viral diseases that can easily spread among humans, leading to widespread illness and significant social disruption. In contrast, the term "endemic" describes the continuous presence and frequent manifestation of a particular illness or infectious entity within a particular geographic area or population. Unlike epidemics or pandemics, which involve the sudden and widespread incidence of an illness over a larger region, endemism is characterized by the ongoing persistence of a disease in a specific locality or population over an extended period. Both pandemic and endemic diseases pose substantial global health concerns. Early monitoring and regulation of these diseases are crucial in minimizing social damage. The paper discusses a survey conducted on monitoring and regulatory applications designed to contribute more effectively to public health and disease management. These initiatives aim to enhance early detection and control measures, addressing the challenges posed by both pandemic and endemic diseases.

Keyword: - *Pandemic, Endemic, Artificial Intelligence, regulator, health monitor.*

1. INTRODUCTION

Pandemics, described as extensive outbreaks of contagious ailments capable of causing widespread illness and death, present significant dangers to global health. They can result in substantial disruptions across economic, social, and political spheres. The causes of pandemics can vary, stemming from viruses, bacteria, or alternative infectious agents that have capacity to induce severe diseases and spread easily among people. The beginning of a pandemic is marked by the sustained and widespread transmission of the infectious agent, resulting in a high quantity of instances that can strain healthcare systems. The implications of pandemics extend beyond public health, impacting various aspects of daily life such as travel, trade, and employment. This underscores the profound social, economic, and political consequences associated with these global health crises.

1.1 Spread of disease

Over the course of history, pandemics have arisen at different points in time, with notable instances such as the Spanish flu in 1918, the H1N1 influenza pandemic in 2009, and, more recently, the COVID-19 pandemic triggered by the SARS-CoV-2 virus. The latter began in late 2019 and persisted into subsequent years, marking a significant global health crisis[23]. These trends are expected to persist and amplify, necessitating heightened vigilance and strategic planning.

1.2 Endemic viruses and their impact

In an endemic setting, an infectious agent like a virus, bacterium, or other pathogen becomes established and consistently circulates within a community. This results in a baseline level of cases that may vary with seasons or over time but generally remains stable. Endemic diseases are often well-adapted to the local environment and show a pattern of recurring infections. Examples of such diseases include malaria in specific tropical regions, where the Anopheles mosquito, a carrier of the malaria parasite, is widespread. Another instance is dengue fever, which is endemic in various parts of Southeast Asia, the Pacific Islands, and certain regions of the Americas, where Aedes mosquitoes transmit the dengue virus.

1.3 Importance of Endemic Regulator application

Despite notable advancements, there exist some difficulties in global pandemic and endemic preparedness. There is inconsistency towards meeting the International Health Regulations, with many countries striving to fulfil basic rules regulations. Previous outbreaks, such as the 2014 Ebola epidemic in West Africa, have revealed shortcomings in timely disease detection, access to basic health care, infection tracing, separation and quarantine procedures, broader preparedness beyond the health sector. This includes challenges in global support and response militarization.These challenges are especially evident in areas with limited resources and have consequences not only in frameowrk of local epidemics but also serve as a cautionary signal for potential complications during a comprehensive global pandemic. In today's interconnected and digitally advanced world, having the capacity to retrieve up-to-date health information is crucial. With the increasing occurrence of contagious diseases, there is a pressing need for a tool that not only predicts the spread of diseases but also provides in-depth insights into their causes, symptoms, treatments, and preventive measures. Looking back at historical pandemics, such as the first plague pandemic (6th century – 8th century) and the second plague pandemic (14th century – early 19th century), we observe individual outbreaks like the Plague of Justinian (first pandemic) and the Black Death (second pandemic). Because there aren't good vaccines, and monitoring systems are costly, there is a need to rethink how to find, predict, and deal with diseases affected by climate. Right now, the methods to control outbreaks are not very good. They tend to step in late when the disease is already going down instead of getting in early when it starts. There is a need of a practical plan to predict the risk of disease spreading and to set up actions to control it [1].

1.3 Risks and impacts of Endemic Regulator application

Risks:-Historical Background: Throughout history, pandemics have happened, and it seems like they are occurring more frequently. This is partly because new viral diseases are emerging, often originating from animals. Factors Driving Risk: The risk of a pandemic happening involves two main factors - "spark risk," which is where a pandemic is likely to start, and "spread risk," which is how likely it is to spread widely among people. Regional Differences: Certain regions of the world, such as Central and West Africa, are more prone to being the epicenters of pandemics; however, they are not as well- equipped or prepared for such situations in comparison to other regions.

2. MOTIVATION

Frequency of occurrence of pandemic is surveyed to understand the spreading rate of the disease and how it will threaten human lives.[16].

Analysing Risk: Experts use tools like probabilistic modelling and analytical tools (such as exceedance probability curves) to assess the risk of a pandemic and estimate how severe it could be.

Table 1 Frequency And Duration Of Occurance Of A Pandemic[16].

Pandemic disease	**Duration/ Frequency**
Zika Virus Epidemic	2015-2016
Severe acute respiratory syndrome corona virus infection (SARS CoV1)	2002-2004

Influenza A H1N1 2009 (Swine Flu) Pandemic.	2009-2010
Western African Ebola virus epidemic	2013-2016
Middle East respiratory syndrome (MERS) CoV infection	2012-present

Influenza Warning: Among all pathogens, the influenza virus is most likely to cause a severe pandemic. Analysis suggests that there's a 1 percent chance each year of an influenza pandemic causing nearly 6 million deaths worldwide. Impacts:-Health Impact: Pandemics can lead to widespread illness and death, with a more significant impact on countries with fewer resources (Low- and Middle-Income Countries or LMICs). Economic Consequences: Pandemics can harm economies in various ways, causing immediate financial problems and long-term damage to economic growth.
Behavioural Changes: People changing their behaviour, like avoiding workplaces and public spaces due to fear, can contribute to economic challenges during pandemics. Models whose state assumes value on a graph rather than on a standard Euclidean space describe naturally many physical or artificial systems of considerable interest. The spreading of an epidemic within a fixed population is among the network dynamics with especially relevant applications and dynamic behaviour [2]. Here, the graph models the social network. Each node describes either a subject or a group of subjects, and the arcs the contacts. Basic local update rules can effectively depict the accurate spread of the disease. Recently, these models have been widely employed to elucidate the transmission dynamics of Covid-19 [3]. Pandemic and Endemic Monitor and Regulator Applications serve crucial roles in public health and disease management. These applications are crafted to oversee, trace, and manage the dissemination of infectious diseases, furnishing valuable information to healthcare professionals, policymakers, and the general public.

2.1 Advantages

The following are some essential requirements and advantages linked with these applications:
1. Early Detection and Monitoring: Rapid identification of potential outbreaks or the emergence of new diseases is vital for early intervention. These applications can monitor real-time data, including the quantity of instances, geographical spread, and other relevant information to detect and track potential pandemics or endemic situations.

2. Surveillance and Situational Awareness: By furnishing surveillance tools, these applications aid health authorities and organizations in staying abreast of the present status of infectious diseases. This promotes improved situational awareness, enabling timely and well-informed decision-making.

3. Resource Allocation: During outbreaks, it is essential to allocate resources efficiently. Monitoring applications can assist authorities in pinpointing areas with a higher prevalence of the disease, allowing them to allocate medical supplies, personnel, and other resources to where they are most required.

4. Public Communication and Education: These applications play a crucial role in disseminating accurate and timely information to the public. They can provide guidance on preventive measures, vaccination campaigns, and other public health initiatives, contributing to increased awareness and compliance.

5. Regulatory Compliance and Enforcement: Regulator applications can facilitate the enforcement of community health regulations, such as quarantine measures, travel restrictions, and vaccination requirements. This helps in managing the dissemination of infectious diseases and ensuring public safety.

6. Data Analytics and Modelling: Advanced data analytics and modelling capabilities within these applications enable health professionals to analyse trends, predict potential outbreaks, and assess the efficacy of interventions. This information is valuable for refining and optimizing public health strategies.

7. Global Collaboration: In the event of pandemics, international collaboration is essential. These applications can facilitate the sharing of information between countries and organizations, fostering a coordinated global response to health emergencies.

8. Research and Development: Information gathered via these applications can play a role in advancing scientific research and formulating novel approaches for preventing, treating, and managing diseases.

9. Emergency Response Planning: These applications assist in the progress and refinement of emergency response plans. By simulating different scenarios and evaluating potential outcomes, authorities can better prepare for and respond to health crises.

10. Continuous Improvement: Consistent observation and examination of data play a crucial role in the ongoing enhancement of public health strategies. Insights gained from past outbreaks can guide more effective responses to forthcoming challenges. The Pandemic and Endemic Monitor and Regulator Applications are vital instruments for proactive disease management, enabling rapid response, informed decision- making, and the protection of public health on a global scale.

3. LITERATURE SURVEY

As the main heart of the system is on disease monitoring, the reviews are done specifically on the existing disease monitoring system that is used by the Ministry of Health to identify their system's structure, data flow, and the required parameters and specifications on the monitoring process. The second part is reviewing current disease mobile applications that disseminate health-related information to the public [4]. Looking at different systems and reading related articles helps us compare them. This way, we can get an idea and figure out the best solution to use in this research.

Opportunities and Challenges for Construction Health and Safety Technologies under the COVID-19 Pandemic:-A quantitative and qualitative content analysis of the interview data was performed. This method was applied in this study to identify the most critical issues concerned by interviewees .The main advantage is it is a relative study on safety methods and technologies for COVID-19. But it fails to provide disease prediction rate in any particular area. And also regarding other diseases[9]. A similar research was done in the paper Impacts of epidemic outbreaks on supply chains: mapping a research agenda amid the COVID-19 pandemic through a structured literature review[10].

To Overcome the above problem, Monitoring and Tracking the Evolution of a Viral Epidemic Through Nonlinear Kalman Filtering: Application to the COVID-19 Case pandemic was reviewed [4]. This is a Mathematical models based on the assumption that the evolution of infected people etc. The main advantage of this system is ,this work has addressed the problem of monitoring and tracking the evolution of a viral epidemic, such as Covid-19, through the application of signal processing techniques to the time series. A similar research was done in the paper A review on Malaysia's solar energy pathway towards carbon-neutral Malaysia beyond Covid'19 pandemic[13]. But it fails to provide early notification for the spreading rate of disease.

A research paper based on waterborne pandemic disease was also reviewed under the name Waterborne protozoan outbreaks: An update on the global, regional, and national prevalence from 2017 to 2020 and sources of contamination [14]. This paper highlights Data extraction and synthesis, Global, regional, and national trends of waterborne protozoan outbreaks, Reasons for disproportionate representation in developed countries. Two similar papers were reviewed. One is Wastewater-based epidemiology for preventing outbreaks and epidemics in Latin America – Lessons from the past and a look to the future [15], and the other one is Antimicrobial Resistance Monitoring of Water Environments: A Framework for Standardized Methods and Qualitative Controls[19].But the main disadvantage is these researches fail to fill the gap to connect with the users.

A solution to the problem mentioned earlier is a system called "early warning and response system for dengue outbreaks." This system is not just in the research phase; it's now being put into action in Mexico.

The integration of an Early Warning and Response System (EWARS) for dengue outbreaks in Mexico marks a significant shift from conventional epidemiological surveillance methods. Traditionally, the focus has been on reporting probable and confirmed cases to the National Epidemiological Surveillance System, with only a subset undergoing laboratory confirmation. However, the new approach proposes a more advanced early warning system that incorporates meteorological, entomological, and epidemiological indicators to predict and respond to potential outbreaks [1] .

In contrast to the simplistic reliance on reported case numbers to trigger responses, this innovative system introduces a range of alarm indicators. These indicators, including transmission risk factors, enable a more sophisticated and proactive approach. For instance, the transmission risk indicator has proven effective in identifying specific clusters that require targeted allocation of resources and control measures. Notably, vector control measures, such as focal spraying, have been strategically applied around probable cases. A noteworthy addition to operational scenarios is the identification of hotspots, enhancing control strategies for Aedes aegypti and dengue transmission, as well as other

arboviruses. The EWARS is positioned as a coordinating tool that elevates dengue surveillance and prevention efforts, enabling more efficient and anticipatory control programs. The success of this approach is exemplified in Mexico, where a combination of high technical competence, streamlined data handling through automation, seamless interface of various data platforms, and the utilization of meteorological intelligence have optimized the EWARS tool[1].

Crucially, the collaboration among different government departments, specifically between epidemiology and vector control, has been instrumental. Additionally, the cooperation between sectors, such as health and meteorology, has played a pivotal role in the successful implementation of the EWARS tool. Developed in partnership with TDR, the tool has benefited from the expertise of institutional partners, including the University of Freiburg in Germany and the University of Gothenburg in Sweden. The impact extends beyond Mexico, with endemic countries in Latin America, Asia, and Africa also leveraging the EWARS tool to enhance their own dengue surveillance and control initiatives. There is no application which analyses the spreading rate of the disease in Geographical region. To support this, below paper was researched.

In this innovative study, the main goal is to use Graph Neural Networks (GNNs) to tackle the challenging job of figuring out how epidemics are spreading in social networks. The findings are very promising, demonstrating an impressive accuracy of more than 70% in estimating the overall situation, especially for nodes that are not directly observed.

3.1 Methodology

The methodology proposed in this work, depicted in Figure-1, stands as a pioneering solution to this intricate challenge. By harnessing the power of neural networks, the system effectively tackles the task of reconstructing the health states of an entire population within a social network, paving the way for more robust and accurate epidemic monitoring and prediction[2]. The primary objective of this system lies in utilizing GNNs as classifiers for 14. Early warning and response system for dengue outbreaks: Moving from research to operational implementation in Mexico. Sanchez Tejeda G, Benitez Valladares D, Correa Morales F, Toledo Cisneros J, Espinoza Tamarindo BE, Hussain-Alkhatee b L, et al. (2023) The utilized retrospective (historical) data covered the period of 2007 to 2011, which defined the run-in period particularly responsible for developing area-specific (municipality) prediction algorithms.

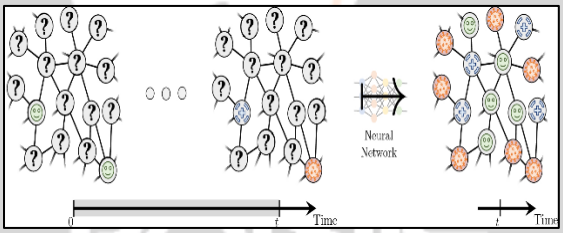

Fig:1 Graph Neural Network

Advantage:-This is perceived as a coordinating tool improved dengue surveillance, prevention, and enabling efficient control programs. Disadvantage:-There is no actual application. This study explores an Early Warning and Response System for dengue outbreaks. In this research paper, the researchers focus on using Graph Neural Networks (GNNs) to figure out how epidemics spread. They are particularly interested in GNNs as tools to classify nodes. The aim is to decide on the labels of nodes by considering the information available about them and their surroundings. Advantage:-This system will estimate the spreading rate of a disease. Disadvantage:- It will not notify the users about critical regions. nodes, seeking to assign labels by incorporating available information about the nodes and their respective neighbourhoods. This classification task naturally extends to the broader goal of reconstructing the entire state of the system. The system adopts this approach in the context of epidemics, employing multiple GNN layers in conjunction with a temporal information encoding mechanism. To illustrate the problem at hand, consider an epidemic spreading across a social network. Health operators, in practical scenarios, face limitations in measuring the condition of the entire population and can only monitor a small subset of individuals. These individuals are subject to continuous testing over time. The system visualizes this scenario by representing each individual as a node, with question marks indicating subjects whose conditions are not directly measured. At the initial time, the two subjects whose states are measured are healthy, portrayed by green smiles. As time progresses to 't', these subjects transition to being either infected (depicted by red dots) or recovered (indicated by blue crosses). The ultimate objective is to reconstruct the comprehensive

configuration of the network by integrating this limited information. The desired output entails knowledge of the health states of all potential subjects, which could number in the thousands.

4. CONCLUSION

The pandemic monitor research survey has provided valuable insights into the perspective of Covid-19, Dengue, waterborne diseases, Monkey Pox and various other pandemics on various aspects of individuals' lives. The data collected highlights frequency of occurrence of a pandemic, the need of an application which identifies spreading of a disease in a particular region, emphasizing the importance of understanding the symptoms and precautions to be taken. As we navigate these challenging times, it is clear that highly populated areas have been particularly affected, underscoring the need for targeted interventions and support. The responses from participants underscore the resilience and adaptability of communities, as well as the importance of medical facilities. Furthermore, this survey serves as a baseline for future research and monitoring efforts. As the situation evolves, ongoing data collection will be essential to track changes, identify emerging trends, and adapt responses accordingly. Ultimately, the collaborative efforts of individuals, communities, and institutions will play a pivotal role in overcoming the challenges posed by the pandemic. By learning from the experiences shared in this survey, we can collectively work towards building a more resilient and prepared society for the future.

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