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Conceptual Paper

Artificial Intelligence for Zoonotic Disease Surveillance: Preparedness for the Future

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Artificial intelligence has revolutionized various fields, and its potential impact on zoonotic disease surveillance is of utmost significane in the recent times. Zoonotic disease surveillance involves the systematic monitoring of diseases that can be transmitted from animals to humans. This surveillance is crucial for early detection, prevention, and control of outbreaks, as zoonotic diseases pose significant public health risks. Surveillance efforts typically include monitoring animal populations, identifying potential sources of infection, and tracking patterns of transmission. By closely monitoring these diseases, public health authorities can implement appropriate interventions, such as vaccination campaigns or improved animal husbandry practices, to reduce the risk of transmission to humans. Effective zoonotic disease surveillance plays a vital role in safeguarding both human and animal health [5].

The advent of technologies such as artificial intelligence, machine learning, IoT, big data analytics, spatial analysis with Geographic Information Systems (GIS), remote sensing, satellite imagery, and molecular technologies (as shown in Figure 1) have demonstrated significant potential in enhancing zoonotic disease surveillance and prediction. AI has the potential to revolutionize zoonotic disease surveillance by offering advanced tools for early detection and prediction of outbreaks. Machine learning (ML) algorithms can analyze vast amounts of data from various sources including animal populations, human health records, environmental factors, and regional dynamics to identify patterns and signals that indicate the emergence of zoonotic diseases. This can enable public health authorities to take proactive measures to prevent the spread of diseases from animals to humans, ultimately reducing the pandemic risk and saving lives. This article will discuss briefly the innovative applications of AI surveillance in important zoonotic diseases in India [1].

AI for COVID 19 prediction

Artificial intelligence (AI) emerges as a crucial tool in estimating the spread and predicting disease patterns of the biggest global health risk in recent times, the COVID 19. With AI it is capable to swiftly analyze vast amounts of data from various sources such as social media, healthcare records, and movement patterns. By detecting correlations and patterns in this data, AI algorithms provide valuable insights into the mechanics of the virus's transmission.

Studies utilizing AI models like Recurrent Neural Networks (RNNs) and multilayer perceptron (MLP) neural networks have shown promising results in predicting COVID-19 trends. These models accurately forecast epidemic curves and can even predict future peaks of the disease by analyzing historical and real-time data. Moreover, researchers have discovered strong correlations between variables such as ischemic heart disease, pancreatic cancer, socioeconomic status, and environmental factors with COVID-19 incidence rates.

The use of AI to track and forecast the spread of COVID-19 has been covered in a number of publications recently. An early warning of the COVID-19 epidemic, for instance, was given by BlueDot's AI program by looking through news articles. An artificial intelligence (AI) system called EPIWATCH uses open-source data to automatically produce early alerts for COVID-19.

These findings are not only crucial for forecasting COVID-19 cases but also for assisting public health decision-makers in understanding the impact of various risk factors at the local level. AI is playing a significant role in our ability to anticipate and respond to the pandemic, paving the way for more effective strategies in combating the virus.

Machine learning and event-based surveillance for infectious disease prediction: insights from Kya Sanur forest disease. ML is the practice of using algorithms to analyze data, learn from it, and make predictions about the future. By processing large amounts of data, ML algorithms can analyze patterns and make predictions, which is incredibly useful in disease surveillance, outbreak detection, and understanding how diseases spread. These algorithms can analyze diverse data sources like electronic health records, genomic data, social media, and environmental data to identify

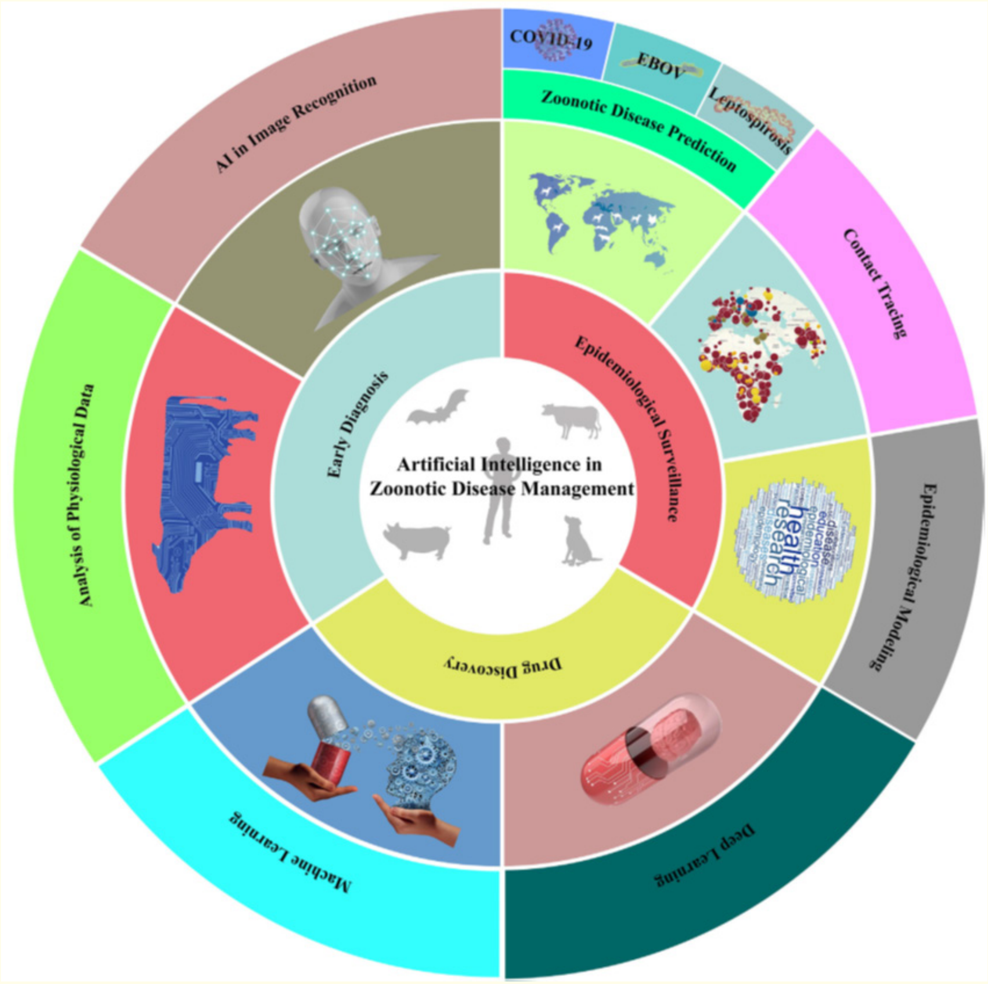

Figure 1: The overview of AI technologies to enhance zoonotic disease surveillance [2].

potential disease hotspots, forecast disease trends, and optimize resource allocation for controlling and preventing diseases.

For effective disease prediction, algorithms typically require extensive, high-quality epidemiological data. However, obtaining such data in practical scenarios can be difficult, expensive, or even impossible, especially for emerging diseases. Modern ML (ML) techniques have addressed these challenges by utilizing alternative data sources.

Transfer learning (TL) is a method within ML that involves transferring knowledge from a related task to improve predictions for a specific target task. By leveraging pre-trained models, TL enables improved performance with less training data and time. TL has recently shown promise in predicting infectious diseases. By incorporating data from related diseases or locations like dengue, Zika, and COVID-19, TL enhances forecasting accuracy, particularly for diseases with limited available data.

“Event-based surveillance" (EBS) refers to the systematic, rapid collection of data on potential public health emergencies, often through unofficial channels like news channels, social media, hospitals, and laboratories. This data source has been effectively used for early epidemiological assessment of disease outbreaks, including Rift Valley Fever, Cholera, Anthrax, Ebola, and COVID-19. One particularly important study by [4] utilised meteorological data, combining it with EBS information, such as news media reports and internet search patterns . The study utilized extensive epidemiological data from areas where KFD is common and applied Transfer Learning (TL) methods to successfully predict KFD cases in new outbreak areas with limited surveillance data. Adding EBS data alongside weather data notably boosted prediction accuracy across all the models in this study.

AI technologies in surveillance of other zoonoses: other examples

Leptospirosis, another important zoonotic disease in India [7], is influenced by changes in weather and the environment. Artificial intelligence (AI) algorithms can analyze various data sources to detect the disease early. These sources include animal populations, environmental factors, and weather patterns. In a study conducted by [6] data mining and ML techniques were used to assess, record, and predict the prevalence of leptospirosis. They focused on understanding how humidity, rainfall, and temperature are linked to the disease. Through exploratory data analysis, the study determined the best time lag for analyzing rainfall. An Artificial Neural Network (ANN) model was then developed to enhance the sensitivity, specificity, and accuracy of disease prediction algorithms. Another research on leptospirosis forecasted illness using a neural network prediction model.

Bacillus anthracis is the bacterium responsible for anthrax, a highly infectious disease that affects both humans and animals. Early detection of anthrax outbreaks is crucial for minimizing cases, deaths, and the risk of disease spread. A recent study aimed to predict anthrax outbreaks in cattle in Karnataka by developing a disease prediction model using ML techniques. The focus was on early identification of anthrax cases. Using R statistical software version 3.1.3, the researchers built an ML model that combined multiple techniques such as adaptive regression splines, flexible discriminant analysis (FDA), generalized linear models (GLMs), and generalized additive models with other data mining methods. Data on anthrax occurrences were obtained from the Animal Husbandry Department in Bangalore, Karnataka, India.

Addressing the threat of Nipah virus (NiV) outbreaks in India, [4] developed a prognostic model for early NiV diagnosis using ML techniques. They combined a range of clinical factors such as symptoms, disease incubation period data, and routine blood test results, all confirmed by laboratory technicians.

Conclusion

In conclusion, the integration of artificial intelligence (AI) in zoonotic disease surveillance represents a significant advancement in public health. By harnessing AI techniques to analyze diverse data sources, including animal populations, environmental variables, and human health data, we can detect and predict zoonotic disease outbreaks earlier and more accurately than ever before. This early detection allows for prompt intervention and control measures, potentially saving countless lives and preventing widespread transmission. The scope of AI and ML in disease surveillance and goes even beyond the realm of prediction. AI has also been successfully used for contact tracing and epidemiological modelling in COVID 19 pandemic response and serves as a model for further pandemic preparedness. Moreover, AI enables us to identify patterns and correlations between various factors associated with zoonotic diseases, providing valuable insights for understanding disease transmission dynamics and informing targeted prevention strategies. As AI technologies continue to evolve, their role in zoonotic disease surveillance will become increasingly vital in protecting both human and animal populations from the threat of emerging infectious diseases.

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