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A Web-based Analysis for Dengue Tracking and Prediction using Artificial Neural Network

Seongtae Hwang[2], Denmar S. Clarite[1], Frank I. Elijorde[1], Bobby D. Gerardo[1], and Yungcheol Byun[2]

[1]Institute of Information and Communications Technology, West Visyas State University
La Paz, Iloilo City, Philippines
[2]Department of Computer Engineering, Jeju National University, South Korea
dendenclarite@gmail.com, {felijorde, bgerardo}@wvsu.edu.ph, {hst2570, ycb}@jejunu.ac.kr (Corresponding author)

Abstract. Providing an accurate analysis of dengue epidemic seasons will allow sufficient time in taking necessary decisions and actions to safeguard the situation for local authorities. This research aims to develop a web-based dengue tracking system (DTS) that makes use of environmental input factors in predicting the future behavior of dengue cases using Artificial Neural Network. The system can serve a valuable purpose for the health sectors as it informs them to take action on recorded cases in areas which are prone to dengue. Through mapping, the system can also generate an analysis of the area where outbreaks of dengue commonly occurs using a graphical representation of case patterns.

Keywords: Decision Support System, Dengue Monitoring, Outbreak Prediction, Heat maps, Artificial Neural Network

1 Introduction

In tropical and subtropical regions of eastern and South-eastern Asia, Dengue fever (DF) and Dengue hemorrhagic fever (DHF) result to an estimated 500000 people requiring hospitalization each year, and a very large proportion of whom are children. About 2.5% of those affected die. The incidence has grown dramatically around the world in recent decades, with some 2.5 billion people now at risk of the disease [1].

In recent years, the National Environment Agency of Singapore has been using rising ambient temperature as an indicator of increase in dengue cases. Previous study has shown that elevated weekly mean temperature and cumulative rainfall influence the risks of dengue cases at lag times up to 20 weeks with higher relative risks of dengue cases at time lag of 3-4 months [2]. Dengue was serologically confirmed in Sri Lanka in 1962, the first outbreak was reported in 1965, and dengue epidemics in Sri Lanka have occurred almost every other year since 2002 [3]. Dengue is described as hyperendemic in Thailand, and remains a major public health problem and represents the foremost cause of hospitalization, mainly in children. Fortunately, due to appropriate case management the mortality rate is low [4]. In the Philippines,

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dengue cases can occur and increase anytime, which is the reason for different organizations to implement various programs which aid in the prevention of dengue cases. However, many of those organizations still encounter difficulties in monitoring dengue cases especially in remote areas where its occurrences can be very rampant due to lack of information dissemination and support.

The main goal of this research is to develop a web-based dengue tracking system (DTS) that determines the correlation of the input factors in predicting the future behavior of the dengue cases using Artificial Neural Network. The system shows area mapping of plot points to determine case patterns as well as to predict the future behavior of dengue cases based on different environmental factors. The system will serve as a DSS for the health sectors that will inform them to take action if an outbreak is predicted in areas which are prone to dengue. The system can also generate an area analysis which determines where the wide spread of dengue commonly occurs based on the number of counts on a given year. Furthermore, this study also aims to provide a graphical representation of dengue case patterns and area analysis using cloud-based applications such as Google Maps.

2 Related Works

In [5], they fitted a Vector Error Correction Model (VECM) to describe the number of dengue patients using the climatic factors. In this study, the authors proposed a model to predict the dengue disease outbreak using the vector correction method. The proposed model only based on the humidity and temperature and does not take rainfall measurements into account. The approximate prediction provided by this model on dengue epidemic seasons could facilitate the local authorities to take the necessary steps to safeguard the situation for local communities.

The work in [6] demonstrates that weather variables could be important factors for the development of a simple, precise, and low cost functional dengue early warning. We developed the weather-based dengue forecasting model based on scientific evidence that temperature and rainfall has significant influence on vectors and dengue viruses. Dengue cases are influenced by complex interactions of ecology, environment, human, vectors, and virus factors. The forecast window of 16 weeks shown in this model offers ample time for local authorities to mitigate a potential outbreak effectively.

To gain better understanding, the authors in [7] examined the effects of meteorological factors on dengue incidence in three geographically distinct areas of Sri Lanka by time series analysis of weekly data. The weekly average maximum temperature and total rainfall and the total number of dengue cases from 2005 to 2011 (7 years) were used as time series data in this study. Subsequently, time series analyses were performed on the basis of ordinary least squares regression analysis followed by the vector autoregressive model (VAR).

In [8], they sought to forecast the evolution of dengue epidemics in Singapore to provide early warning of outbreaks and to facilitate public health response to moderate an impending outbreak. They developed a set of statistical models using least absolute shrinkage and selection operator (LASSO) methods to forecast the weekly incidence of dengue notifications over a three-month time horizon. Statistical models built using machine learning methods such as LASSO is found to have the potential to markedly improve forecasting techniques for recurrent infectious disease outbreaks such as dengue.

3 Web-based Analysis for Dengue Tracking and Prediction

The architectural design of the system is shown in Figure 1, which describes the overall structure of the system and how the major components interact.

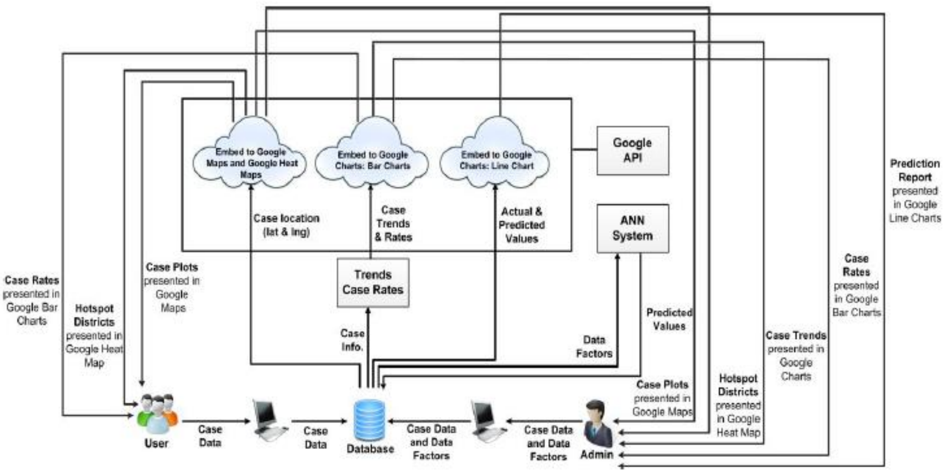

Fig. 1. Architecture of the Proposed System

In this system, the *users* are the hospitals or health centers. The *admin* would be the Department of Health. The user submits case information online, then the system filters it and distributes to its designated area for plotting on the map, identifying the hotspot districts, and case analysis. The *admin* controls the analysis and filter of data throughout the system. Basically, the proposed system aims to track down the number of dengue victims and to predict the outbreak's future behavior so that the health organizations and sectors can take action to prevent its increasing number.

The researchers developed a web-based system which uses cloud computing. Various Google applications were utilized as a service provider and for the overall presentation of the system functions. Google Chart was for displaying the dengue case rates, trends and prediction, Google Map was utilized to plot the dengue cases, and Google Heat Map was used for determining the hotspot districts on a given year.

There are two main users of the system. The regular users are the hospitals in which, they are responsible for the management of the case data. Each hospital user has an account which was created by the admin. They input case information in the *Case Entry* form which requires them to input information about the victim. The *admin* and *user* has a separate system interface. Some of the functions in the *user*'s pages are similar except for the *admin* which holds the entire access to the features of the system.

4 Implementation

The proposed system was implemented using MySql as the backend, while CSS, PHP, Javascript and C# were used for developing the frontend. The *users* of the system are the hospitals from Iloilo City, Philippines while the *administrator* is the City Health Office or the Department of Health. In order to use the system effectively, they must be equipped and knowledgeable in using a computer.

The proposed system generates case plots, hotspot districts, trends and case rate that can help different health sectors in Iloilo City in implementing awareness about dengue and to reduce overall case occurrence. The figures below show the different inputs required and outputs generated from the system as well as various Google Applications that were utilized.

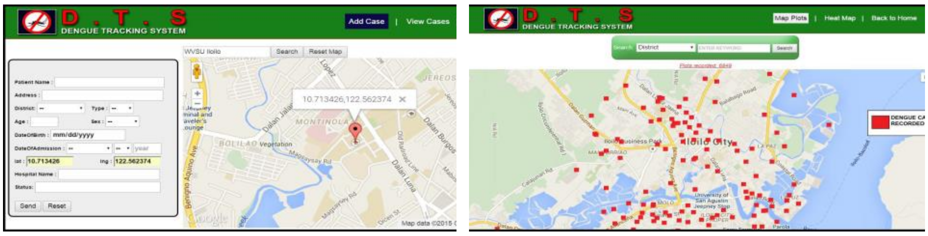

Fig. 2. Add Dengue Case and Dengue Case Mapping page.

Figure 2 shows the interface for entering dengue cases into the system. Aside from the victim's personal details, the information includes the coordinates of the recorded case. The accumulated case data will then be used to generate the *Case Map* of the dengue cases and *Hotspots* of severely affected areas.

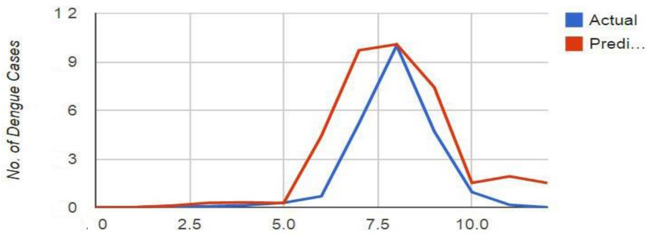

Fig. 3. Dengue case prediction (x=months / y= no. of cases).

Finally, Figure 3 shows an example of how the ANN model was applied to predict dengue cases using historical data. As can be seen, the data trends indicate a close match between the actual and the predicted number of dengue cases.

5 Conclusion and Future Works

The study aimed to develop a system that can help the health sectors in identifying the hotspot areas, trends, dengue outbreak behavior, and case rate in Iloilo City. It was found very useful especially in terms of helping the relevant authorities to implement programs and preventive measures to lessen the number of dengue cases and promote awareness to the people. To further improve the system, the researchers recommend using more advanced tools in generating outputs such as the map system and the charts. Google applications may not be available at all times, thus offline/installable alternatives can also be considered. Secondly, the intuitiveness of the system can still be improved by adding features such as context-aware instructions for understandability. Lastly, the prediction process of the ANN system will be improved and additional algorithm that could handle missing data will also be employed.

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References

1. World Health Organization: Dengue and dengue haemorrhagic fever Factsheet No. 117, Revised February 2015, Geneva, Switzerland, (2015)
2. Hii Y.L., Rocklöv J., Ng N., Tang C.S., Pang F.Y.: Climate variability and increase in incidence and magnitude of dengue incidence in Singapore, Global Health Action 2, (2009)
3. World Health Organization: Communicable disease epidemiological profile, Sri Lanka, (2010)
4. Lumbiganon, P.: Dengue mortality in patients under 18 years old: an analysis from the health situation analysis of Thai population in 2010 project. J. Med. Assoc. Thai. 95 Suppl. 7, (2012).
5. Kavinga H.W.B., Jayasundara D.D.M., Dushantha N. K. Jayakody: A New Dengue Outbreak Statistical Model using the Time Series Analysis, European International Journal of Science and Technology, Vol. 2 No. 10, (2013)
6. Hii, Y.L.: Forecast of dengue incidence using temperature and rainfall, PLoS Neglected Tropical Diseases, Dis 6: e1908, (2012)
7. Goto K., Kumarendran B., Mettananda S., Gunasekara D., Fujii Y., Kaneko S.: Analysis of Effects of Meteorological Factors on Dengue Incidence in Sri Lanka Using Time Series Data. PLoS ONE 8(5), (2013)
8. Yuan S.: Three-Month Real-Time Dengue Forecast Models: An Early Warning System for Outbreak Alerts and Policy Decision Support in Singapore, Environmental Health Perspectives, Advanced Publication, (2015)

