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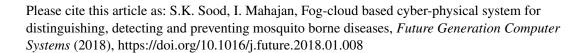
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Fog-Cloud Based Cyber-Physical System for Distinguishing, Detecting and Preventing Mosquito Borne Diseases

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Abstract

Mosquito-Borne Diseases (MBDs) are deadly infectious diseases those transmit quickly through infected mosquitoes to human or from one infected person to another, resulting in substantial increase in worldwide morbidity and mortality rate. The symptoms of MBDs are almost similar to each other which makes it quite difficult to diagnose the specific disease. However, it is required to diagnose the patient for proper treatment and continuous monitoring of infected patients to control the infection of MBDs. Healthcare services based on fog-cloud assisted cyber-physical system are emerging as a proactive and efficacious solution to provide remote monitoring and early detection of infected users suffering from MBDs. Fog-cloud based cyber-physical system facilitates the alliance of devices in the physical space i.e. smart wearables, IoT sensors and smart cameras with cyber space to generate the required information. Afterwards, it uses cyber space to assimilate, analyze and share medical information amongst users and healthcare service providers. A novel system based on IoT sensors, cloud computing and fog computing is proposed to distinguish, classify and monitor the users infected with MBDs. The objective of this system is to control the outbreak of MBDs at an early stage. In the proposed system, similarity factor is calculated to differentiate among MBDs and then J48 decision tree classifier is used to classify the category of infection for each user. The alerts are instantly generated and sent on user's mobile from fog layer in case of any abnormality. Radio Frequency Identification (RFID) is used to sense the close proximity between users. Temporal Network Analysis (TNA) is applied to monitor and represent the current state of the MBDs outbreak using close proximity data. The experimental evaluations of the proposed system resulted in high accuracy and low error rate to distinguish the MBDs and also provided 94% classification accuracy. The results also reveal that the TNA is an efficient tool to evaluate the state of MBDs outbreak using various statistical parameters.

Keywords: Cyber-Physical System, Fog Computing, Cloud Computing, Mosquito Borne Diseases, Decision Tree, Temporal Network Analysis

1. Introduction

Mosquito Borne Diseases (MBDs) are caused by bacteria, viruses or parasites transmitted by the bite of an infected mosquito [1]. Diseases that are transmitted to human body by mosquitoes include dengue, zika, chikungunya, west nile, river rift valley, malaria and yellow fever. All these diseases except malaria and west nile fever are transmitted to human body by Aedes Aegypti mosquito. According to World Health Organization, more than 1 million people die each year from mosquito borne diseases. In 2016, only malaria caused more than 4,00,000 deaths globally and incidence of dengue infection has increased 30 fold in the last 30 years [2]. Estimated 2,00,000 cases of yellow fever are resulting 30,000 deaths worldwide each year [3]. 6,93,489 suspected cases and 37,480 confirmed cases of chikungunya in America (2015) were reported to the Pan American Health Organization regional office [4]. The Zika virus transmission has been identified in a total of 148 countries and territories from 1st January 2007 to 5th January 2017 [5]. The rapid infection of MBDs is due to climate change, expanding global transportation network and inability to control growing population of mosquitoes. All these diseases have almost similar symptoms. So it becomes very difficult to identify exact disease from which person is suffering. The only way to identify the exact MBD is to make the person undergo several tests. However, all these tests are not easily available and affordable. Due to the ever increasing number of patients suffering from MBDs and limited healthcare resources in hospitals, doctors have less

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