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Corona Virus Disease (COVID 19): Analysis and Design of an Alert and Real-time Tracking System

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ABSTRACT

Microscopic agents such as viruses, protozoa, bacteria, fungi, etc. are common aetiologic agents in most infections affecting man. Whereas some infectious diseases are localized owing to the unique geospatial and biochemical characteristics of the aetiologic agents, others are not bound by such restrictions hence their manifest tendencies towards evolving an epidemic or even a pandemic. CoVID-19 sprang up in Wuhan China in November 2019 and was declared a pandemic by the in January 2020 World Health Organization (WHO). Like the Spanish flu of 1918 that claimed millions of lives, the COVID-19 has caused the demise of thousands with China, Italy, Spain and the USA having the highest statistics on infection and mortality rates. Regardless of existing sophisticated technologies and medical science, the spread has continued to surge high. Tracking of suspected carriers (cases) has been difficult, thereby increasing the risk of spread. As a novel infection, real-time information management beyond national geographical borders is vital to the success of any disease management campaign. Currently, information on the Covid-19 and applicable management procedures in most countries is limited thus creating a knowledge and management gap among the populace and even health management personnel especially in areas susceptible to the pandemic. In response to the aforementioned, this paper proposes an Alert and Tracking System (CVATS) that enhances information dissemination, disease management, tracking of cases, and management of confirmed cases. The system follows an object-oriented approach in articulating the various actors and evolves a model that could be implemented on both web and mobile platforms. On mobile platform, it employs google maps and could be used to track persons as well as geographical areas with prevalence of infections.

Key words: COVID-19, Corona Virus, Epidemic, Pandemic, Infectious disease, Informatics

1. INTRODUCTION

In many cases, medical science and medicaments have prevailed over diseases though knowledge, expertise, capacity and medicaments applied to disease management are inequitably distributed with Africa being the worst hit in most cases. In the 21st century, advances in information communication technologies (ICTs) have played vital roles in the management of diseases, disease transmission, treatment, and prevention. ICTs have proved effective and efficient tools in the management of a plethora of diseases such as Cholera, Malaria, Hypertension, etc. It is believed that suitable technologies could be harnessed for managing COVID-19.

Through the integration of technology in the spectrum, instrumentation and control campaigns, robust systems including those with real-time capabilities have been developed and implemented across different socioeconomic sectors of the global society including the health sector. Alert systems have been deployed for managing natural disasters [1] [2] [3] In the area of public health management, medical alert system have been developed to manage patients [4]. In this paper a COVID 19 tracking and alert system is proposed. The prototype would be a software with web and mobile components. Using these platforms, information dissemination, disease prevalence and position tracking of carriers, confirmed carriers and status of treated patients could be easily managed.

1.1 Aetiology of COVID-19

Every disease irrespective of the infectious agent presents a challenge especially when it is novel like COVID-19. Like other infectious diseases the corona virus present some symptoms in the infected patient. However, in some individuals, the disease is asymptomatic thus posing a special concern as it could spread unnoticed through the droplets of saliva or discharge from the nose, mouth, eyes, or other body cavities of asymptomatic patients [5]. The incubation period of the virus is between 1-14 days within which there may be visible symptoms. Thus, the affected person may be living with the virus with or without symptoms. The most common symptoms of COVID-19 are fever, tiredness, and dry cough [6]. The symptoms indicate the level of infection, which ranges from mild infection, severe infection, and critical infection. The symptoms are well-documented and include:

1. Uncomplicated (mild) Illness that starts with mild fever, sore throat, sneezing, dry cough, naso-pharyngeal congestion, headache, malaise, muscle pain, and breathlessness. These symptoms which accompany upper respiratory tract viral infection [7] are pronounced and often associated with the sinuses, throat, airways, lungs,etc.
2. Symptoms like shortness of breath (tachypnea in children) and dry cough may not be accompanied by signs of pneumonia.
3. Acute Pneumonia with severe dyspnea, fever, respiratory difficulties, hypoxia, tachypnea (35 breaths/min or higher), and hypoxia. Fever may be moderate but sometimes absent. It may present cyanosis in children in which case clinical diagnosis including radiologic imaging would be employed to exclude complications [8].
4. Acute Respiratory Distress Syndrome (ARDS) that suggests fresh onset severe respiratory failure and/or worsening pathophysiological conditions. Differential diagnosis of ARDS could be done based on the extent of hypoxia using PaO2/FiO2 as reference point
5. Sepsis, a life-threatening organ dysfunction often caused by impaired host response to infection with organ dysfunction [8]. Sepsis is characterized by a set of signs/symptoms indicating multi-organ involvement, which include severe dyspnea, hypoxemia, altered mental status, renal impairment with reduced urine output, tachycardia and pathophysiological or blood chemistry reports of acidosis, hyperbilirubinemia, high lactate, coagulopathy, and thrombocytopenia [8] [9].

1.2 Ugandan, COVID-19, and Technology-enhanced Healthcare

Uganda is located in southeast Africa between the latitude 1.1027° N and longitude 32.3968° E. with a land surface of 241,139 square kilometers. The country has borders with the Democratic Republic of the Congo, Kenya, Rwanda, South Sudan, and Tanzania (see Figure 1)

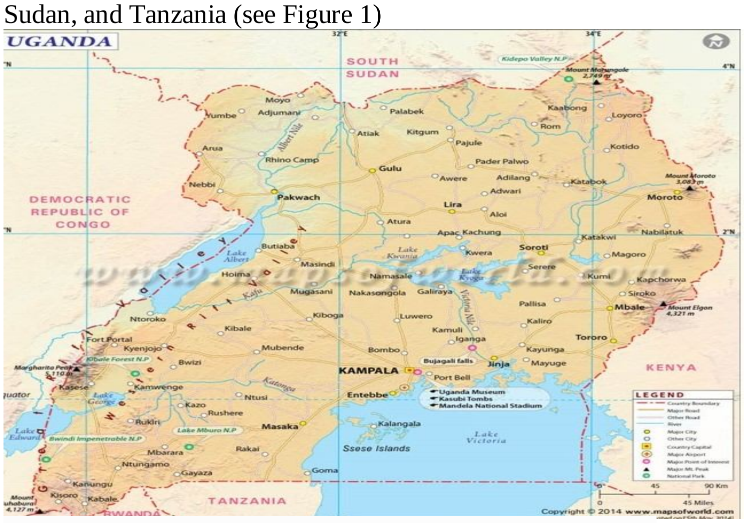

Figure 1 : Uganda map showing boader countries (Source: Maps of world)

Uganda has an equatorial climate, with a mean annual temperature of 16º C in the southwest highlands, 25º C in the northwest, and often exceeds 30º C in the northeast. Rainfall occurs regularly in northeast Uganda, while the south has two rainy seasons [10]. With population estimated at 41,263,225 as at April 2020 [11], the citizenry depend mainly on agriculture and tourism for livelihood.

1.2.1 Public Health

Like every other nation of the world, Uganda have had its fair share of health concerns such as HIV and malaria to mention but few. Through its ministry of health, projects have been initiated to manage and curb epidemics and communicable diseases. Such projects include the Uganda Population Based HIV Impact Assessment (UPBHIA) which takes HIV counselling and testing to homes; the Mosquito Net Distribution Campaign which ensures distribution of mosquito nets to curb malaria spread, etc [12]. With the outbreak of COVID-19, and the identification of an index case on 21 March 2020 several operational measures are being examined and undertaken to curb the menace. Statistics from the ministry of health shows that as at 28 April 2020, 27,275 persons have undergone tests with 79 positive cases recorded 52 recoveries, 14 undergoing treatment and some persons repatriated respectively. Table 1 is a distribution based on age of the infected person (see also Figure 2) [13]. It may be submitted that the country is making some progress in managing the pandemic. Nevertheless, the country is in search of innovative solutions that could aid in combatting the menace. Accordingly, this paper is intended to provide a technology-enhanced solution that would promote case tracking and management.

Table 1: COVID-19 case distribution by age

S/N	Age	Ugandan Indigene Positive cases
1	00 - 09	5
2	10 -19	4
3	20 - 29	15
4	30 - 39	21
5	40 - 49	7
6	50 - 59	7
7	60 - 69	5
8	70 - 79	0

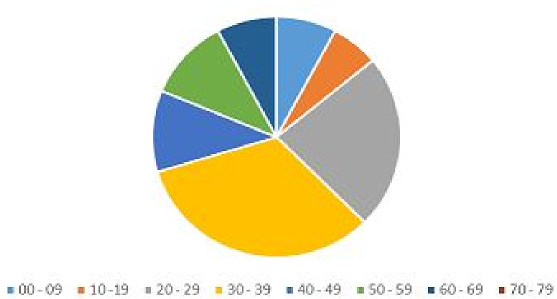

Figure 2: Case distribution based on age

Since the identification of its index case, the Ugandan Health authorities initiated some measures to check the effect of the pandemic. The primary measure undertaken was a partial lockdown on all social and economic activities with exception of agriculture, cargo transit, and logistics of medicals and essential service operatives. These measures have helped in managing the situation but with some extensive economic burden on the nation. The economy has declined with remarkable downturn on transportation businesses, and tourism, which are key contributors to the Gross Domestic Product of the nation. Though agricultural operations are excluded in the lockdown order, the distribution and preservation of the products have been seriously marred by transportation challenges. With the growing new cases coming from truck drivers, it has become imperative that there is a gap in the control of COVID-19 hence the need to track truck drivers and truck movements within and around the borders in the country.

1.2.2. Technological Solutions and Health Management

Technology has played a significant role in the detection, prevention and control of public health problems [14] [15]. Sophisticated evolutionary technologies have been applied to various areas of health care delivery. Notable systems include clinical decision support systems, expert systems, electronic health systems, to mention but few. To a great extent, computing and information technologies have demystify diagnosis and management of complex medical cases as they are employed at various levels ranging from information gathering, documentation, intelligent insights to accurate decision making. Modern ICTs readily augment human expertise in several ways, such as: system-enabled diagnosis, disease management, drug administration, expert prognosis, etc. With the outbreak of COVID 19, tracking of cases has been challenging in prevalent regions and less prevalent regions alike. Having regard to the foregoing, this work proposes a full tracking system to augment the activities of public health workers and security agencies in tracking cases from the point of entry and association with cases.

2. METHODOLOGY

The object-oriented approach (OOADM) was strictly adopted owing to the ease at which the system problem domain could be decomposed into participating components [15] [16]. System extensibility was also considered as against the limitations of some methodologies [16]

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The procedures adopted included: general survey and documentation of covid-19 cases and public health technology requirements in Uganda; conceptualization of an automated multi-platform model with requirements, actors, inputs, processing and outputs defined.

To produce valid specifications of the proposed system, the following OOAD components were employed: use cases, class diagrams, and component diagrams respectively.

The Hardware utilized are: PC@2.80 GHZ with 16GB RAM running Microsoft Windows 10; Tecno mobile Tablet, with android 8.0 installed.

The software platform for requirements engineering, analysis, and design are:
Microsoft Visual Studio 2019(CE), Android studio 3.5, MySQL DBMS, and SQL Lite

3. DISCUSSION

3.1 Analysis of the Proposed Alert and Tracking System

To analyze the proposed system, we employed the use case diagram. The use case diagram in Figure 3 models the system at the interaction level. Use case provides an efficient tool for representing the functionality of the system at the level of interaction among actors and/or objects. Three categories of actors were recognized: officers (medical/health personnel and volunteers), **cases** (also called patients), and guests.

We adopted the use of the technical term ‘case' in place of ‘patient' convention. *Officer* represents any medic or paramedic with specialized skill in managing cases. Guest represents any user of the system who could report an issue; request for information, a visitor to the country,etc. The use case diagram presents various actions supported on the system by way of use cases. The following use cases are notable: identification of cases, documentation, coding, tracking cases, reporting of suspected cases, and automated invitation of ambulances for case evacuation, and management. Incorporated in the system is a tracking functionality that augments the effort of public health workers in tracking geographical positions of cases using codes assigned to suspected cases, confirmed cases, and treated cases.

In addition to confirmed cases, the codes may also be attached to persons such as truck drivers at the point of entry to Uganda (usually at the borders or airports) across all districts/states. When cases are confirmed codes would be assigned at public health facilities. In the event of a suspected outbreak in a less-prevalent region, the codes are fed into the system to track the geographical location of cases. A centralized database is available to sustain data persistence.

3.2 System Design

Figure 4 presents a class diagram of the system. The class diagram models the system structure at a lower level as against the high-level structure presented in figure 5. The various use cases in figure 3 are translated to objects in Figure 4. The class diagram also defines the properties of interest. For simplicity, the methods are not indicated in the class diagram. The class diagram did not include the officer and guest as they would be enmeshed in the person super object.

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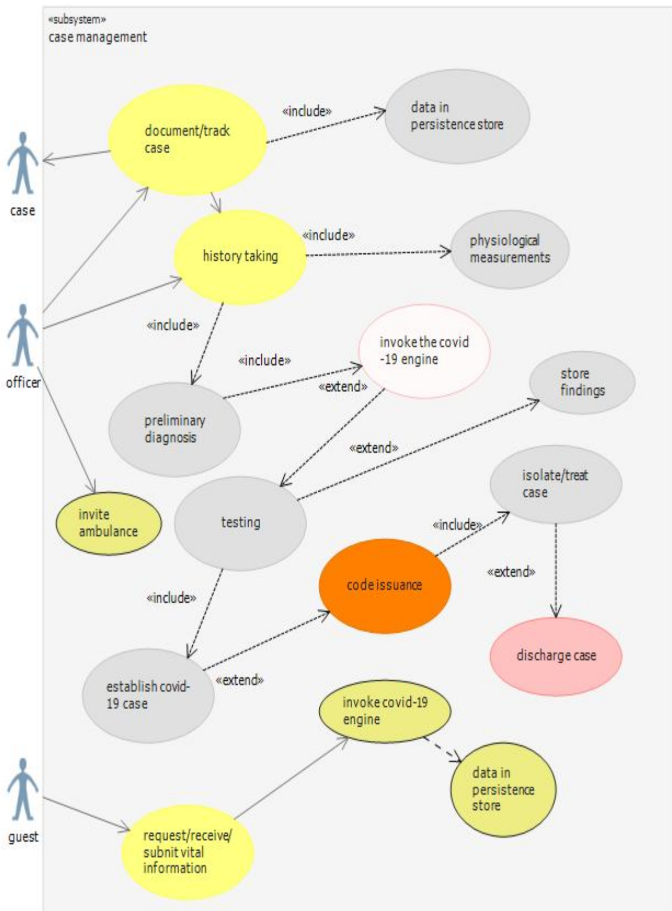

Figure 3: Use Case Diagram of the proposed system

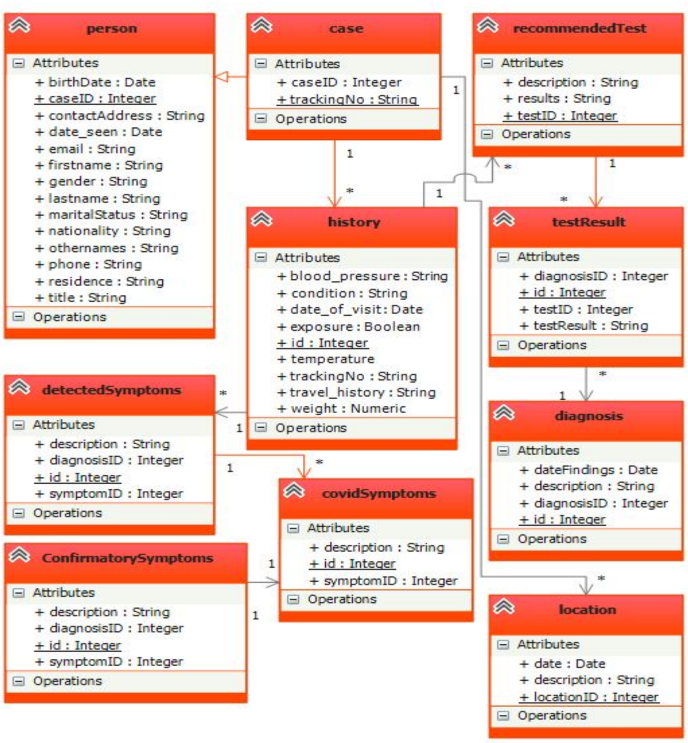

Figure 4: Low-level structure of the system using class diagrams

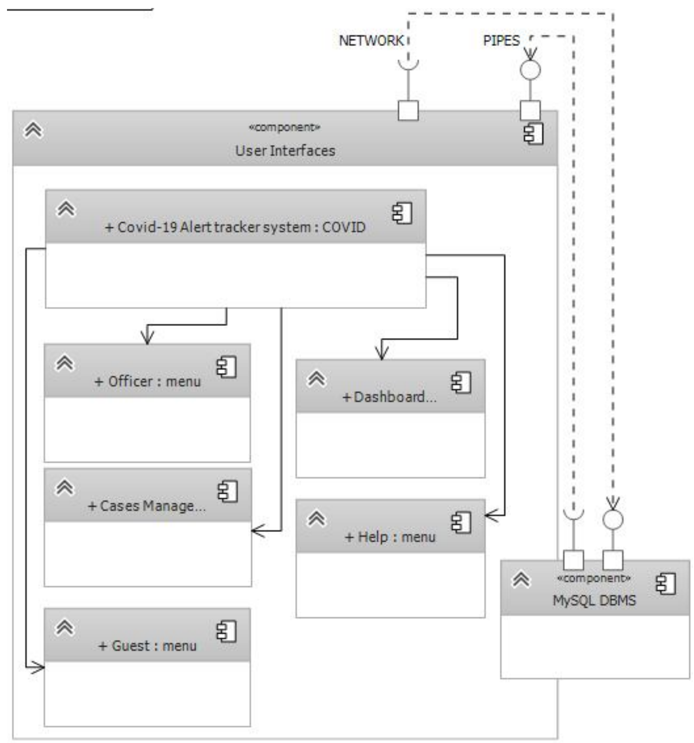

Figure 5: High-level model of the system using component diagram

3.3 Implementation

The system is code-named COVID-19 Alert and Tracking System. It is would be a portable system operable on different platforms (Web, Smartphones and other information dissemination platforms). Mobile development is done using android studio whereas the web front end is developed using ASP.Net Core on Microsoft Visual Studio 2019 platform. The software system comprises modules: login/sign-up, coding, case tracking module, and information module respectively. Figure 6 shows the welcome screen as may be presented on mobile displays such as smartphones.

Login/Sign-Up Module: This module enables all actors to create an account and access their accounts on the proposed system.

Coding Module: This module enables codes to be assigned to suspected cases. Symptoms and health information of cases are documented by the officers and accounts created based on identified symptoms, which include high body temperature, sneezing, and coughing. The code is associated with the residential address and mobile phone number of the case.

Tracking Module: This module helps the officers to track the geographical positions of the cases when the need arises. The module will map the code assigned earlier to the case. The tracking functionality works on two ways: mapping the location of the case based on the phone number provided and against the residential and contact addressed provided. This may be needed in times of emergency outbreaks in formerly less-prevalent areas.

Information Module: The information module provides a guest with a platform to interact with the system. The guest may request or report some issues and can also obtain relevant information on transmission, distribution, etc.

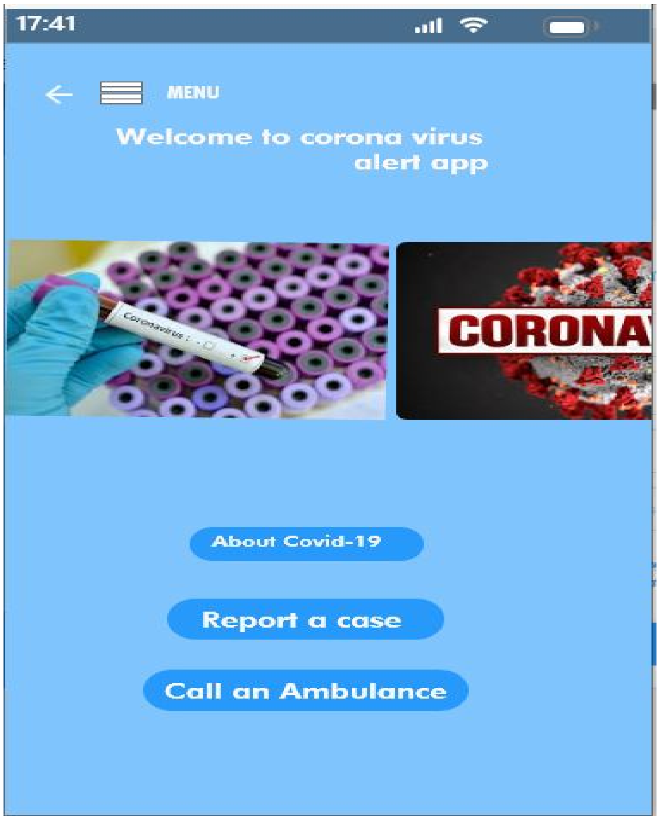

Figure 6: Mobile Home View of the system on Android device

3.4 System security considerations

System security pervades the usefulness of the software [17] [18]. To ensure that data communicated through the mobile, web, and database stores [19] are kept within the basic security provisions of availability, confidentiality and integrity, various measures would be adopted including role-based security and encryption [20][21] in the database; use of secure sockets and stored procedures at the application layer and deployment of secure socket layer certificates at the host server respectively. In addition to security guaranteed through technical design, assurances would be provided to ensure that data on cases are kept confidential in line with the extant laws governing medical and healthcare information on patients. It would be promoted on social media to help broaden social acceptability across all social classes.

4. CONCLUSION

COVID-19 pandemic has resulted to loss of lives of thousands across the globe. Socially and economically, the burden it exerts on governments and societies are quite huge. No government is taking chances and in Africa with known poor healthcare delivery facilities and systems, there is every tendency that it may take an unexpected toll on the people. Having taking into cognizance the damages the pandemic could cause, the authors believe that it would be ideal to conceptualize and evolve a technological tool that could assist in managing the challenges presented by this august visitor. Consequently, the authors proposed, analyzed and designed an alert and tracking system. Going forward, the authors conclude that it is possible to implement a system that could be used to manage cases whether locally or remotely. The authors believe that paper has identified the various players that could be affected using the proposed system and that it is possible to tag and track confirmed cases and suspected cases alike using the system. However, the authors note that as this project is a work-in-progress, the system could be extended using technologies such as IoT and wearable intelligent computing straps that would enable the direct transmission of data from the case (patient) to the remote care management platform to enable remote management of cases.

REFERENCES

1. G. Jayasinghe, F. Fahmy, N. Gajaweera, D. Dias, **A GSM Alarm Device for Disaster Early Warning**, *First International Conference on Industrial and Information Systems.* IEEE, 2006. [online] https://doi.org/10.1109/ICIIS.2006.365757
2. Hussam Elbehiery, **Developed Intelligent Fire alarm system**, *8*(8), 2012
3. F. Sikder, S. Halder., T. Hasan., J. Uddin, and Mrinal Kanti Baowal, **Smart Disaster Notification System,** *4th International Conference on Advances in Electrical Engineering (ICAEE),.* Dhakar Bangladish, 2017. [online] https://www.researchgate.net/publication/322514703_Smart_disaster_notification_system https://doi.org/10.1109/ICAEE.2017.8255438
4. N.A.I. Omoregbe and A.Azeta., **Design and Deployment of Mobile-Based Medical Alert System.** In *Handbook on E-Health Systems and Wireless Communications: Current and Future Challenges, 2013.* IGI Global. [online] https://www.researchgate.net/publication/308880684_Design_and_Deployment_of_Mobile-Based_Medical_Alert_System
5. World Health Oorganisation, **Sepsis**,*2020*. [online] https://www.who.int/news-room/fact-sheets/detail/sepsis
6. Centre for Disease Control, **Coronavirus Disease 2019: Symptoms and Testing**, *2020. [online]* https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html
7. J. R. Balentine and S. N. Nabili, **Upper Respiratory Tract Infection (URTI)**, 2020 [online]

https://www.medicinenet.com/upper_respiratory_infection/article.htm

8. M. Cascella, M. Rajnik; A. Cuomo; S.C. Dulebohn; Raffaela Di Napoli, **Features, Evaluation and Treatment Coronavirus (COVID-19).** StatPearls Publishing, 2020. [online] https://www.ncbi.nlm.nih.gov/books/NBK554776/
9. World Health Organisation, **International classification of functioning, disability and health : ICF**,2001. [online] https://apps.who.int/iris/bitstream/handle/10665/42407/9241545429.pdf;jsessionid=F87F4DEA4D5166BEC3D81E7652508D54?sequence=1
10. L. Krone. **Uganda Location Geography Climate** [online] https://cpb-us-w2.wpmucdn.com/u.osu.edu/dist/9/1401/files/2014/03/Uganda-25qjgxn.pdf
11. Uganda Bureau of Statistics. **Population Clock**. April 27, 2020. [Online] https://www.ubos.org
12. Ministry of Uganda, **Projects**. [Online] https://www.health.go.ug/projects/
13. Ministry of Uganda, **Projects**. April 27, 2020 [Online] https://www.health.go.ug/visualisation-2/

14 W. Nwankwo, **Harnessing E-healthcare Technologies for Equitable Healthcare Delivery in Nigeria: The Way Forward**, International *Journal of Science and Research*, Vol. 6, Issue 3, 2017

15. W.N. Nwankwo, C. Umezuruike(2018). **An Object-Based Analysis of an Informatics Model for Zika Virus Detection in Adults**, *Computational Biology and Bioinformatics*, Vol. 6, No. 1, pp. 1-20. doi: 10.11648/j.cbb.20180601.11
16. W. Nwankwo and K.E. Ukurebor, **Web Forum And Social Media: A Model For Automatic Removal Of Fake Media Using Multilayered Neural Networks,** *International Journal Of Scientific & Technology Research*, Vol. 9, Issue 1, 2020
17. W. Nwankwo, and K.C. Ukaoha, **Socio-Technical perspectives on Cybersecurity: Nigeria's Cybercrime Legislation in Review**; *International Journal of Scientific and Technology Research*, Vol.8, issue 9,pp. 47-58, 2019
18. W. Nwankwo, **A Review of Critical Security Challenges in SQL-based and NoSQL Systems from 2010 to 2019**. *International Journal of Advanced Trends in Computer Science and Engineering*, Vol. 9, Issue 2, April 2020
19. W. Nwankwo and C.C. Njoku, **Adoption of i-Voting Platform in Nigeria: Dealing with Network-level Cybersecurity concerns**, *Technology Reports of Kansai University*, Vol. 62, Issue 3, April 2020
20. M. Robinson Joel, V. Ebenezer, M. Navaneethakrishnan, N. Karthik, **Encrypting and decrypting different files over different algorithm on Cloud Platform,** *International Journal of Emerging Trends in Engineering Research*,Vol.8,No. 4, April 2020
21. K. Andrey, K. Anton, S. Alexandra, S. Polina, **Automation of tax control mechanism with the use of specialized information and analytical systems within the framework of ensuring security**, *International Journal of Emerging Trends in Engineering Research*,Vol.8,No. 4, April 2020