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An Improved Social Distancing Mobile Application Development Procedures for Covid-19 Pandemic

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Abstract

Health systems worldwide promote maintaining social distancing actions to break the chain of Covid-19 infection by decreasing the rate of interactions and physical near contact with persons outside of one's home. This can be achieved by maintaining a two-metre distance between individuals. The mobile Application known as Kaduna trace application (KDTRACE), was designed as one of the measures to reduce the spread of the virus by maintaining social distance in Kaduna State. The application can be improved to enhance compliance, adherence to social distancing and quarantine rule to reduce the spread of the pandemic. Therefore, this paper improved the mobile application system by including an element that can help officials in monitoring the activities of Kaduna State citizens. The improved application can be integrated on mobile devices and wearable devices like smart watches and smart hand bands are used. It has many functions that include provide users with information related to COVID-19, monitors individuals in quarantine, track contacts that are in close proximities, and trails individuals tested positive for the virus. The improve application also plays an important role in enforcing COVID-19 guidelines. To gain this, both Bluetooth and Geographical positioning/information system (GPS) gadgets are used. A flutter written in DART programming language is used for the frontend design while firebase is used for the backend design. The result is an app that is compatible with both mobile (iOS, and android) based devices and wearable smart gadgets to help individuals in conforming with social distancing and quarantine rules in the State.

Keywords: Covid-19, Social Distancing, Mobile Application, Pandemic.

1. Introduction

The term pandemic is said to be defined as epidemic occurring worldwide or over a long period of time by crossing international boundaries and usually affecting a huge number of people that may occurs annually in each of the temperate southern and northern hemispheres, given that seasonal epidemics are not considered pandemics.

COVID-19 is spread globally by and large as a result of movement of people. With its emergence, researchers', "entrepreneurs, governments and industries around the world have been involved in discovering or adapting existing technologies to support" healthcare, government and industries in tackling the new crisis. Therefore, based on the classification of the COVID-19 Apps, social distancing apps is classified under contact tracing apps based on these related study (Behar et al., 2020). A lot of studies proffer solution to curtail the wide spread of COVID-19 pandemic globally. For example, the contact tracing apps in China such as WeChat and AliPay (Behar et al., 2020; Sookman, 2020); Singapore, TraceTogether (Cho et al., 2020); BlueTrace (Bay et al., 2020); India "Aarogya Setu" (Bridge to Health in English) app (Behar et al., 2020; Tiwari et al., 2020). South Korea and Taiwan (Behar et al., 2020).

Millions of persons have been infected, nearly 200,000 death have been realised globally since its discovery based on this study (Alanagreh et al., 2020). Similarly, in Nigeria according to the Nigeria Centre for Disease Control and Prevention (NCDC) daily updates the number of infected persons is 67,220 and the number of deaths is 1,171 nation-wide. Just as any other state in Nigeria, Kaduna state recorded 3,044 cases of infected persons and only 47cases of death recorded so far. Nigeria as a nation is finding a possible way out to fight the epidemic. They rely on classical public health measures in collaboration with its health agencies such as NCDC to curb the epidemic. The main goal of the public health measures is to prevent person-to-person spread of the disease by separating people to interrupt transmission using all the necessary tools obtainable. According to Tiwari (Tiwari et al., 2020), there are many negative consequences of a pandemic. Pandemic may engender psychological stress (Brooks et al., 2020), physical health problems (Zhang et al., 2020) and decreased social support (Tiwari et al., 2020).

The NCDC has redefined social distancing as "remaining out of congregate settings, avoiding mass gatherings, and maintaining distance (approximately six feet or two meters) from others when possible" during the COVID-19 pandemic period. Hence, the term connotes physical distancing that aims to curtail the wide spread of the virus by contact. According to World Health Organization (WHO) when "an infected person coughs or sneezes, droplets containing the virus are deposited on objects and surfaces where people may likely touch". Hence, anyone in close proximity of about 1-2 meters may be at risk and the possibility to contract and spread the virus is negligible when appropriate physical distance is upheld (Agusi et al., 2020).

More so, monitoring the environment in the society particularly the societal interactions of human in public places such as work places, markets, religious places of worship, schools, hospitals, motor parks, airports are highly required. Having to views on the societal interactions of citizens in such places will provide cue on the appropriate technological tools to utilize in fighting against COVID-19 pandemic in the society (Huynh, 2020). However, so far, just as social distancing app are being utilized globally in bridging gaps in the fight against coronavirus spread. Thus, the Kaduna state government (KDSG) utilized the right tools such as (social distancing mobile app) KDTRACE for effective and efficient eradication of the pandemics in it society and this bridges the gap of having social distancing mobile app to mitigate the spread of COVID 19 in Nigeria, particularly in Kaduna State. With the app distributed in the society, people were allowed to maintain adequate distance while they are out and about. This serve as a great achievement to the KDS society by having the opportunity to return to normalcy without confinement of large segments of the population.

As such, this paper further enhanced the KDTRACE by proposing to integrate monitoring features into the app which can be deployed on both mobile and wearable devices. Example of the mobile devices are smart phones and that of the wearable devices to be considered in this study are smart watches and smart hand bands.

2. COVID-19 PANDEMIC IN KADUNA STATE

Kaduna State being situated in the northwest zone of Nigeria, is one biggest educational center in the country and the 18th state of the Federation. Education is one of the key objectives of the government of Kaduna State. It was formerly Liberal State. It has now become Centre of Learning because of the presence of many tertiary institution in the state. The State consists of 23 local government areas. Population of over six million people.

The KDSG being the Centre for learning is at all times doing it best to see all activities have returned normalcy without confinement of large segments of it population. The Industries both commercial and private, Universities and all other governmental bodies have resumed normal activities with utilization of the social distancing app (KDTRACE) in tandem with other measures. Unlike the other states in the country, the KDSG is further motivating and encouraging innovations that will assist in offering solutions that will automatically bring an end to COVID-19 virus and it like in the state.

3. SOCIAL DISTANCING MONITORING APPLICATION IN PANDEMIC

Generally, pandemic cannot easily be predicted for, it is not time-bounded, single, or discrete event (Ammirato et al., 2020). It is rather a continuous process that functions for a certain period that lasts until its cure has been introduced and social distancing has been recognized to be one of the main component of protecting individuals against pandemics (Marchiori, 2020). The use of technology based social distancing apps during this critical moment is vital to curtail mass contaminations and loss of lives.

To successfully uphold adherence and compliance with social distancing guidelines, the social distancing apps typically depend on wireless tools. They also utilize the tools to trace, track, and monitor the adherence to the guidelines (Ranisch et al., 2020). For example, the social distance apps can collect unknown or pseudonymized nearness or "geolocation data" using Bluetooth or a GPS tools as origins of data to store the data in central or distributed database for further processing (or warning) of possible exposure to risk (Woodhams, 2020).

Often, mobile phone applications and wearable smart gadgets (for example, smart watches, smart hand bands and smart helmets) are designed for multitasking solutions, e.g. symptom checkers can makeup data used for epidemiological modelling, monitor the virus spread or to evaluate public health issues. (Woodhams, 2020).

4. IMPROVED MOBILE APPLICATION OVERVIEW

The improved mobile application is the social distancing app called KDTRACE where KD is represent Kaduna and TRACE is a monitoring process of the application. It was mostly designed for Kaduna state citizens of Nigeria.

The Enhanced version uses both Bluetooth and GPS tools. These tools are used together with the mobile phone and wearable smart gadgets (for example, smart watches, and smart hand bands). Although they are so many wearable gadgets available in the market today, the smart helmets, smart face mask, smart face shield and several AI Internet of medical things (IoMT) smart gadgets (Mbunge et al., 2021). Those gadgets are designed for multitasking solutions to cater for human needs in the society.

The enhanced app is designed using Bluetooth with beacon technology just as what is obtainable in the design of KDTRACE. Beacon is a tiny wireless transmitter which utilize low-energy Bluetooth to send signals to other nearby smart devices. They are able to connect and transmit information to those smart devices by making position-based searching and interaction much easier and very accurate.

When two or more participating devices come into close proximity of 2 meters of radius to each other, they exchange identifiable messages that are non-personal containing temporary identifiers. The identifier is a unique ID number that smartphones identifies as unique to the beacon. The uniqueness of the beacon technology is that after searching for devices within the proximity, it connects to smartphones that has similar app installed on them and ignore the rest unlike using only Bluetooth that can connect to any device that broadcasted signal within the proximity range. This verification procedure is demonstrated in Figure 1.

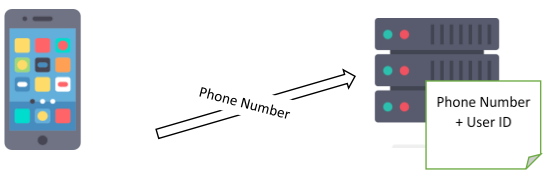

Figure 1. User Verification Adapted from (Bay et al., 2020)

When it searches and connect to devices having the app installed on them, the app beep a number of times and triggers a simple voice message "Kindly Maintain the 2 Meters Distance Apart as stipulated by the KDSG" as warning. For the frontend design of the App, a flutter as a framework for building cross platform apps written using DART programming language. The advantage of using DART is that it has cross platform features one can write a single software that can run on multiple platforms such as on iOS, and Android devices. While for the frontend a

firebase was utilized for user authentication. It has advantage of being server less software, no need not to develop backend from scratch and it save cost of infrastructure on the cloud.

5. PROCEDURES OF HOW THE IMPROVED MOBILE APP WORKS

There are four basic stages involved; the first three stage, that is, the (initialization/information stage, the authentication and the activation stage) are similar to the stages in KDTRACE (Mustapha et al., 2021), as shown in Figure 2. In the improved mobile app, a monitoring component was added to determine compliance with social distancing and quarantine rules in Kaduna State.

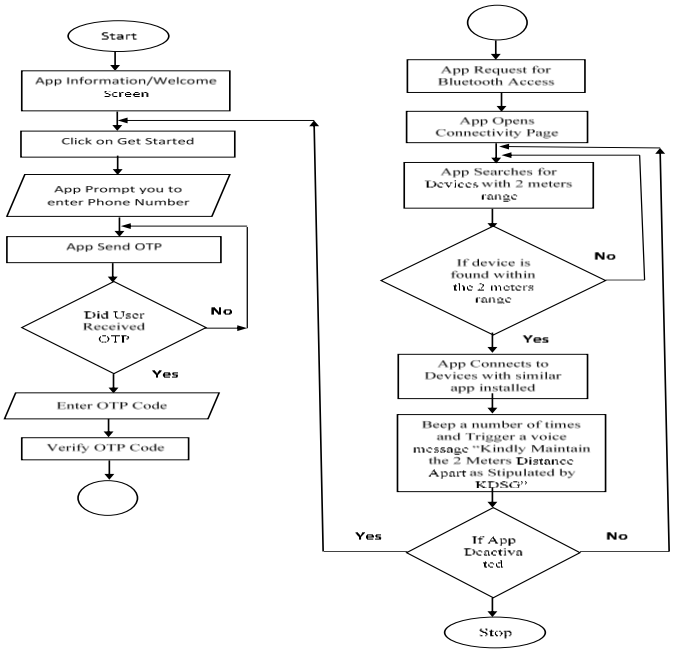

Figure 2. KDTRACE Working Procedures Adapted (Mustapha et al., 2021)

The stage constitutes more of the discussion in this section. The improved mobile app activities can be demonstrated using pseudocode as shown in Listing 1. The improved mobile app works in two modes; social distancing mode (for all citizens) and quarantine mode (for infected individuals). The social distancing mode is to ensure that citizen maintain the required distancing rule set out by the State government, particularly in public places. The quarantine mode is to ensure that infected individuals are within the defined quarantine location for the set period (14 days). The improved app can be deployed as mobile and wearable (hand band) devices.

In social distancing mode, the app searches for nearby devices with similar app installed within two meters range using beacon technology periodically, that is every two minutes. It is also recommended both scanning and broadcasting duty cycles should be > 1, to guarantee that devices have the chance to see each other (Bay et al., 2020). If a device is found within the range, the app beeps three times and trigger a voice message "Kindly maintain the two meters Distance Apart as Stipulated by KDSG". A snoozing period of two minutes is provided during the warning. If such warning is violated after 10 minutes (after five warnings), the mobile app exchange information over the Bluetooth Low Energy (BLE) protocol. In the BLE jargons, devices can either taken on Peripheral or Central function or may alternate between the functions. This can be illustrated in Figure 3. When two devices are linked, the Central reads the Peripheral's Encounter Message, and then writes back its own Messages that it comes across; each of the linking permits a two-way communication between the Central and Peripheral. Allowing two-way communications encourages symmetry and handles the constraint where other devices are only able to work as Peripherals.

Listing 1: Mobile Application Pseudocode (Authors own Source).

```
Begin
        initializeVariables();
        displayAppInformation();
        initializeAppSettings();
        userIdentity = getUserIdentity();
        authenticateUser(userIdentity);
        appMode = setAppMode();
        if(appMode == SocialDistance){   // For Social Distancing
         While(socialDistancePeriod != Expired)
            {
                nearDevice = getNearbyDevice();
                if(deviceRange <= 2 meters && deviceRange >= 0){
                    warningVoiceMessage(1);
                }
                checkIDStatus();
          }
     }
    elseif(appMode == Quarantine){   // For quarantine monitoring
          Qlocation = setQuaratineLocationSpace();
      While(QuarantinePeriod != Expired){
                location = getGPSLocation()
                if(location is outside QlocationSpace)
                {
                        warningVoiceMessage(2);
                }
          }
    }
```

After the exchange of information, one of the devices will take a central function and report the information to NCDC central server.

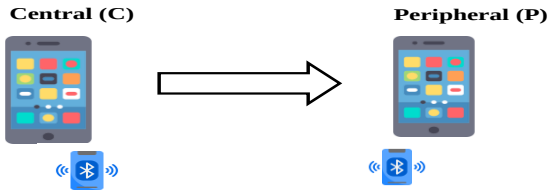

Figure 3. BLE handshake flow Adapted from (Bay et al., 2020)

In quarantine mode, the app periodically gets the current GPS location of an individual every 10 minutes and compare with the assigned coordinate of the location of the quarantine. If the current location of the individual is outside the quarantine region, the app will invoke warning message "Kindly go back to your quarantine region within 10 minutes as stipulated by KDGS" and also snooze of two minutes. If the warning is violated, a message for violation of quarantine rule will be sent to NCDC server showing that such individual has violated quarantine of the rule.

6. DEVICES USED FOR ENHANCED KDTRACE DESIGN PROCEDURE

A. Bluetooth Device

Bluetooth technology is extensively used for short distance (5-10 Meters) interchange of data using computing devices. The technology of Bluetooth has been broadly adopted in designing COVID-19 contact-tracing apps and collection of nearness data (Ahmed et al., 2020). The Bluetooth tool can also be used for COVID-19 contact tracing activities, detection of Crowd particularly in public places, to uphold a safe distance between two or more individuals to improve social distancing. However, this technology needs the majority of the populace to utilize smartphones and activate Bluetooth always to permit the social distancing apps to collect nearness data and close contacts which has implications (Security/Privacy) and this gadget can only be utilized by individuals with smartphones (Mbunge et al., 2021).

The Bluetooth protocols comes with several versions but this study is using the Bluetooth Low Energy (BLE) that is very common in applications because it consumes less energy and it is cheap. As the monitoring apps needs to run continuously for logging the contacts, BLE low battery consumption is suitable for use. Though, it has a short-range coverage, mostly within proximity. The key advantages of this tool is that it can connect a gadget to multiple gadgets without needing any access point and creating an ad-hoc named piconet (Shahroz et al., 2021). Hence, this gadget has been used in designing the improved mobile app.

B. GPS (Global Positioning System)

This navigation system utilizes networks of satellites to find the exact position of the GPS-enabled devices. Recent smartphones gadget are GPS permitted, that can be used for monitoring/surveillance. Being globally available, serve as a great advantage. This technology can be utilized to restrict the physical contact between individuals. Thus, the social distancing of individuals in the public can be greatly be monitored utilizing this technology. That is the main reason why this study adopted the integration of this technology in the design of the enhanced KDTRACE App.

C. WEARABLE DEVICES (OR GADGETS)

Wearable smart gadgets have been utilized to improve symptoms monitoring, stay-at-home and social distancing guidelines and to ensure quarantine compliance during the COVID-19 epidemic (Swayamsiddha & Mohanty, 2020). Wearable smart gadgets may include "smart watches, smart hand band and smart helmets (particularly in the mining segment) (Mbunge et al., 2021).

This study adopted the use of smartphones and smart hand bands which the KDSG may customized and disseminate to its citizens for free in advocating the awareness and eradication of the deadly virus in its state. The customized smartphones and smart hand bands will be giving to each and every citizen in the state for free and the KDSG agencies together with the NCDC officials will ensure adherence to the use of the devices by the citizens. Those customized hand bands will be used by only the infected victims that are on quarantine period. Those devices are integrated with a lock and only the NCDC officials and the representatives of the government agency can unlock the devices. And if the quarantine individual with the hand band device tries to remove the device, the device will flag an alert to the NCDC server and the NCDC officials will connect with their nearest office close to the victim for further action. The smartphone devices are main for all individuals in the state. Therefore, each and every individual in KDS will be haven this device.

The smartwatches/hand bands are sensor-based wearable devices that gather physiological data such as pulse, temperature and sleeping patterns data for early screening of COVID-19 (Singh et al., 2020). Such data can be used for real-time health monitoring, surveillance and to evaluate the probability of COVID-19 incidences.

8. IMPROVED MOBILE APP IMPLEMENTATION ISSUES

A. iOS background Bluetooth Challenges

Whereas Android category of the improved application reference execution functions fully for Central and Peripheral whereas the app is in foreground and contextual execution modes, the iOS category of KDTRACE has restriction on contextual Bluetooth workability.

When in the contextual, the iOS app broadcasts in a proprietary broadcasting format which is not part of the Bluetooth standard and hence not readable by non-iOS devices. It may also unable to scan for other KDTRACE devices around it. As such, this is done to encourage iOS users to keep their app open, especially when in dangerous environments. The app also alerts the user if access is not granted/ Bluetooth is not on, this may cause the app not to function well.

B. Transmission Power Differences

There are transmission power differences across devices. The enhanced KDTRACE utilise RSSI readings to estimate distance. Though, through tests of devices in local environments, it has been confirmed that the alteration in transmission power across popular mobile devices can be as large as 30 dB (1000x). At the course of testing, also it was discovered that transmission power varies little between different devices of similar model and is slightly affected by mobile phone covers. To account for the differences, reference signal strength -readings has been taken for popular mobile devices" in greater than API 18. This have been used to standardize RSSI readings when categorizing encounters by nearness.

9. CONCLUSION

This study improved the mobile Application Social Distancing for Covid-19 Pandemic by using devices that can help in monitoring the activities of the COVID-19 victims and the general public in the state. The mobile app devices and the wearable gadgets like smart watches and smart hand bands are used.

The app functions may include creating awareness by providing users with information related to COVID-19, monitors individuals in self-isolation and quarantine, track contacts that are in close proximities, tracks individuals tested positive for the virus. The app also plays an important role in enforcing COVID-19 guidelines. The enhanced app uses both Bluetooth and GPS gadgets, to achieve that a flutter written in DART programming language is used for the frontend design while firebase is used for the backend design. The result was a designed app for both mobile (iOS, and android) based devices and wearable smart devices. The future work of this study will handle security, data protection, ethical and privacy issues related to COVID-19 and contact tracing.

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