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An Internet of Things (IoT) and blockchain model for controlling the spread of the COVID-19 virus

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ABSTRACT

Finding a dramatic approach to stop the global spread of COVID-19 is difficult since the number of individuals infected and killed by the virus continues to rise. Early diagnosis, patient isolation, and contact tracking are all crucial steps. This study provides a unified strategy for controlling the transmission of COVID-19 by linking hospitals/laboratories, COVID-19 negative individuals, COVID-19 positive persons, and contact persons to a consortium blockchain system hosted in the cloud. The suggested approach ensures normal, contact, and positive COVID-19 case statuses are tracked and updated in real time, with the corresponding changes made in the blockchain depending on the outcomes of the execution of the blockchain smart contract rules. Internet of Things (IoT) sensors measure contact time and distance between infected people and their contacts. Distances between affected persons and their contacts were calculated using GPS, Bluetooth, and Ultra-Wideband (UWB) IoT sensor technologies. The solidity programming language and the Remix integrated development environment were used to create the proposed blockchain Ethereum system smart contract. The suggested method was put to the test, and the results showed that it properly recognised contact situations and controlled the various statuses of people using the cloud-based blockchain system, all while implementing the smart contract regulations. Due to the fact that the suggested model yields an error rate of 11 cm or less when applied to distances of one metre or less.

Key words

COVID-19 is a keyword combination for Internet of Things, Cloud Computing, Blockchain, and Smart Contracts.

INTRODUCTION

At the year's conclusion, an unique coronavirus pandemic swept across Wuhan, China, killing over 1800 people and infecting over 70,000 in the first 50 days. The coronavirus family was revealed to include this virus. The Chinese scientists who discovered the new virus have given it the moniker 2019 novel coronavirus (2019- nCov). The virus was designated SARS-CoV-2 and the sickness was designated COVID-19 by the International Committee on the Taxonomy of Viruses (ICTV) [1]. The transmission of the virus from one individual to another is facilitated by the infected host's coughing, sneezing, or the inhalation of respiratory droplets or aerosols. These aerosols are small enough to be breathed in via the nose or mouth and deposited in the lungs. Droplets may drop on surfaces, spreading the virus to anybody who touches their face thereafter, especially the eyes, nose, or mouth. The virus may live on a surface anywhere from a few hours (copper, cardboard) to a few days (plastic and stainless steel). However, with time, the amount of live virus drops, and it may not always be present in sufficient quantity to induce infection [2]. It is now thought that COVID-19 has an incubation period of between one and fourteen days [3]. IoT today plays an essential role the health sector, IoT has radically impacted the lives of both the young and old, since it can continually follow their health [4]. The role of the IoT landscape has been drastically transformed owing of the COVID-19 epidemic. It may be used directly to control the transmission of the virus (e.g., contact tracking, temperature screening, etc). (e.g., contact tracing, temperature screening, etc.). It is crucial to be able to recognise early instances, track, and isolate sick persons during pandemics.

RELATED WORK

In the medical area, several studies highlighted in general the usefulness of the IoT in the face of COVID-19 pandemic and early diagnosis of zoonotic infections [7-9]. However, many of them lacked clear technical information on how to use the IoT to combat COVID-19. On the other hand, numerous researchers contributed extensively in diverse ways in applying IoT, in addressing COVID-19 and it will be explored in five key approaches which are:

• The survey papers that discuss IoT technologies to combat COVID-19.

• The IoT models, frameworks, structures, techniques, systems, and applications to face COVID-19. • Integrating IoT and artificial

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intelligence to tackle COVID-19. \s• Integrating IoT and blockchain to confront COVID-19.

• Analyzing the produced data from the IoT surroundings.

In the following, we shall cover in depth each of these directions. On the first approach, several researchers studied the current literature on the usage of IoT in COVID 19. K. Kumar et al. [10] examined the tracking methodologies, and suggested an architecture based on IoT that may be utilised to limit the spread of Covid-19. Musa Ndiaye et al. [11] offered a survey regarding the IoT technology and how to profit from it in the COVID-19. Also, the report analysed the issues confronting the sensor deployment process and the influence of the COVID-19 epidemic on the future of IoT networks. Ravi Pratap Singh et al. [12] analysed and studied and investigated twelve apps which are operating based on IoT and its usefulness in tackling the COVID-19 pandemic. Awishkar Ghimire et al. [13] studied and discussed several models based on the Internet of Things and artificial intelligence and assess the outcomes of these models. Mohammad Nasajpour et al. [14] analysed the applications and systems that depend on the IoT to tackle COVID-19, and the evaluation was based on three phases: early diagnosis, quarantine period, and post recovery.

MOTIVATION AND CHALLENGES FACING THE PROPOSED MODEL

In this part, rationale of the suggested model and the primary issues confronting the proposed approach are described.

Motivation of The Proposed Model

According to WHO statistics, the number of fatalities and infected people with COVID-19 is growing everyday. In 17 November 2021, the number of confirmed cases reached 254,256,432 and fatalities cases reached 5,112,461 instances [38]. The daily growth in numbers was the major motivator for us, and the main cause for the increase in numbers was intimate contact with infected patients. The WHO produced a revised document in February 2021 for definition of “contact person” [39]. It was defined as a person who was exposed to a likely or verified by direct physical contact within 1 metre and for at least 15 minutes. This paper indicated that the contact person is the most harmful aspect in the process of transmitting Covid-19. Internet of things technology with multiple tracking methods that employ IoT sensors such as GPS/Bluetooth/UWB plays a key part in measuring the distances between individuals [40]. Thus, we can trace the affected persons and those in touch.

Challenges Facing the Proposed Model

There are various obstacles confronting the suggested model, the most prominent of which being the following:

• The main technological barrier to monitoring infected or contact cases is to detect the specific position of the individual and hence the capacity to estimate distances between people in distance less than one metre.

• Storing the infection history for each individual as the system will react with situations differently via an alerting module.

• Ensure the secrecy and privacy for infected or contact patients.

THE PROPOSED IOT AND CLOUD BLOCKCHAIN MODEL FOR COVID-19 INFECTION SPREAD CONTROL

The suggested technique is based on three categories of cases:

• Normal case: uninfected or non-contact case, as depicted in figure 1 in green with the letter “A”.

• Contact case: a case that contact with an infected case at a distance of less than one metre and for more than 15 minutes, as depicted in figure 1 in orange with the letter “B”.

• Infected case: a verified case in which it has been proved by chest CT or laboratory test (such as PCR and D-dimer [41]) as depicted in figure 1 in red with the letter “C”.

The Proposed IoT and Cloud based Blockchain Model

Architecture for COVID 19 Infection Spread Control The suggested model architecture comprises of basic four components, as illustrated in figure 1, which are IoT environment, alerting module, blockchain management system, and cloud-based consortium blockchain. IoT ecosystem has many kinds of sensors which are GPS, Bluetooth and UWB for position tracking. it is impossible to depend on GPS sensors exclusively in in finding locations, particularly in interior or confined settings where error rate is higher than 1 metre. On the other hand, the infection distance according to WHO report is less than or equal to 1

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metre, the other two sensors have the capacity to detect the position with better precision in indoor or closed settings where error rate is 10 cm. Therefore, all location data are captured and saved in the cloud-based location database in real time. The alerting module sends the information about the contact persons (case B) to the blockchain management system and in parallel it broadcasts all the necessary procedures and information for each case according to its type in a way that helps to reduce the spread of infections, especially by focusing on contact cases (case B) and confirmed cases (case C) (case C).

MODEL IMPLEMENTATION AND RESULTS DISCUSSION

There are numerous subtleties in the implementation process for the suggested model, but the emphasis will be on two key elements which are, smart contracts implementation and outdoor/indoor tracking.

Smart contracts implementation

Smart contract built using solidity programming language utilising one of the most frequent tools for implementing contracts to the Ethereum network which is the Remix IDE. Figure 5 displays the implemented code to execute the rules of smart contracts. As illustrated in figure 5, there are five rules was evaluated to define the kind of case.

```
pragma solidity ^0.8.5;
contract Covid19_Infection_Spread_Control{
  uint256 public createTime= block.timestamp;
  enum Person1_Statelist{ A, B, C }
    Person1_Statelist Person1S_choice;
  enum Person2_Statelist{ A, B, C }
    Person2_Statelist Person2S_choice;
  enum MedicalReportlist{ P, N }
    MedicalReportlist MedicalReport_choice=MedicalReportlist.N;
  constructor() public {}
  function getCurrentState() public view returns(Person1_Statelist){
    return Person1S_choice; }
  function SetNewState(uint256 Distance,uint256 ContactTime,uint256
InfectionDate) public{
    //Distance in centimeter, Date and Time in seconds
    uint256 QuarantineDays=createTime-InfectionDate;
    if(Person1S_choice==Person1_Statelist.A && Distance < 100 &&
Person2S_choice == Person2_Statelist.C && ContactTime>900) {
      Person1S_choice=Person1_Statelist.B;
    } else if (Person1S_choice==Person1_Statelist.A &&
MedicalReport_choice==MedicalReportlist.P){
      Person1S_choice=Person1_Statelist.C;
    } else if (Person1S_choice==Person1_Statelist.B && QuarantineDays>1209600){
      Person1S_choice=Person1_Statelist.A;
      //14 days quarantine in seconds=1209600
    } else if (Person1S_choice==Person1_Statelist.B &&
MedicalReport_choice==MedicalReportlist.P){
      Person1S_choice=Person1_Statelist.C;
    } else if (Person1S_choice==Person1_Statelist.C &&
MedicalReport_choice==MedicalReportlist.N){
      Person1S_choice=Person1_Statelist.A; }}
  function getNewState() public view returns(Person1_Statelist){
    return Person1S_choice; }}
```

Figure 1: Smart contracts implemented code

A brief description of the smart contracts rules is as follows:

- Checking the contact case which is within 1 meter with (CASE C) for at least 15 minutes. Figure 1 shows the test results for a contact case that its type changed from A represented as zero to B represented as one. Note that the distance is measured in centimeters and time in seconds.

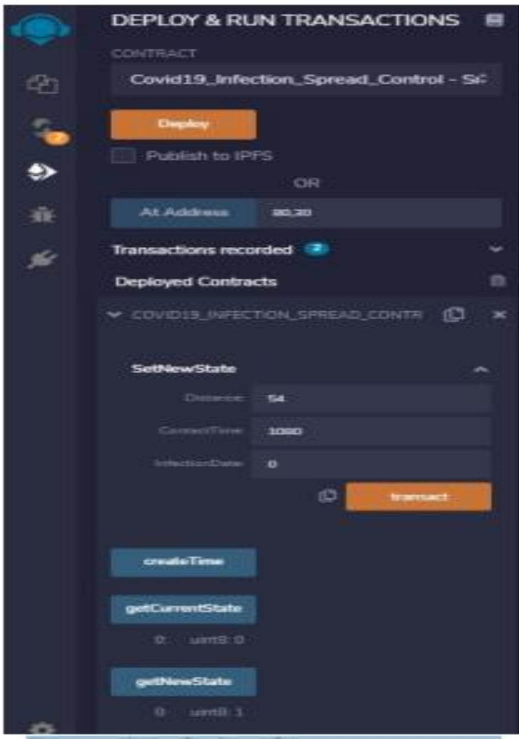

Figure 2: Rule 1 in the smart contracts

- Checking normal cases that are infected and confirmed according to positive reports from hospitals and laboratories. Figure 7 shows the test results for a case that its type changed from case A (0) to case C (2).

Figure 3: Rule 2 in the smart contracts

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• Checking contact cases after 14 days quarantine without any symptoms.Figure 8 shows the test results for a case that its type changed from case B (1) to A (0). Note that the assumed currentdate/time (Unix epoch time): 1623584270 which is Sunday, June 13, 2021 11:37:50 AM and infection date/time (Unix epoch time): 1621398914 which is Wednesday, May 19, 2021 4:35:14 AM.

Figure 4: Rule 3 in the smart contracts

• Checking contact cases that were confirmed as infected cases according to positive reports from hospitals and laboratories. Figure 9 shows the test results for a case that its type changed from case B (1) to case C (2).

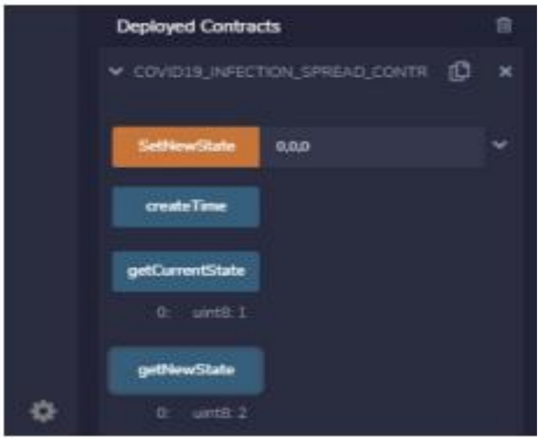

Figure 5 : Rule 4 in the smart contracts

• Checking confirmed infected cases which are recovered according to negative reports from hospitals and laboratories. Figure 10 shows the test results for a case that its type changed from case C (2) to case A (0).

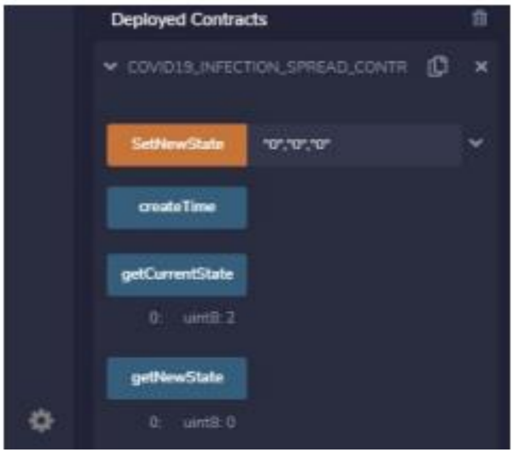

Figure 6: Rule 5 in the smart contracts

Outdoor/Indoor

Tracking To calculate accurate values of distances between people, cloud-based location DB is used to store locations every moment, and thus the ability to determine the distances between people. Figure 7 shows the database model of cloud-based location DB which shows the integration between indoor and outdoor technologies. GPS used for outdoor tracking, and on the other side Bluetooth and UWB used for indoor tracking.

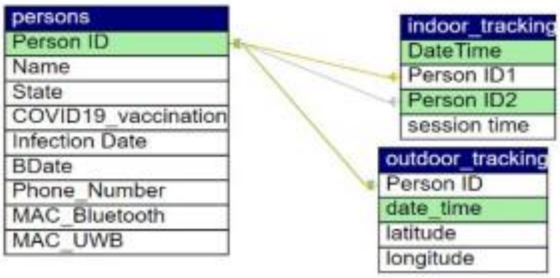

Figure 7: The database model of cloud-based location DB

Outdoor tracking in the proposed model is based on GPS technology, GPS location captured through IoT sensors and manipulated in model code by Geolocation.getCurrentPosition() function. Figure 12 shows a part of the code that explains how to determine the current position of the device.

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```
var options = {
  enableHighAccuracy: true,
  timeout: 5000,
  maximumAge: 0
};
function position(pos) {
  var crd = pos.coords;
  console.log('current position:');
  console.log(`Latitude : ${crd.latitude}`);
  console.log(`Longitude: ${crd.longitude}`);
  console.log(`More or less ${crd.accuracy} meters.`);
}
function ErrorHandler(err) {
  console.warn(`ERROR(${err.code}): ${err.message}`);
}
navigator.geolocation.getCurrentPosition(position,
ErrorHandler, options);
```

Figure 8: Determining the current position.

Then the distances are calculated between two coordinates by latitude and longitude which are generated by GPS sensors. The distance is calculated based on the "haversine" function:

$$a = \sin^2(\Delta\varphi/2) + \cos\varphi 1 \cdot \cos\varphi 2 \cdot \sin^2(\Delta\lambda/2) \quad (1)$$
$$c = 2 \cdot \mathrm{atan2}(\sqrt{a}, \sqrt{(1-a)}) \quad (2)$$
$$d = R \cdot c \quad (3)$$

where φ is latitude, λ is longitude, R is earth's radius (mean radius = 6,371km). Figure 13 shows a part of the code that explains how to determine the distances based on GPS.

```
function distance(lat1, lon1, lat2, lon2) {
  var p = 0.017453292519943295;
  // Math.PI / 180 = 3.141592653589793 / 180
  var c = Math.cos;
  var a = 0.5 - c((lat2 - lat1) * p)/2 +
          c(lat1 * p) * c(lat2 * p) *
          (1 - c((lon2 - lon1) * p))/2;

  return 1274200000 * Math.asin(Math.sqrt(a));
   //  R = 6371 radius of earth in KM ;
  2*1000*100*6371 to convert it to centimeters
}
```

Figure 9: Determining the distances based on GPS

Indoor tracking in the proposed model is based on two technologies which are Bluetooth and UWB. The distance is calculated based on received signal strength indicator RSSI because the signal strength depends on distance and broadcasting power value. Figure 9 shows a part of the code that explains how to determine the distances based on Bluetooth and UWB.

```
protected static double calculateDistance
(int txCalibratedPower, double rssi) {
    if (rssi == 0) {
        return -1.0;
    }

    double ratio = rssi*1.0/
    txCalibratedPower;
    if (ratio < 1.0) {
        return Math.pow(ratio,10);
    }
    else {
        double distance =  (0.89976)*Math
        .pow(ratio,7.7095) + 0.111;
        return distance*100;
    }
}
```

Figure 10: Determining the distances based on RSSI

Figure 10 shows an example that applied in the real environment to verify that the calculated distances between two points are equal to the real distance in the real environment.

Figure 11: An example to determine

the distance In the applied example, Bluetooth and UWB can measure distances with a maximum coverage level of up to 50 meters and the GPS can measure distances with an unlimited maximum coverage. The results can be shown in figure 11.

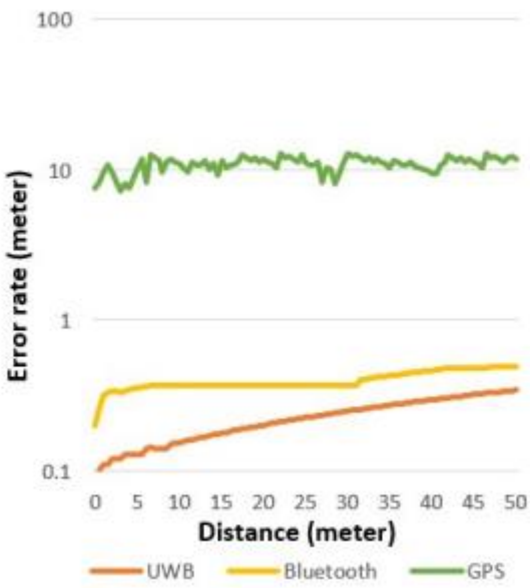

Figure 12: Distance error rate in GPS/Bluetooth/UWB

According to testing results as shown in figure 12, there are error rates in the calculated distances using the proposed model as following:

- In a distance of less than or equal 1 m (using Bluetooth and UWB only), the error rate does not exceed 11 cm.
- In a distance between 1 m to 50 m (using Bluetooth, UWB, GPS), the error rate does not exceed the values between 11 cm and 35 cm.

CONCLUSIONS

By establishing a trustworthy, safe, and efficient collaboration and monitoring system between approved hospitals/laboratories, COVID-19 patients/contacts/normal cases, and the Internet of Things (IoT), this research provided a novel IoT and Cloud based Blockchain Model for Infection Spread Control. The concept proposes a novel method for managing and limiting the spread of COVID-19 by combining existing outdoor and interior IoT monitoring technology with a blockchain system hosted in the cloud. With a distance calculation error rate of less than 11 centimetres per metre, the developed model was able to effectively employ IoT outside GPS based sensors and indoor UWB/Bluetooth based sensors technologies to identify COVID-19 patients and determine contact individuals. Distances are determined by sending data from Internet of Things (IoT) sensors to a consortium blockchain system in the cloud, where it is processed by a pre-programmed smart contract that determines each user's normal, contact, or patient status and then sends out a location-based warning when it detects a COVID-19 infected case or contact.

REFERENCES:

[1] J. Cui, F. Li, Z.-L. Shi, "Origin and evolution of pathogenic coronaviruses", Nat Rev Microbiol, 17 (3), 2019, pp. 181-192.

[2] Riou J, Althaus CL. Pattern of early human-tohuman transmission of Wuhan 2019 novel coronavirus (2019-nCoV), December 2019 to January 2020. Eurosurveillance,25(4),2020.

[3] Dhouib, W., Maatoug, J., Ayouni, I. et al., "The incubation period during the pandemic of COVID-19: a systematic review and metaanalysis", Syst Rev 10, 101, 2021.

[4] Javaid, M.; Khan, I.H., "Internet of Things (IoT) enabled healthcare helps to take the challenges of COVID-19 Pandemic", J. Oral Biol. Craniofacial Res. 2021, pp. 209–214.

[5] Yousif, Mohamed, Hewage, Chaminda, Nawaf, Liqaa, "IoT Technologies during and Beyond COVID-19: A Comprehensive Review", Future Internet, volume 13, issue 5, 2021.

[6] C. V. N. U. B. Murthy, M. L. Shri, S. Kadry and S. Lim, "Blockchain Based Cloud Computing: Architecture and Research Challenges", IEEE Access, vol. 8, 2020, pp. 205190-205205.

[7] Rahman MS, Peeri NC, Shrestha N, Zaki R, Haque U, Hamid SHA., "Defending against the Novel Coronavirus (COVID-19) outbreak: How can the Internet of Things (IoT) help to save the world?", Health Policy Technol, 2020,

[8] Ting, D.S.W., Carin, L., Dzau, V. et al., "Digital technology and COVID-19", Nature Medicine 26, 2020, pp. 459–461.

[9] Ketu, S., Mishra, P.K., "Enhanced Gaussian process regression-based forecasting model for COVID-19 outbreak and significance of IoT for its detection", Applied Intelligence, 2020.

[10] K. Kumar, N. Kumar and R. Shah, "Role of IoT to avoid spreading of COVID-19", International Journal of Intelligent Networks, vol. 1,2020, pp. 32-35.

[11] M. Ndiaye, S. S. Oyewobi, A. M. AbuMahfouz, G. P. Hancke, A. M. Kurien and K. Djouani, "IoT in the Wake of COVID-19: A Survey on Contributions, Challenges and Evolution," in IEEE Access, vol. 8, 2020, pp. 186821-186839.

[12] Ravi Pratap Singh, Mohd Javaid, Abid Haleem, Rajiv Suman, "Internet of things (IoT) applications to fight against COVID-19 pandemic,Diabetes& Metabolic Syndrome: Clinical Research & Reviews" ,Volume 14, Issue 4,2020,pp. 521-524.

[13] Ghimire, S. Thapa, A. K. Jha, A. Kumar, A. Kumar and S. Adhikari, "AI and IoT Solutions for Tackling COVID-19 Pandemic", 2020 4th International Conference on Electronics, Communication and Aerospace Technology (ICECA), Coimbatore, 2020, pp. 1083-1092.