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An IOT and ML Based Covid-Safe System for Automated Health Monitoring and Surveillance

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ABSTRACT:

In the early months of the COVID-19 pandemic with no designated cure or vaccine, the only way to break the infection chain is self-isolation and maintaining the physical distancing. In this paper, we present a potential application of the Internet of Things (IoT) in healthcare and physical distance monitoring for pandemic situations. The main aim of the project is to build a covid-19 safety device which is used to monitor the sensor data into the thingspeak platform which the user access from anywhere in the world. To identify the number of covid-19 cases in region has using fuzzy mamdani algorithm, raspberrypi3.This system uses GPS module to track the person. Pi camera is used to detect the mask whether the person is wearing a mask or not. This system gives the Buzzer alerts if the sensor data exceed threshold value or if the person does not wear a mask. The status of the project will displays on LCD.

Keywords:
IOT, health monitoring, smart healthcare, pandemic, fuzzy inference system, machine learning, fuzzy logic, covid -19.

1. INTRODUCTION:

Internet of Things (IoT) development brings new opportunities in many applications, including smart cities and smart healthcare. Currently, the primary usage of the IoT in healthcare can be categorised as remote monitoring and real- time health systems. Controlling and managing dire situations, such as the one in 2020 when the coronavirus disease (COVID-19) took over the world, can be achieved with the help of IoT systems, without imposing severe restrictions on people and industries. COVID-19 causes respiratory symptoms and appears to be more contagious in comparison to SARS in 2003 [1].

One way to control the spread of viruses, until a vaccine is available, is to observe physical (or social) distancing [2]. By implementing better systems for surveillance, healthcare, and transportation, contagious diseases will have less chance of spreading [3], [4]. An IoT system, combined with Artificial Intelligence (AI), may offer the following contributions when considering a pandemic [5]: 1) improving public security using surveillance and image recognition systems, 2) utilising drones for supply, delivery, or disinfection, 3) contact tracing and limiting people's ac- cess to public places through apps and platforms empowered with AI .

An IoT system for healthcare is typically composed of many sensors connected to a server; it gives real-time monitoring of an environment or users. Tracking people's geolocation can be another useful feature. During the outbreak of a contagious disease, tracking the distance between people can provide valuable information. Using technologies, such as Bluetooth, we can get a reasonable estimate of how much distance people maintain when walking in public places. This data can be used to warn people who are not physically distanced within a specific range, 2 m for example [6], of a person, and thereby, potentially prevent further transmission of the virus.

During the development of such platforms, it is also crucial to consider security and data management thoroughly to prevent abuse of personal information [7], [8]. Governments may try to use these platforms and information for permanent surveillance after a pandemic to control and track people's behaviors.

2. LITERATURE SURVEY:

In [10] author proposed "Chinese experts, consensus on the Internet of Things-aided diagnosis and treatment of coronavirus disease 2019 (COVID-19),"The aim is to diagnose COVID-19 earlier and to improve its treatment by applying medical technology, the ''COVID-19 Intelligent Diagnosis and Treatment Assistant Program (nCapp)" based on the Internet of Things. and control as soon as possible.

In [11] author proposed "Evaluating How Smartphone Contact Tracing Technology Can Reduce the Spread of Infectious Diseases: The Case of COVID-19,"This paper evaluates the effectiveness of these technologies and determines the impact of contact tracing precision on the spread and control of infectious diseases.

In [12] author proposed "Dual-Functional Plasmonic Photo thermal Biosensors for Highly Accurate Severe Acute Respiratory Syndrome Coronavirus 2 Detection,"A dual-functional plasmonic biosensor combining the plasmonic photo thermal (PPT) effect and localised surface plasmon resonance (LSPR) sensing transduction provides an alternative and promising solution for the clinical COVID-19 diagnosis.

In [13] author proposed "On the Coronavirus (COVID-19) Out- break and the Smarts City Network: Universal Data Sharing Standards Coupled with Artificial Intelligence (AI) to Benefit Urban Health Monitoring and Management," As the Coronavirus (COVID-19) expands its impact from China, expanding its catchment into surrounding regions and other countries, increased national and international measures are being taken to contain the outbreak.

3. IMPLEMENTATION:

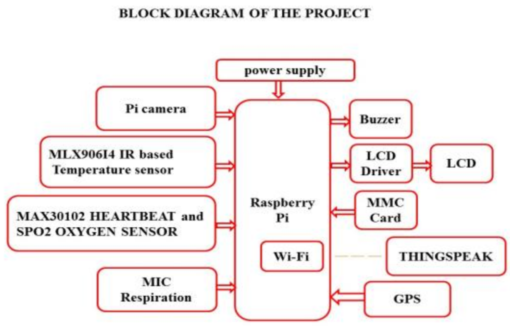

Fig: 3.1 Block diagram of Covid-Safe System.

For the implementation of the model Raspberry pi 3 B+ is used, programmed with fuzzy inference system(FIS). Raspberry pi B 3+ is connected with three main sensors which are MLX90614 (temperature sensor), MAX30102 (heartbeat and Spo2 sensor) and Mic (respiratory sensor). Also GPS is connected to the USB port of raspberry pi to track the exact location of the person. Raspberry pi3 has inbuilt Wi-Fi which is used to upload the sensor data into the thing speak cloud. Whatever process is happen in raspberry pi it will displays on LCD module. And also active the buzzer when the sensor data exceed threshold value or when the pi camera not detect a mask.

4. RELATED WORK:

4.1 The brief introduction of different modules used in this project is discussed below:

4.1.1 RASPBERRY PI 3:

Fig: 4.1.1 Raspberry pi3

The Raspberry Pi 3 Model B is the latest single-board computer from the Raspberry Pi Foundation. In this version, they've upgraded to a 1.2 GHz 64-bit quad-core ARM processor and added 802.11n Wireless LAN, Bluetooth 4.1 and Bluetooth Low Energy. If you're looking to incorporate the Pi into your next embedded design, the 0.1" spaced 40-pin GPIO header gives you access to 27 GPIO, UART, I2C, SPI as well as both 3.3V and 5V power sources. Raspberry Pi processor is programmed using embedded 'Linux'. Linux is the best-known and most-used open source operating system.

4.1.2. PI CAMERA MODULE:

Fig.4.1.2 Raspberry Pi camera module

The Raspberry Pi camera module can be used to take high definition video, as well as stills photographs. The module has a five megapixel fixed-focus camera that supports 1080p30, 720p60 and VGA90 video modes, as well as stills capture. It attaches with a 15cm ribbon cable to the CSI port onto the Raspberry Pi Processor.

4.1.3 MLX90614:

Fig: 4.1.3 MLX90614 sensor

MLX90614 is a contactless temperature sensor used to measure temperature without touching the object using Infrared Rays.MLX90614 Sensor can measure the temperature of an object which is 2-5 cm for from the sensor. The sensor has a field of view of 90 degrees and returns the average temperature value of all objects within this field of view. The module has an internal 17 bit ADC and DSP which provides high resolution and accuracy.

4.1.4. MAX3012:

Fig. 4.1.4 MAX3012 Sensor

The MAX30102 features a 1.8V power supply and a separate 5.0V power supply for internal LEDs for heartrate and blood oxygen acquisition in wearable devices, worn on the fingers, earlobe, and wrist. The standard I2C-compatible communication interface can transmit the collected values?? to the , KL25Z and other micro controllers for heart rate and blood oxygen calculation.

4.1.5 LCD DISPLAY:

Fig: 4.1.5 LCD display

One of the most common devices attached to a micro controller is an LCD display. This project presents a 16*2 LCD it means 16 characters per line by 2 lines respectively. The status of the project will display on LCD module.

4.1.6 MICROPHONE CONDENSER:

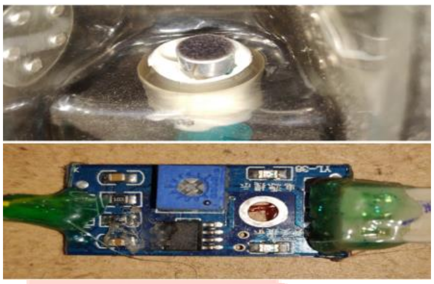

Fig: 4.1.6 MIC condenser

- Detectable sound signal size
- Built-in filter-rectifier circuit, DC signal output
- Good sensitivity, built-in amplifier circuit, adjustable gain
- Voltage signal for sound intensity can be obtained by AD conversion
- Analog voltage signal output, signal amplitude VCC/2

4.1.7 GPS:

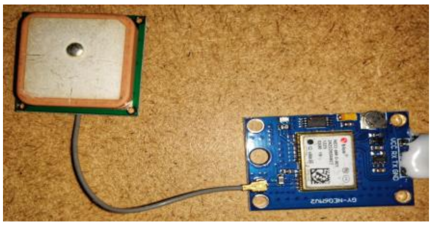

Fig: 4.1.7 GPS module

GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receivers take this information and use triangulation to calculate the user's exact location. Essentially, the GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is. Now, with distance measurements from a few more satellites, the receiver can determine the user's position and display it on the unit's electronic map.

4.2 SOFTWARE

4.2.1 HaarCascade Algorithm:

Face Detection, a widely popular subject with a huge range of applications. It is an Object Detection Algorithm used to identify faces in an image or a real time video. This paper presents a machine learning techniques to get a high degree of accuracy from what is called "training data". This uses "integral image" concepts to compute the "features" detected. Haar Cascades use the Ad boost learning algorithm which selects a small number of important features from a large set to give an efficient result of classifiers.

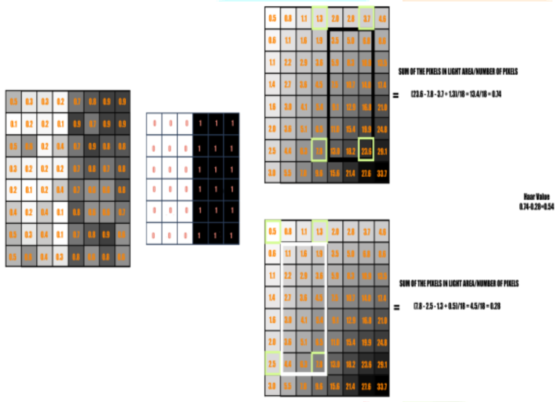

Fig: 4.2.1 Haarclasification

This is a case where there is a sudden change of pixel intensities moving vertically from the left towards the right in the image. Again repeating the same calculation done above, but this time just to see what haar value is calculated when there is a sudden change of intensities moving from left to right in a vertical direction. The haar value here is 0.54, which is closer to 1 in comparison to the case earlier.

4.2.2 Implementation of fuzzy inference system:

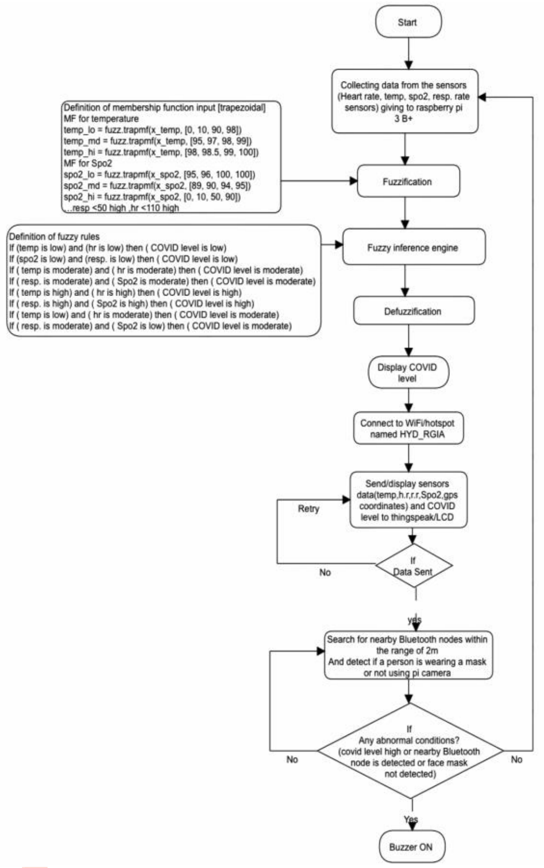

Fig: 4.2.2.Flow chart of the developed fuzzy inference system model.

Step 1: Collection of all the sensors crisp data and giving it to fuzzy inference model in raspberry pi. The input variables from temperature, heartbeat, Spo2 and respiratory sensors are converted into fuzzy variables in next fuzzification step.

Step 2: Fuzzification is a procedure through which the input variables are turned into fuzzy measures of their membership to given classes. Such a conversion from deterministic sizes to fuzzy sizes is performed through the membership functions pre-set for those classesBy convention, the real number which represents the level of membership [μ (x)] takes a 0 value when the element does not belong to the set, and 1 when it belongs to it completely.

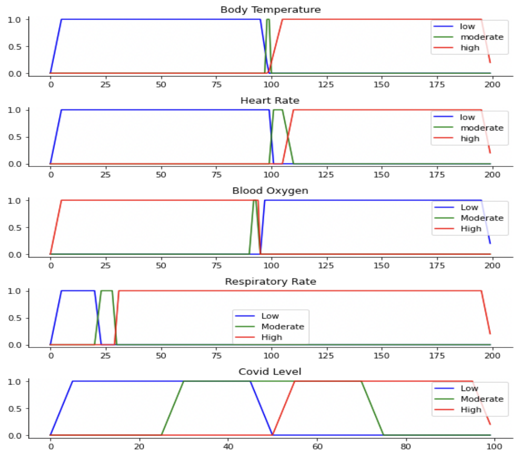

Fig: 4.2.3 Trapezoidal Membership function

Step 3: After the definition of the fuzzy data which comes from the fuzzification process, it is necessary to insert in the decisional engine the rules which supply the fuzzy output. The rules are usually made up of an if–then–else structure, which in its turn is made up of an antecedent which defines the conditions, and a consequent which defines the action. For each input variable of the model, in the antecedent we have a clause of the type (x is L) where L is a linguistic label revealing a fuzzy set. In this way, the antecedent supplies a characterization of the condition of the system we want to model, namely its description in quantitative terms. Usually the antecedent includes a conjunction of clauses, one for each observed variable, while the condition of the consequent determines the condition of outputs.

Definition of fuzzy rules
If (temp is low) and (hr is low) then (COVID level is low)
If (spo2 is low) and (resp. is low) then (COVID level is low)
If (temp is moderate) and (hr is moderate) then (COVID level is moderate)
If (resp. is moderate) and (Spo2 is moderate) then (COVID level is moderate)
If (temp is high) and (hr is high) then (COVID level is high)
If (resp. is high) and (Spo2 is high) then (COVID level is high)
If (temp is low) and (hr is moderate) then (COVID level is moderate)
If (resp. is moderate) and (Spo2 is low) then (COVID level is moderate)

Fig: 4.2.4 if- then rules

Step 4: Defuzzification consists in drawing the output deterministic value from the fuzzy model. A careful analysis of the problem is at the basis of a correct defuzzification: it can be linguistic, when the output is a predicate to which a level of membership is associated, or numerical, of ‘‘crisp’’ type (non-fuzzy) (used in fuzzy control). Many criteria of defuzzification exist: often in engineering the choice depends on computational simplicity. The most used defuzzification methods are the following:

Centroid method: the chosen numerical value for the output is calculated as the center of mass of the fuzzy set.

Bisector method: the output is the abscissa of the bisector of the area subtended to the fuzzy data set

Step 5: Using Wi-Fi/hotspot all the input and output of the system is uploaded/sent to thingspeak and remote.it. If the data are not set due to low speed Wi-Fi connection then this process of sending will keep on continuing.

Step 6: Raspberry pi is also programmed to detect if a person is wearing a mask or not using Pi camera hardware along with opencv which uses haar cascade algorithm to accomplish this task of detecting .The model is trained using multiple negative as well as positive images of people wearing a mask and not wearing a mask.

Firstly for any facial feature detection it is important to to detect a face after this other process can be done. It is an Object Detection Algorithm used to identify faces in an image or a real time video. Haar Cascades use the Adaboost learning algorithm which selects a small number of important features from a large set to give an efficient result of classifiers. The process is extensively explained in the decision making algorithm section.

Using Bluetooth technology within the radius of 2m other Bluetooth devices are detected for social distancing, if there are devices closer to the node then buzzer is activated. This process of searching will continue till it finds all the Bluetooth devices nearby. If the Bluetooth device detected name is unique for all then contact tracing can also be done, as the device name will be stored in cloud server.

Step 7: If there are any abnormalities such as covid level is high or if there is Bluetooth device detected which is closer than 2m or if a person is not wearing a mask then buzzer is activated.

5. CONCLUSION:

The wearable covid-safe device is an advanced information and communications technology has opened the window to a new era of cost-effective remote healthcare services. The system include monitoring sensor data in IOT platform via wireless, the system can display sensor parameter on LCD. It can also track a person’s live location which can help in contact raising and it can detect if a person is wearing a mask or not. The system workout on Fuzzy Mamdani algorithm to identify the percentage of covid infection risk in a person. Moreover, timely and effectively by using this project we can managing the COVID-19 outbreak and reducing viral transmission.

6. ACKNOWLEDGEMENT

We would like to thank all the authors of different research papers referred during writing this paper. It was very knowledge gaining and helpful for the further research to be done in future.

7. RESULTS:

The project "Covid-safe" was designed to monitor the health parameters such as body temperature, cough rate, respiratory rate, blood oxygen and heart rate then updates them in Thingspeak. With the use Covid-safe node it helps to maintain 2m distance from other person who is wearing covid-safe node with the help of Bluetooth technology. This system detects if a person is wearing a mask or not using pi camera and machine learning algorithms. In addition, Fuzzy Mamdani algorithm and based on the parameters data we can estimate the covid-19 cases a region has. The COVID-SAFE framework can assist in minimizing the corona-virus exposure risk.

Fig: 7.1 Reading of Heart Rate and SPO2

Fig: 7.2 Rating of body temperature

Fig: 7.3 Detecting other Bluetooth devices

Fig: 7.4 Covid level of the user being displayed

Fig: 7.5 Message when there is no mask detected

Fig: 7.6 Message When Mask Is Detected

Fig: 7.7 Covid level, spo2 monitoring into the thingspeak

Fig: 7.8 Heart rate and Respiration into the thing speak

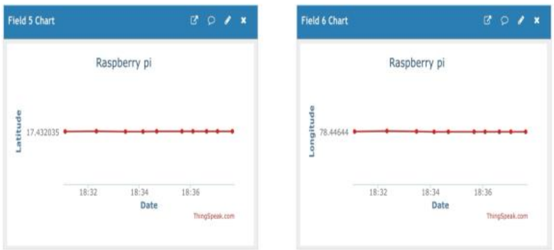

Fig: 7.9 GPS values in the form of latitude and longitude

REFERENCES:

[1] D. S. W. Ting, L. Carin, V. Dzau, and T. Y. Wong, “Digital technology and COVID-19,” Nat. Med., vol. 26, no. 4, pp. 459-461, 2020, doi:10.1038/s41591-020-0824-5.

[2] J. A. Lewnard and N. C. Lo, “Scientific and ethical basis for social- distancing interventions against COVID-19,” Lancet Infect. Dis. , vol. 20, no. 6, pp. 631-633, 2020, doi: 10.1016 S1473-3099(20)30190-0.

[3] S. Woolhandler and D. U. Himmelstein, “Intersecting U.S.Epidemics: COVID-19 and Lack of Health Insurance,” Ann. Intern.Med., vol. 173, no. 1, pp. 63-64, 2020, doi: 10.7326/M20-1491.

[4] E. Christaki, “New technologies in predicting, preventing andcontrol- ling emerging infectious diseases,” Virulence, vol. 6, no. 6,pp. 558– 565, 2015, doi: 10.1080/21505594.2015.1040975.

[5] T. L. Inn, “Smart City Technologies Take on COVID-19,” Penang in-stitude, 2020. Accessed: Aug. 2, 2020. technologies-take- on-covid-19/

[6] L. Setti, F. Passarini, G. De Gennaro, P. Barbieri, M. G. Perrone, M.Borelli, J. Palmisani, A. Di Gilio, P. Piscitelli, and A. Miani,“Airborne Transmission Route of COVID-19: Why 2 Meters/6 Feet of Inter-Per- sonal Distance Could Not Be Enough,” Int. J. Environ.Res. Public Health,vol. 17, no. 8, pp. 2932-2937, 2020,doi:10.3390ijerph17082932.

[7] G. Yoon, J. Y. Lee, K. J. Jeon, K.-K. Park, H. S. Yeo, H. T. Hwang, H. S. Kim, and I.-D. Hwang, “Multiple diagnosis based on photoplethysmography: hematocrit, SpO2, pulse, and respiration,” in Proc.Optics in Health Care and Biomed. Optics: Diagnostics and Treatment, vol. 4916, pp. 185-188, 2002, doi: 10.1117/12.482947.

[8] T. Sharon, “Blind-sided by privacy? digital contact tracing, the ap- ple/google api and big tech’s newfound role as global health policy makers,” Ethics Inf. Technol., 2020, doi: 10.1007/s10676-020-09547x.

[9] Y. Yin, Y. Zeng, X. Chen, and Y. Fan, “The internet of things in healthcare: An overview,” J. Ind. Inf. Integr., vol. 1, pp. 3-13, 2016, doi: 10.1016/j.jii.2016.03.004.

[10] L. Bai, D. Yang, X. Wang, L. Tong, X. Zhu, M. Ye, C. Tu, J. Jiang, H. Yu, and F. Tan, “Chinese experts ’consensus on the Internet of Things-aided diagnosis and treatment of coronavirus disease 2019 (COVID-19),” Clin. eHealth, vol. 3, pp. 7- 15, 2020, doi: 10.1016/j.ceh.2020.03.001.

[11] E. Hernández-Orallo, P. Manzoni, C. T. Calafate, and J. Cano, “Eval- uating How Smartphone Contact Tracing Technology Can Reduce the Spread of Infectious Diseases: The Case of COVID-19,” IEEE Access, vol. 8, pp. 99083–99097, 2020, doi: 10.1109/ACCESS.2020.2998042.

[12] G. Qiu, Z. Gai, Y. Tao, J. Schmitt, G. A. Kullak-Ublick, and J. Wang, “Dual-Functional Plasmonic Photothermal Biosensors for Highly Accurate Severe Acute Respiratory Syndrome Coronavirus 2 Detection,” ACS Nano, vol. 14, no. 5, pp. 5268–5277, 2020, doi: 10.1021/acsnano.0c02439.

[13] Z. Allam and D. S. Jones, “On the Coronavirus (COVID-19) Out- break and the Smarts City Network: Universal Data Sharing Standards Coupled with Artificial Intelligence (AI) to Benefit Urban Health Monitoring and Management,” Healthcare, vol. 8, no. 1, 2020, doi: 10.3390/healthcare8010046.

[14] C. Sartini, M. Tresoldi, P. Scarpellini, and A. Zangrillo, “Respiratory Parameters in Patients with COVID-19 after Using Noninvasive Ventilation in the Prone Position Outside the Intensive Care Unit,” JAMA, vol. 232, no. 22, 2020, pp. 2338-2340, doi: 10.1001/jama.2020.7861.

[15] L. Setti, F. Passarini, G. De Gennaro, P. Barbieri, M. G. Perrone, M. Borelli, J. Palmisani, A. Di Gilio, P. Piscitelli, and A. Miani, “Airborne Transmission Route of COVID-19: Why 2 Meters/6 Feet of Inter-Per- sonal Distance Could Not Be Enough,” Int. J. Environ. Res. Public Health, vol. 17, no. 8, pp. 2932-2937, 2020, doi: 10.3390/ijerph17082932

[16] A. Imran, I. Posokhova, H. N. Qureshi, U. Masood, S. Riaz, K. Ali, C.N. John, I. Hussain, and M. Nabeel, “AI4COVID-19: AI Enabled Pre-liminary Diagnosis for COVID-19 from Cough Samples via an App,” Inform. Med. Unlocked, 2020, doi: 10.1016/ j.imu.2020.100378.

[17] Z. Han, B. Wei, Y. Hong, T. Li, J. Cong, X. Zhu, H. Wei, and W. Zhang, “Accurate screening of covid-19 using attention based deep 3d multiple instance learning,” IEEE Transactions on Medical Imaging, 2020.

[18] D. Painuli, D. Mishra, S. Bhardwaj, and M. Aggarwal, “Fuzzy Rule Based System to predict COVID19 - A Deadly Virus,” Int. J. Man-agement and Humanities, vol. 4, no. 8, pp. 78-82, 2020, doi: 10.35940/ijmh.H0781.044820.

[19] C. F. Pasluosta, H. Gassner, J. Winkler, J. Klucken, and B. M. Esko- fier, “An emerging era in the management of Parkinson’s disease: Wearable technologies and the Internet of Things,” IEEE J. Biomed. Health Inform., vol. 19, no. 6, pp. 1873–1881, 2015, doi: 10.1109/JBHI.2015.2461555.

[20] C. Kotronis, G. Minou, G. Dimitrakopoulos and H. Djelouat, “Man- aging Criticalities of e-Health IoT systems,” 2017 IEEE 17th Int. Conf. on Ubiquitous Wireless Broadband (ICUWB), Salamanca, Spain, 2017, doi: 10.1109/ ICUWB.2017.8251004.

[21] P. Castillejo, J.-F. Martinez, J. Rodriguez-Molina, and A. Cuerva, “In- tegration of wearable devices in a wireless sensor network for an E-health application,” IEEE Wireless Commun., vol. 20, no. 4, pp. 38– 49, 2013, doi: 10.1109/MWC.2013.6590049.

[22] L. Zhang, J. Liu, and H. Jiang, “Energy-efficient location tracking with smartphones for IoT,” in Proc. Sensors 2012 IEEE, Taipei, 2012, doi: 10.1109/ICSENS.2012.6411521.

[23] S. Matos, S. Birring, I. Pavord, and D. Evans, “Detection of Cough Signals in Continuous Audio Recordings Using Hidden Markov Mod- els,” IEEE Trans. Biomed. Eng., vol. 53, no. 6, pp. 1078–1083, 2006, doi: 10.1109/ TBME.2006.873548.

[24] A. Mackey, P. Spachos, L. Song, and K. N. Plataniotis, "Improving BLE Beacon Proximity Estimation Accuracy Through Bayesian Fil-tering," IEEE Internet Things J., vol. 7, no. 4, pp. 3160-3169, 2020, doi: 10.1109/ JIOT.2020.2965583.

[25] D. Karaboga and E. Kaya, “Adaptive network based fuzzy inference system (ANFIS) training approaches: a comprehensive survey,” Artif. Intell. Rev., vol. 52, no. 4, pp. 2263–2293, 2019, doi: 10.1007/s10462- 017-9610-2.