Telemedicine application to reduce the spread of Covid-19

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2020 IEEE 2nd International Conference on Electronics, Control, Optimization and Computer Science (ICECOCS) | 978-1-7281-6921-7/20/$31.00 ©2020 IEEE | DOI: 10.1109/ICECOCS50124.2020.9314459

***Abstract*— the usage of wearable sensors network (WSN), is one of the most useful methods to monitor the daily life of people especially when we deal with healthcare issues such as human body temperature monitoring, heart rate monitoring, and other vital parameters like that, this area of study is called telemedicine. This work will mention about the usage of a temperature and location wearable sensors network with one platform for making the diagnosis of the people whom affected by COVID 19 very easy, moreover several statistical studies will be done in real time. The first reason to use WSN is to avoid the frequent direct contact with the suspected cases, the second reason is to reduce the diagnosis time because a lot of patients will be connected to one platform and the data analysis will be done automatically. In this paper we will deal with the proof of concept of the most important part in telemedicine by doing many simulations on LabVIEW Software including the platform development, and those demonstrations are based on the actual data in order to highlight the efficiency of our approach and our platform as well.**

Keywords— COVID 19, telemedicine, wearable sensors network, healthcare, statistical studies.

I. INTRODUCTION

Nowadays coronavirus is affecting lot of people in several countries, actually each country has adopted a strategy of precautions against Covid-19, most of governments started with early detection process only for suspected cases, and the symptoms of the infection appear between 1 and 14 days according the world health organization (WHO) That is why the suspected people must be isolated during 14 days under the medical monitoring. [1]. In order to fight against corona virus many studies and researches have done. Some of them were dealing with daily statistics, especially the application of machine learning to predict the spread rate of the virus [2].

In this paper one of the remote diagnostic solutions is proposed. It is about the usage of the wearable sensors network for the medical monitoring of all the suspected cases. This digital solution helps the medical staff to perform the Covid-19 detection remotely and in real-time. This solution plays an important role in the medical telemonitoring of suspected cases.

The wearable sensors network became very useful and very helpful for patients monitoring or people daily life monitoring. In this regard the Holter ECG device is enough to prove to everybody the efficiency of wearable sensors. Because the subject takes this small device with him/her during 24 hours or 48 hours to record the electrical Activity of the heart and storing the ECG time series [5]. After that the subject comes to the hospital in order to take out this device for interpretation. So instead of staying in the hospital for a long time the patient comes just for 10 to 20 minutes.

In the last few years lot of Scientifics and engineers started to deal with wireless wearable sensors, they started to supervise many physical parameters remotely including the the vital parameters of the patients such as temperature [3], ECG, EMG etc. in this regard and in order to improve the medical tele monitoring and the tele diagnostic as well. One platform with one database can be sufficient to record, store and display the vital parameters evolution of many patients in the same time and also in real-time.

The rest of this paper will be organized as follow: Section 2 mentions about the platform architecture and the description of each software/hardware part and the interaction between them. Section 3 describes the proof of concept with the related demonstration to highlight our contribution. Section 4 describes the results and their interpretation.

II. PLATFORM LAYOUT DESCRIPTION

In order to carry out this digital solution one application is developed using LabVIEW software for supervising some of Covid-19 symptoms in real-time :

-The sensing node acquires the temperature values of the subject then the acquired values will be sent via Wi-Fi to the local server first for processing and after that, those values will be stored and sent to the main server [6].

-The local server is responsible for the data processing and the high temperature is detected by this PC, then the notification will be sent to the doctor's phone, and in the same time it will be sent to the main server with the associated statistical data.

-Doctor's phone will receive the name and the location of the patient who has a high temperature. The doctor will check and perform the test for the patient then he will confirm via his/her Mobile. By using this process the confirmed cases of all the country will be sent to the main server. One of the doctors will have access as an administrator, hence he can enter the recovered cases, the number of death and the negative cases among all the suspected cases.

-The main server is acquiring the statistical data from all the local servers of the country. And many other statistical studies related to the spread the virus in all the regions of the country will be done.

-This platform was designed in order to reduce the direct contact between the doctor and suspected subjects by using wireless connection from the sensing node to the local server, moreover all the modifications are managed from the personal mobile phone of the doctor to avoid the usage of common tools like keyboard, mouse... because Covid-19 is a contagious disease.

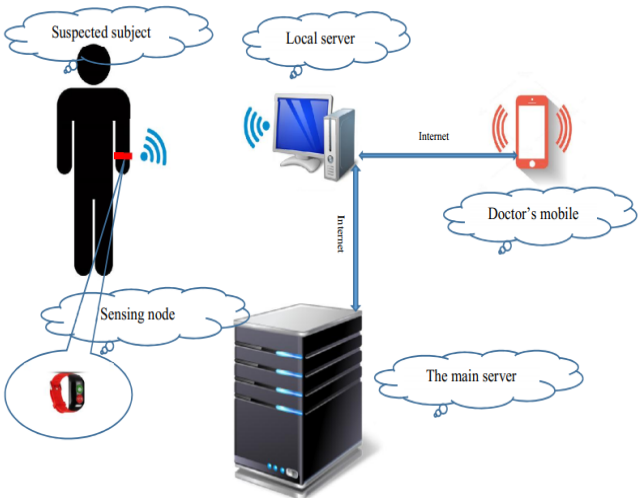

Fig.1: *architecture of the information system with WSN*

III. THE PROOF OF CONCEPT

In order to validate the feasibility, we tried to carry out one prototype with the available tools during this period of quarantine. The usage of the bellowing items:

- NodeMcu
- Temperature sensor DHT11
- Location sensor
- 2 Workstations
- Cables for connection

A. Materials specifications

- NodeMcu specifications

The NodeMcu is Wi-Fi module based on ESP8266, it has GPIO, PWM, 1-Wire and ADC all in one PCB. This last can be programed using Arduino IDE software [9]. Temperature sensor DHT11 is one of the most useful sensors in the proof of concept of such kind of projects [8].

- DHT11 specifications is presented in TABLE I.

TABLE I. DHT11 SPECIFICATIONS

Specification	***value***
Resolution	16 Bit
Repeatability	±1 °C
Accuracy	25° C ±2° C
Response time	1/e (63%) 10s
Power supply DC	3.3～5.5V

- Location sensor :

Chip: U-Blox NEO-6M; Supply voltage: 3-5 VDC; Interface: UART (Serial); Data transfer rate: 9600 bits per second; Module size: 2.5 × 3.5 cm; Size of the ceramic antenna: 2,5×2,5×0,8 cm

- Workstations:

In order to carry out this prototype we used standard computers with the bellowing technical specifications:

CPU: core™ i5-7200U 2.50GHz (4cpu); RAM: 8192Mo

B. Data processing algorithm

In order to deal with of data acquisition and processing we need first to mention about the temperature range of sick people and normal ones as well. Most of people tend to think that the normal body temperature is fixed at 36.66°C, actually this value is not correct because the person's temperature is changing during the day [3] and recently Myroslava Protsiv et al have even discovered that; the average body temperature varies over the years. And according the study they performed, the actual average body temperature is 36.11°C and not 36.66°C [3]. The

CDC (centers for disease control and prevention) team define an ill person when he/she has a fever, it means that his measured body temperature is 38°C or greater [3]. Consequently our algorithm will somehow compare the acquired temperature with 38°C, if it is less than this value it means that he/she is not sick and vice versa.

The figure (2) illustrates the simulation of the developed algorithm with normal temperature value.

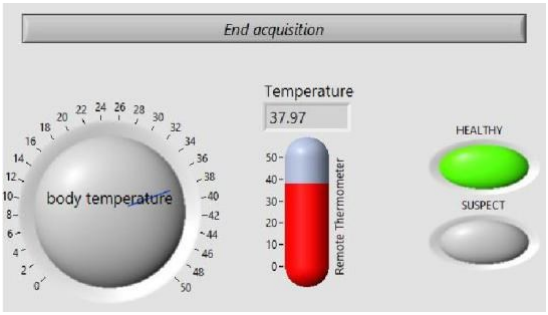

Fig.2: *the detection algorithm interface 1*

This subject's body temperature is in the normal range so according to covid19 symptoms this subject is healthy.

As described in the introduction section our aim is detect the suspected cases affected by corona virus. That is why when the person's temperature is out of the normal range, other analysis must be done in order be confirmed.

In the previous program we change the temperature manually in for simulation purpose. In bellowing figure (6) two programs are used Matlab and LabVIEW and the temperature value is changing randomly in order to test the efficiency of our algorithm [10]. The generated values are used as the connected sensors to the platform.

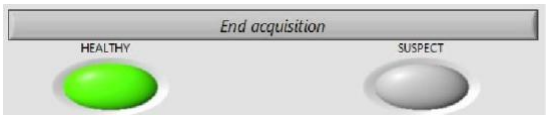

Fig.3: *the detection algorithm interface 3*

In the platform database our elements are the sensing nodes. Each node has the information bellow:

- The unique ID is the CIN/passport number,
- The patient name,
- The patient age,

• The patient's condition.

C. *Information system*

In the information system the subject or the patient will be identified by three elements.

• The subject's name

• The CIN/ passport number

• The patient's location

According to the temperature changes the subject will be confirmed as a covid19 suspected case or not, that is why in this platform will communicate in real-time with the sensing node [9], in order to get the related parameters such as the location and the temperature.

As we are in the proof of concept step, "Thingspeak" cloud space is used for online temperature recording [6]. The figure bellow illustrates the recorded temperature using the NodeMcu module and temperature sensor [9].

Fig.4: *online recording interface*

We used Thingspeak cloud space because in the same time, it allows us to collect data from different sensors [9] and analyze the collected data using Matlab software. So we can perform many statistical studies using the same platform, such as high temperature detection and the number of confirmed suspected persons etc.

According to the temperature of each patient the bellowing table will be displayed in the main server [11].

Tab.2: *local server data processing*

CIN	***Name***	***City***	***Status***
A22020	Alami	Rabat	healthy
A25252	Saadani	Rabat	suspect
C52458	Ghita	Casa	recovered

Another table will be displayed in bellow for the statistical purpose, in order to have an idea about the spread rate for each city [11].

Tab.2: main server data processing

City	***confi***	***recove***	***death***	***rate***
Rabat	511	300	18	15%
Casa	1500	1200	75	25%

N.B: all data in the previous table are random values just to highlight the proof of concept.

IV. RESULTS & INTERPRETATION

The wearable sensors network (WSN) and the platform of data processing. Hence the infection by that contagious virus will be reduced as follow:

-The direct contact between the suspected people and the medical staff is reduced thanks to the remote temperature monitoring.

-The high temperature detection is done automatically and the healthcare professionals are informed by notifications on their smartphones.

-The temperature measurements is performed in real-time, so the suspected person will be detected in the proper time.

-All the statistical studies related to the spread of corona virus are done automatically and in real-time on the main server, in order to have an idea about the pandemic situation over all the country.

V. CONCLUSION

This paper presents the application of telemedicine for the purpose to reduce the spread of covid-19. First by the human body temperature telemonitoring of the isolated people. Secondly by the computerization of all the statistical studies related to the spread of corona virus.

The proof of concept (POC) of this project is done by using sensing nodes (NodeMcu) as an example of WSN, and many simulations are performed on LabVIEW software to carry out the data processing platform. The first aim in this work is the POC to make this project achievable and also to highlight the practical side of our research. That is why our next aim is to deal with the manufacturing of several units of sensing nodes, on the other hand we develop the platform that will be installed in one hospital, in order to start with evaluation and enhancing the performances of all the parts of our project..

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