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METHODOLOGICAL PROPOSAL FOR THE AMBULATORY  
DETECTION OF COVID-19 SYMPTOMS, USING LOW-COST DEVICES

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**Wilver AUCCAHUASI, Oscar LINARES, Nicanor BENITES, Mónica DIAZ, Grisi BERNARDO, Alfonso FUENTES, Iván PEREZ, Fernando SERNAQUE, Edward FLORES: Methodological proposal for the ambulatory detection of COVID-19 symptoms, using low-cost devices**

**Keywords: Covid-19, wearable, applicative, oxygen saturation, blood pressure, heart rate.**

## ABSTRACT

The pandemic caused by COVID-19, allowed to know at many levels, the situation of hospitals and its impact on the services they provide to the population. At the times with the highest rate of infections, health centers in most countries were brought to their maximum capacity, most of them collapsing and ceasing to attend to patients. Many health centers were dedicated only to treating patients infected by COVID-19. Lacking medical attention to the other specialties. In this environment, many of the symptomatic patients, such as asymptomatic ones, did not know if they had been infected, much less, did not know if they were infected, many of them were unable to detect certain symptoms so that they could

request specialized medical attention. This work is dedicated to using low-cost devices as an evaluation and alert mechanism for possible symptoms caused by COVID-19, the methodology is based on the analysis of heart rhythm, blood pressure and oxygen saturation, the latter is the most important, because if the oxygen saturation begins to decrease, it is a symptom that the airways are being affected, which could be complicated if the oxygen saturation has a tendency to decrease, the variation of the rhythm can also be analyzed heart rate and blood pressure, but the predominant one is Oxygen Saturation. The results show that wearable devices in the form of a watch are widely used to control people's movements, the exercises they perform, the proposed methodology consists of a device that has the ability to evaluate these three biomedical variables, it is not necessarily a medical device with a high degree of sensitivity or accuracy. The usefulness of the device is to be able to carry out a quick analysis that helps people make a decision, the technique is not to measure oxygen saturation with a high degree of accuracy, the idea is to be able to measure if the saturation has a tendency to decrease. In the results we present the measurement of several people to verify the methodology.

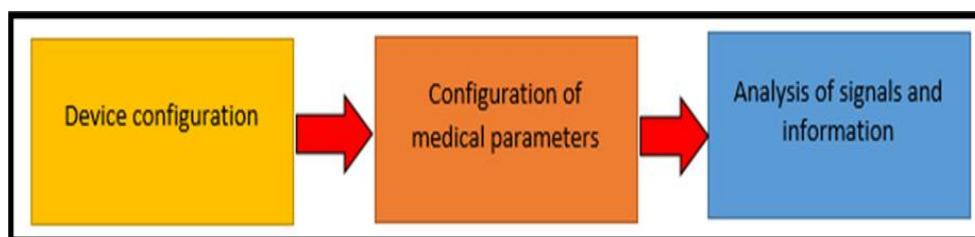
### **Introduction**

In these times when people's health is highly compromised by the effects of the COVID-19 pandemic, a number of solutions based on hardware and software are emerging in the marketplace, where they try to register most of the biomedical variables that They are occurring in people with positive and negative symptoms. One of the most important factors is oxygen saturation, so there are many developments that try to measure it [1]. Patient monitoring is one of the techniques that are being considered at this time and devices in common use are being used for such purposes [2]. Diagnostics in times of pandemic are being carried out remotely, so it is necessary to have equipment to be able to record biomedical variables and with this the doctor can improve his diagnosis and low-cost devices help a lot to this objective [3].

In these times of pandemic, many solutions are emerging based on many solutions based on hardware and software, for which from commercial solutions to academic solutions are being used on a larger scale [4]. With the use of mobile devices, a great variety of mobile applications have emerged capable of providing large-scale solutions, both for recording and analysis, which is why their use is being widely used. In the present research, low-cost devices are used to record oxygen saturation, heart rate and blood pressure, in order to be able to monitor the values mainly of oxygen saturation, in order to verify whether it remains constant or some decrease is taking place.

### **Materials and methods**

The materials and methods are related to the configuration and integration of the device as well as the way in which the readings of the device are interpreted through a mobile application. The following is the block diagram of the methodological proposal:



**Figure 1. Block diagram of the proposed Methodology**

**Device configuration:** The beginning of the methodology begins with the configuration of the wearable device, where the data of the person will be entered, such as weight, age, among others, as well as the download, installation and configuration of the mobile application, so that all the data that are registered in the device can be connected with the mobile application, through a wireless connection.

**Configuration of medical parameters:** The parameters to be evaluated are mainly those related to biomedical signals, which have to be configured, the readings are carried out constantly, the device performs a reading of the parameters according to the established frequency, the data is sent to the application for registration and evaluation. The three parameters to evaluate are the following:

- **Oxygen Saturation (SPO<sub>2</sub>),** measures the amount of oxygen that is present in the blood at the time of recording.
- **Heart rate: (BPM):** measures the number of beats per minute that the heart is presenting at the time of recording.
- **Pressure (mmHg):** measures the blood pressure that the person is developing at the time of registration.

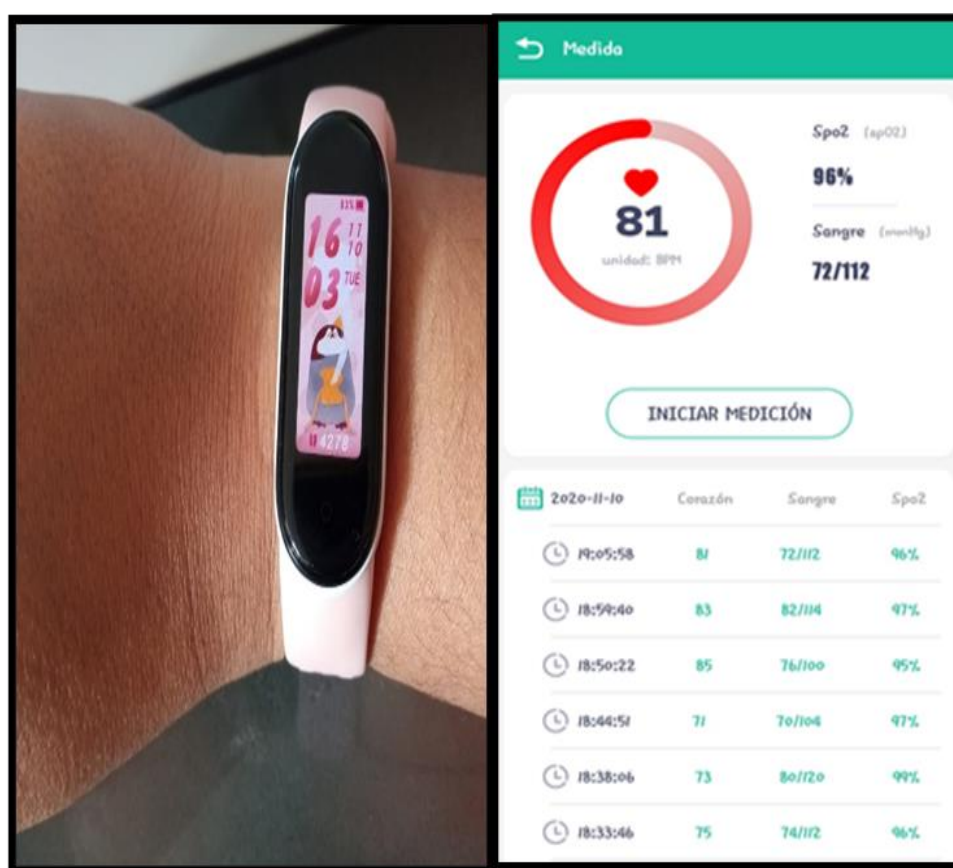
**Analysis of signals and information:** The information analysis stage consists of being able to analyze the tendency of the biomedical signals, present in the application, at this stage the mobile application is the most important actor of the methodology and the one that will determine success, by being able to determine the trend of oxygen saturation, if the trend is constant, it means that the patient does not present symptoms to COVID-19, if the trend of oxygen saturation is negative, which means that it is decreasing, there is a high probability that the person is infected with COVID-19, and also their lungs are compromised which would cause a decrease in the oxygen concentration in the blood.

## Results

The results determine a practical application in the use of the methodology, there is a low-cost mechanism with enormous functionality in terms of being able to identify certain changes in the physiology of the person, being able to measure and record oxygen saturation levels in blood,, measuring an

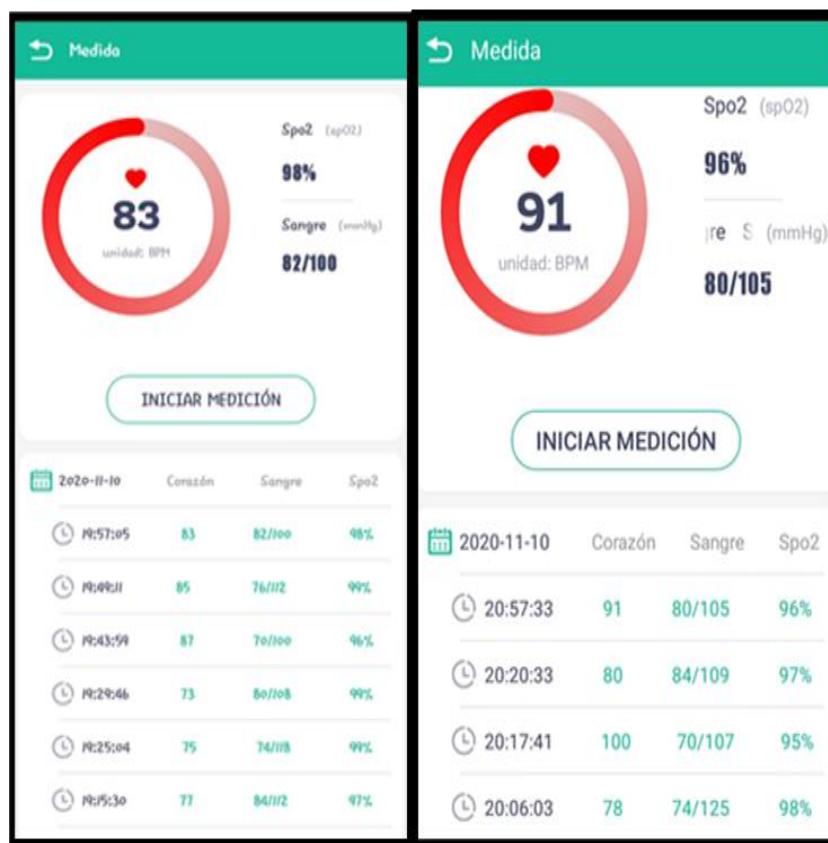
approximation to the heart pulse and finally being able to determine blood pressure, makes these devices a practical use in the fight against the effects of COVID-19.

In practice it is not because these low-cost devices can accurately measure the aforementioned values, because they are not considered as medical grade equipment, what they do is use certain algorithms with the intention of being able to perform a calculation and be able to provide an approximate value towards the values to be measured, it is for this reason that we do not use it to measure exactly how much the oxygen saturation value is, on the contrary we use the saturation value and measure the trend, if the values remain constant or if the values are going down, which means that the lungs are being affected.



**Figure 2. Use of the wearable device and its application installed on a cell phone**

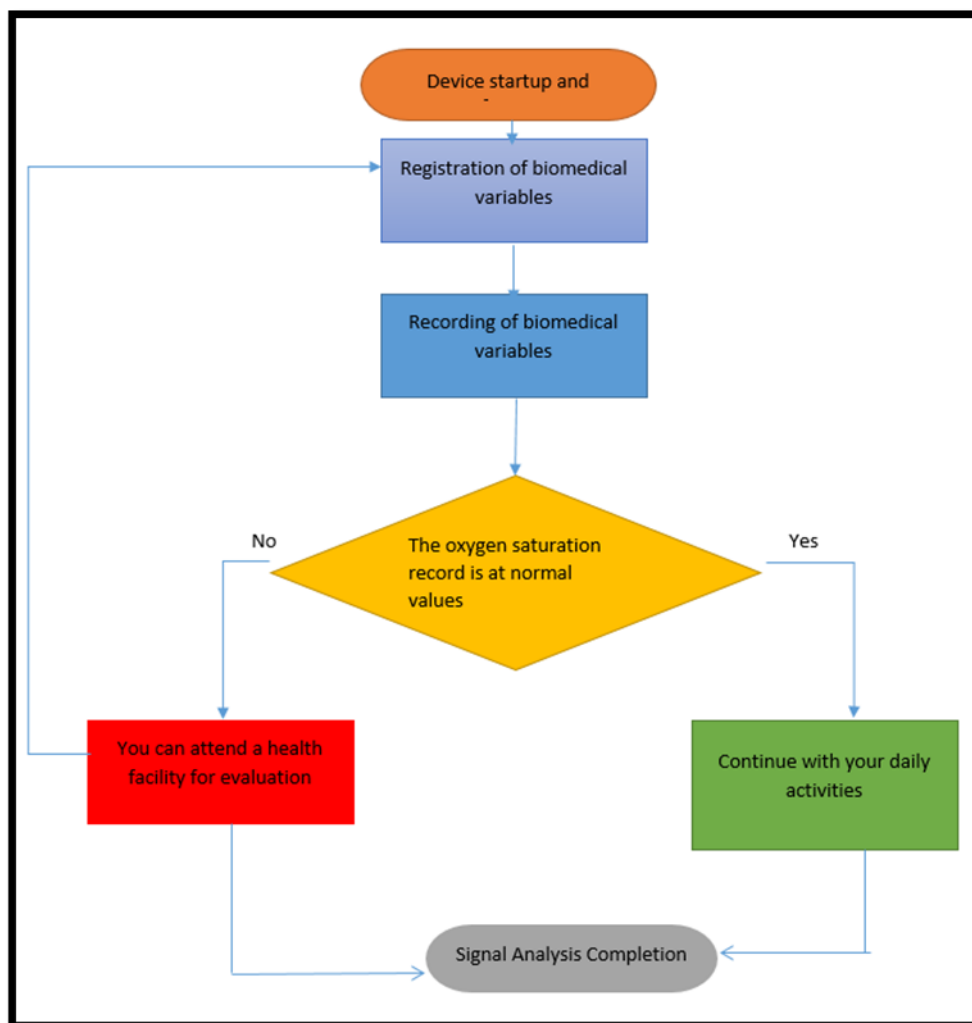
In figure 2, the use of the device is presented, with the registration of biomedical variables using the mobile application. the record can be seen according to the programmed frequency, every certain period of time.



**Figure 3. Registration of biomedical variables, through the mobile application**

In figure 3, two records of the biomedical variables are presented, where the heart rate present in each of the measurements is visually presented, as well as the oxygen saturation and blood pressure, one of the benefits of the application is to be able to carry out a programming of the measurements, for this reason there is a record for every certain time, it is in this part of the application, where the methodology works, evaluating the measurement of the records, we can indicate that if the oxygen saturation is constant or It is decreasing, with which we can indicate that the respiratory system is possibly being affected by COVID-19, for which the person should go to the health center to be discarded according to the established protocols.

In the following figure, the flow diagram of the methodology is presented, with emphasis on the analysis of oxygen saturation, the main point to analyze if the respiratory system is being affected.



**Figure 4. Values analysis flow chart of the proposed methodology**

In figure 4, the steps to be able to determine when changes in the sleep pattern can be evidenced are presented, being able to keep a control helps to determine certain changes that can trigger in the presence of Sleep Apnea.

**Conclusions**

The conclusions reached at the end of the research is that there are many devices on the market that are in charge of being able to evaluate certain physiological parameters of people, but without the medical degree that allows us a possible diagnosis, characterized mainly by a high index of error in the measurement of the biomedical parameter, for example a medical equipment that evaluates the heart rate can measure in a person 80 beats per minute and one of the inexpensive devices that is not of medical grade, can measure between 75 and 85 beats per minute, which would not exactly be useful for a cardiologist if he wants to make a diagnosis of the cardiac system.

What is attempted in the proposed methodology in the present work is to be able to use these medical devices in order to find the trend of the measurement, for example we do not try to measure exactly how much the person is saturating in oxygen, to study some pathology of the respiratory

system or power study if their airways are working normally, otherwise the intention is to make measurements to determine if the oxygen saturation values are decreasing, with which even if the measurement is not exact, it can be estimated if the values are suffering any decrease, which would indicate that the lungs are being affected by a possible contagion with COVID-19, and with this the person can approach a health center for a discard according to the established protocols.

It can be concluded that the methodology presented can be of great help in the fight to locate the people who are being affected by COVID-19, they can alarm health centers, by means of a telephone call to an emergency center when they are They are in a stage of decreased oxygen saturation, not only when they feel any of the symptoms, but by measuring the trend of oxygen saturation, the diagnosis can be improved and the results of the health protocols to locate people infected by COVID-19.

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