Cardio-vascular disease detection using smart watch

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Abstract: - In this project we are going to evaluate the existing devices and create an algorithm to get an prior alert before the occurrence of heart disease using smart watch and to calculate accurate heart rate of the user according to clinical standards.

1. INTRODUCTION

According to the statistical survey of 2021 nearly 26 percent of all deaths in India are caused due to Cardio vascular diseases. Even the analysis of medical certification of cause of death (MCCD)is reporting that there is a drastic increase in proportion of deaths due to Heart Diseases compared to last ten years.

The correct prediction of CVDs can prevent life threats, and incorrect prediction of CVDs can to be fatal at the same time. Continues elevation of heart rate can result in Tachycardia, endothelial dysfunction and arrythmia.

Many inventions were made to monitor heart diseases by using wearable smart watches. However, there were many drawbacks like inaccurate readings and wrong detection of CVDs. Therefore, in this project we are going to evaluate the existing devices and going to create an algorithm that gives the accurate heart rate like clinical standards which also senses the heart disease prior which will make us alert. This will help the user to go to hospital on time and get treated on time.

Smartwatch and health band wearable constomer electronics can passively calculate pulse rate from the wrist by using photoplethysmography (PPG). Identification of pulse irregularity or variability from these facts has the ability to pick out atrial fibrillation or atrial flutter (AF, collectively). The unexpectedly increasing client base of these gadgets permits for detection of undiagnosed AF at scale.

2. EXISTING TECHNIQUES

Heart rate monitoring gadgets and strategies had been innovated through many years. A range of present gadgets makes use of famous heartrate tracking tactics inclusive of Electrocardiogram (ECG) and Photoplethysmography (PPG) primarily based totally sensing strategies. The ECG strategy is normally used for chest strap sensors inclusive of QardioCore. This approach captures sino atrial node electrical impulse to measure heartrate. The PPG approach has been often utilized in currently commercialized smart watches, which are now geared up with heartrate sensors. This approach makes use of mixture of green, red, or infrared (IR) LED emitters and optical sensor to measure heartbeat.

When the emitters emit light to the skin, blood below the pores and skin absorbs the light and the optical sensor measures the modifications in light absorption. With a given coronary heart rate monitoring proficient hardware, users can examine day by day heartrate on smart phone or smart watch applications.

3. HEART DISEASE DETECTION ALGORITHM

The sensors present in the smart watches do gather coronary heartrate records which can be used to detect abnormal coronary heart rhythms through artificial intelligence. Even if this doesn't pinpoint a selected coronary heart-associated ailment this proactive method of notifying users might be able to prevent future issues if the user sees a physician and troubles are detected early.

If the heartbeat is irregular or abnormal the notification system will send an alert message to their family members and to the hospital so that they can save the users life in correct time. this will also feed all other health progress in hospital server so that the doctor can stay up to date with the progress of the user and their cvd's.

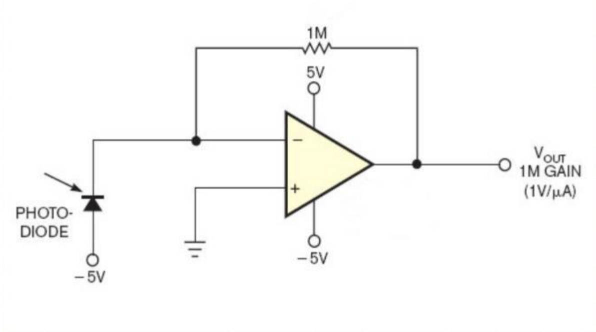
Several algorithms have been evaluated to put into effect the pathology type, including: k-Nearest Neighbour's (kNN), Decision Trees, Support Vector Machines (SVMs) and Artificial Neural Networks (ANNs). Experimental assessment allowed to finish that ANNs provide the best classification scores, while the use of Probabilitic Neural Networks (PNNs).

Hence, a PNN was once designed that is composed of a set ofthree layers: input layer, radial basis function (rbf) and competitive layer.

4. HARDWARE IMPLEMENTATION

We specifically select photodiode sensor as it generates current in the circuit when light incidents on it. When photodiodes come across light they allow some current to flow through it and the amount of current is directly proportional to the amount of the light detected by the Photodiode. Due to this property of Photodiode, it is fairly utilized in conditions where light needs to be detected.

We will develop a measurement logging application using this smart watch in which the health progress of the user is updated to their family and uploaded to the hospital server in daily basis.



Then we use reflective and optical sensors in smart watch to capture the heart rhythm and healthiness of the user's heart. With the assist of the fitness Kit library, we access the coronary heart rate sensor and gather heartbeats per minute (BPM) information. With this, we show the BPM data on the surface of the smart Watch. This software makes use of the green LED to detect heartbeats and stores information to the memory. As a part of our destiny work, we plan to additionally acquire BPM information on the smart watch and examine the logged BPM information from both watches to ground truth clinical devices. In order to offer correct heartrate tracking approach, we plan to layout our own filtering algorithm. The algorithm could be verified with real hospital, clinical-scale gadgets to enhance the quality of disease detection on wearable devices.

A smartwatch consists of a PPG-based embedded coronary heart rate monitor, which makes use of green LED lights paired with light sensitive photodiode sensors to measure the frequency of blood pumps from the heart. Given that red coloured blood will reflect red lights and take in green LED lights, the photodiode can make an estimation of the blood flowing via the veins using the modification in light absorption levels. The watch flashes green LED lights at rates greater than 100 Hz to measure the coronary heart beats per minute (bpm). For exact coronary heart rate measuring, most smartwatch providers propose customers to wear the watch in good fit so that the watch stays tight to the wrist.

5. ERRORS OF SMART WATCHES ON DETECTING HEART RATE

Using the software, our first aim was to understand wearing habits of smartwatches on the accuracy of coronary heart rate readings. We set as ground reality readings from (smartwatch-1) in a chest strap form-factor (i.e., less motion artifacts), with FDA-approved ECG-based coronary heart rate measurements, In total, we ask 4 volunteers (average age of 24; 1 female, 3 male) to naturally walk in a hallway and an open field under florescent and day-light conditions, respectively, while wearing (smartwatch-1). Each participant was asked to repeat the test twice for each of the three smartwatches. the trace of heart rate readings from each smartwatch along with the (smart watch-1) readings taken simultaneously for ∼10 minutes while wearing the watch either tight to the skin (top) or comfortably loose (bottom). We additionally plot interior accelerometer readings and PPG sensor light intensity readings provided by the(smart watch-2) (normalized on an 0:100 scale). Note that plots are from a single participant and other participants showed related trends. Results from the smart leaves us with a some of exciting observations. First, we will note that after that when client wears the watch tight, despite actively moving, the smartwatch coronary heart rate sensor readings are highly correlated with (smart watch-1). Quantitatively speaking, the common distinction (i.e., error) is solely 3.39 bpm.

Second, if the watch is loosely worn while mobile, the coronary heart rate accuracy diverges some distance from the Bio Harness (avg. disparity of 18.4 bpm; 8.73 bpm for (smart watch-3), 17.78 for LG Urbane, and 28.69 for (smart watch-2)). This may be proof that movement itself isn't the main factor behind poor measurements. Third, for both tight and loose experiments, the accelerometer readings are similar. Specifically, by means of evaluating the loosely worn and tightly worn cases, we see a suggest cross- correlation coefficient of ~0.77 for the three scan pairs. We be aware that given that the two test pairs for every watch was once carried out separately, we carried out lag changes for motion-time synchronization when computing the coefficient. Considering that the experiments are autonomous a coefficient of 0.77 may be taken into consideration high. In turn, this shows that studying the accelerometer facts might not be a reasonable indicator for classifying “imprecise” heart rate readings, given that correct and misguided instances aren’t distinguishable. Finally, and fortunately, observe that the PPG light intensity, provided by (smart watch-2), are considerably one of a kind for the tight and loose cases. While now no longer furnished in (smart watch-3), such observations display the capacity of using PPG light intensity as a feature for identifying exact measurements. Given this capacity, we present extra experimental results to show the impact of various factors which can have an effect on the light intensity and their effects on the coronary heart rate reading quality. Specifically, we 3D printed rings for the watches to vary the space between the PPG sensor and the skin: varying ring sizes would effect the absolute value of the PPG light intensity. We additionally designed these rings with and with out holes to have a look at the effect of outside lighting conditions among the skin and the sensor. Notice that when still, mistakes for all instances are much less than 10 bpm. Especially, for the 3 and 5 mm rings, the common distinction from the ground truth is <5bpm This comparatively small mistakes holds for 3 and 5 mm rings even when mobile, alike to the closely worn. Nevertheless, the three smartwatches show similar patterns in increased mistakes when mobile and using the 7 mm ring or the ring with holes. This suggests that while the fixed level of PPG light intensity, for (smart watch-2), gives some impact (71.55, 61.22, 52.31 for 3, 5 and 7mm rings respectively, when normalized to 0:100 scale), when stable (standard deviation of light intensity samples for the 3 rings when mobile are all within ± 2.54),coronary heart rate reading accuracy may be high. We notice that the ring height can effect the LED diodes optical focus. If so, this could be an explanation for the increased mistakes trends with thicker rings, regardless of having similar light intensity variance styles.

Nevertheless, this requires further investigation, while our outcome are valid enough to bring to a close that with minimal external light impact, the accuracy can remain within a reasonable error-bound.

6. design

The observations in our preface studies lead us to the winding up that by analyze the PPG sensor light intensity variance, we have the potential of designing a filter for classify the exactness of the smartwatch’s heart rate sensor readings. spontaneously, a threshold-based scheme for PPG light intensity variance may seem reasonable. However, we notice that the changes among two consecutive readings are too exact that the immovability of the decision-making may go through without the knowledge of long-term readings. The propose of our filter employs the Viterbi algorithm as a way to make out the most probable series of hidden states (e.g., in our case, sensing data quality). Explicitly, the Viterbi algorithm is used for discovery of the most likely succession of secreted states (i.e., Viterbi path) that results in a succession of practical events. We particularly chose this approach given that the PPG sensor light intensity readings can be consistently gather and used as observations.

We spot out once again that (smart watch-2) traces advices that when the smartwatch’s coronary heart rate readings diverge from the (smart watch-1), the light intensity values generally tend to expose higher variations. With this in mind, we define $\Delta l(T_1{:}T_1{+}W)$ as the set of differences among successive PPG light intensity readings throughout a given time window $[T_1{:}T_1{+}W]$, and $\max(|\Delta l(T_1{:}T_1{+}W)|)$ as the absolute maximum of this set. We first divide this maximum value with the number of possible observations NO in the HMM toextract the step size Sstep.

$$Sstep = \max(|\Delta l(T_1{:}T_1{+}W)|) / No$$

Specifically, we set NO by examining the light intensity variance traces. Based on the records we collected, we seen that a disparity of more than 6000 units for the light intensity caused significant variations in coronary heart rate measurements. The min-max range of the PPG sensor light intensity suggests that for our record set NO should be set to 11. We plan to design algorithms to adaptively configure such parameters with respect to the input data as part of our future work since the number of viable observations can have impact the granularity and responsiveness of the system. Notice that we keep two states in the HMM, one for declaring corrrect reading and the other for identifying inaccurate measurements. At each time instance in which we compute the coronary heart rate measurement accuracy, we compute an observation On (e.g., HMM input) as the following.

$$On = b\,|\Delta L(t{:}t+w)| / Sstep$$

Finally, given that the early state of HMMs is vital in making correct estimations, we educate our HMM the use of the Baum-Welch expectation maximization algorithm over multiple samples with different levels of light intensity. We observe that HMMs aren't the only filter design choice. Nevertheless, we go comparisons as future work.

7.conclusion

the smartwatch is automated in such an algorithm that it will alert the user before getting cardio attack. The smart watch will produce an output with 92% of accuracy and the photodiode sensor user here will sense the heart beat per minute and ensures the good functioning of heart. It will verify both these cases and produce the output as health progress of the user in daily basis. This smart watch is also equipped with Ip rating which can survive water splashes.

8.future work

In future we are going to concentrate on our sensor functioning to give a output of 100% accuracy using advanced generation photodiode sensor according to clinical standards. As blood pressure is also a cause that leads to miner cardio attacks we are going to improvise the system in such a way that it can detect the BP levels and indicate it us prior.