Pulse Measurement with Web Camera

Kentaro Kajioka^{a,*}, Lifeng Zhang^a

^aFaculty of Engineering, Kyushu Institute of Technology,
1-1 Sensui-cho, Tobata-ku, Kitakyushu, Fukuoka, 804-8550, JAPAN

* Corresponding Author: p108030k@mail.kyutech.jp

Abstract

Stroke was the leading cause of death until 1980 in Japan. Although the number of deaths has currently dropped to third place due to the evolution of treatment, the number of patients has not decreased. The causes of stroke can be classified into cerebral infarction and cerebral hemorrhage. Patients with cerebral hemorrhage are decreasing, but patients with cerebral infarction are increasing. This research focused on cerebral infarction due to the increasing tendency. There are two leading causes of cerebral infarction. The first cause is arteriosclerosis that occurs in the blood vessels of the brain itself. When arteriosclerosis progresses, a thrombus is formed on the part, and the blood flow is completely blocked. The second cause is atrial fibrillation, which is an arrhythmia. Small emboli in the heart block blood vessels in the brain. Therefore, we focused on arrhythmia such as atrial fibrillation that caused the stroke. In this study, we use a web camera to capture changes in the skin brightness of the face, output pulse waveforms and then calculate pulse rates. We compare the output results to determine which color to use and which part of the face to cut. Simulation results show that the proposed method can measure pulse correctly compared to home-use pulsometers.

keywords: Pulse rate, Web Camera, Welfare, Healthcare

1. Introduction

Pulse depends on the function of the heart, mainly. If we have an abnormality of pulse, we need to suspect heart disease. In other words, the pulse is one of the critical factors in finding heart disease. Just measuring the pulse is not enough to know the exact name of the disease, but there is no doubt that it leads to early detection of illness.

There are mainly two conventional methods of pulse measurement. The first method is to place our finger on the wrist artery and count the number of pulse per minute. The ad-

vantage of this method is that people can always measure the pulse only need to take time accurately without any extra special equipment is needed. However, there may be few people who purpose to measure the pulse without any uncomfortable feeling.

The second method is to measure pulse using medical equipment such as an electrocardiogram, which can measure the pulse more seriously and accurately than the former method. However, we have to go to the hospital, or else we cannot measure the pulse without such equipment. It seems cumbersome and inefficient. although a portable electrocardiogram is also on the market recently, but it is also considered to be expensive and not easy to reach.

So the main propose of this research is to create a product that can measure the pulse without attach anything to or touching the human body and can be accepted economically for each family, especially for the elders who live alone. The proposal is to measure the pulse by capturing the face image with a webcam and detecting the change of luminance in a local area part that can not be recognized with the naked eye. In this paper, we also plot the captured pulse in real-time and try to carry out the pulse rate from the pulse waveform.

2. Proposed System

This chapter describes the proposed system. Fig. 1 shows the flowchart of the proposed system, and the target area decision shows in the yellow part is determined empirically by experiment. In this paper, it first uses a web camera to detect faces with an existing cascade classifier, then cuts out a part of the face, and thirdly obtains an average pixel value from the decided local area of the face. Finally, a pulse waveform was plotted from the average pixel value of the sequential movie images after applied the noise reduction uses a low pass filter. Furthermore, detecting each locally peak value from the pulse waveform, the pulse rate is calculated. The system updates in real-time and keeps outputting the pulse

Fig. 1. Flowchart

Fig. 2. Blue pulse waveform

Fig. 4. Red pulse waveform

Fig. 3. Green pulse waveform

waveform and pulse rate.

3. Experiment

3.1 Experimental Method

The contents of the experiment in this study are shown as following.

(1) Determine the color of the pixel value

The Opencv can acquire three colors of blue, green, and red pixel values from an image. We identify the color that is most likely to capture changes in face brightness from these three colors. In order to decide the target area to cut in this experiment, the alternation altitude from the whole front face was checked. The size of the local surveillance area is set to 20×20 pixels.

(2) Decide where to cut out the face

After inspected the color alternation altitude, the candidate local area to cut out form the face could be found in (1). Candidacies for this experiment are found that the Forehead, cheek, and chin can measure the pulse smooth and obviously. The size of the frame to cut out is 20×20 . Face detection is not included to minimize noise caused by face detection and obtain appropriate results.

(3) Compare with a household pulsometer

In order to verify the pulse measurement result of the

Fig. 5. Pulse waveform of cheek

Fig. 6. Pulse waveform of chin

proposed method based on (1) and (2), a comparison of the measurement results with the values obtained with a household pulsometer is performed.

3.2 Experimental Result

Three experiments were performed as shown in 3.1. Each result is shown below.

(1) Determine the color of the pixel value

Figure 2, 3 and 4 show waveforms obtained from blue, green and red pixel values respectively. All waveforms contain noise, but it is clear that the waveform obtained from the green pixel value is closest to the pulse waveform. Therefore, we use green in this study.

(2) Decide where to cut out the face

Figure 3, 5 and 6 show the waveforms obtained from the forehead, cheek and chin respectively. All were able to obtain a waveform close to the pulse, but we use a forehead where the peaks are clearly visible in this study.

(3) Compare with a household pulsometer

Figure 7 is a diagram measured with face detection included. It can be seen that it contained much noise and

Fig. 7. Pulse waveform without taking average value

Fig. 8. Pulse waveform with taking average value

could not be measured accurately. This unexpected result is because the position of the acquired face moves each time when performing the face detection, and the target area image to be cut out is also unstable. We acquired 20 coordinates, widths, and heights, and determined the position of the face by the average value in order to solve this. Fig.8 is a diagram acquired by the corrected program. we could get a more beautiful waveform than Fig. 7.

Then We compare the results of the household pulsometer and this system. Table 1 measures the pulse rate 10 times and compares the results. We find that the third and ninth results have large errors.

4. Conclusions

In this paper, we proposed to capture the change of face brightness and acquire the pulse waveform and pulse rate using Web camera. It is able to capture changes in face

Table 1. Pulse measurement result

	Household pulsometer	Web camera	Error(%)
1st	59	64	8.5
2nd	65	66	1.5
3rd	62	72	16.1
4th	63	65	3.2
5th	58	62	6.9
6th	83	83	0.0
7th	62	62	0.0
7th	62	60	3.2
9th	68	57	16.2
10th	70	70	0.0

brightness using green component values of image pixels and remove noise by performing low-pass filtering and waveform smoothing. As a result, we succeeded in acquiring a waveform close to the pulse waveform. However, the results in this study do not boast perfect accuracy because they contain some errors due to the extra noise is difficult to be separated from the original signal. Furthermore, the characteristic of irregular since biological signals are important factors when analysis the errors. Thus there is likely to be room for improvement.

Nowadays, Juvenile cerebral infarction is attracting attention, and the patients are thought to increase in the future, and such kind of diseases has been proved can be predicted by Pulse Wave Velocity(PWV). In this paper, we turned out that it is possible to measure the pulse with the Web camera. Next, we are planning to develop the technology to extract and remove only the noise so that we can get more accurate pulse data to include the PWV. As a future task, we would like to create a product with higher accuracy, pulse diagnosis, and other new functions.

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