Surface Skin Blood Flow Dynamics During Muscle Contraction Using Filtered Camera

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Education

Naoki Yamamoto

- **Bachelor of Engineering** ~ 03/2023
  The University of Electro-Communications
  Management Science and Social Informatics Program
- **Master student** 04/2023~
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  Department of Informatics

Background

Muscle Active State

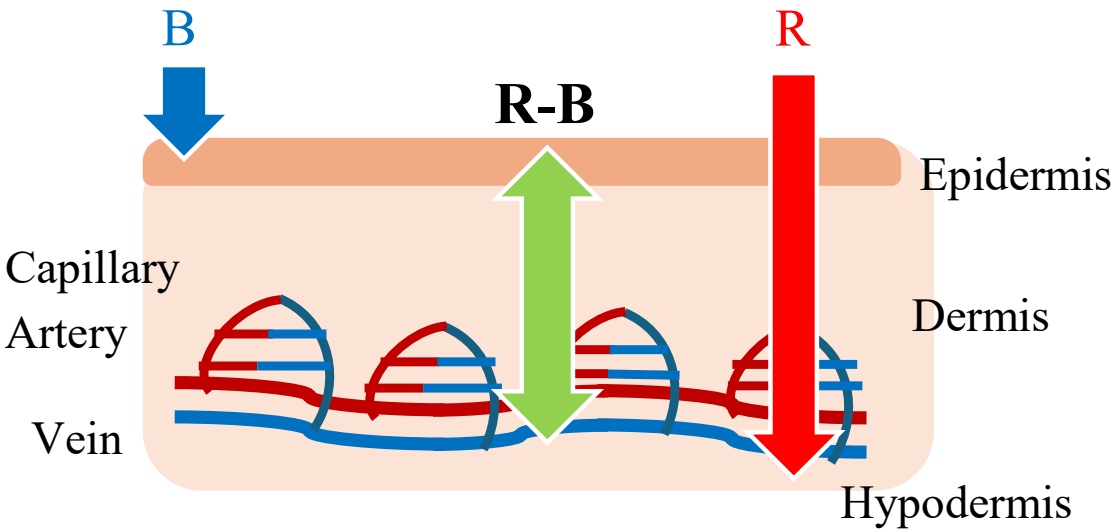
- Rehabilitation
- Development of Sports Science

Conventional

Electromyography	Thermography	Near Infrared Spectroscopy(NIRS)
Muscle contraction force	The amount of heat generated	Oxygenation kinetics
Problem	**Problem**	**Problem**
・Electrode attachment (contact) ・Noise influence is large.	・Expensive ・Non real time	・Expensive

Non-contact, Low-cost, Real-time, and General-purpose methods

Previous research



Real image ➡ R-B value：Subcutaneous blood flow changes

⬇ Time-series data analysis

Estimated changes in surface skin blood flow

Previous research[1]	Previous research[2]
Measurement area: **Nose**	Measurement area: **Biceps brachii muscle**
Assessment: **Autonomic Nerves Activity**	Assessment: **Muscle Activity**

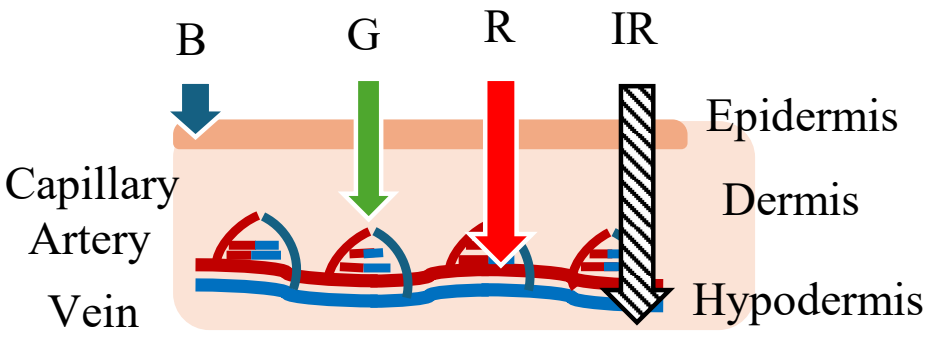
1.M. Shimizu, Y. Matsumoto, N. Itakura, K. Mito, T. Mizuno, “Evaluation of Methods for Estimating Autonomic Nervous Activity Using a Web Camera”, 27th International Symposium on Artificial Life and Robotics (AROB), 2022/1

2.N. Yamamoto, M.Shimizu, N. Itakura, K. Mito, T. Mizuno, “Surface Skin Blood Flow Dynamics During Muscle Contraction Using Real Images”, Graduation Thesis, The University of Electro-Communications, 2022/2

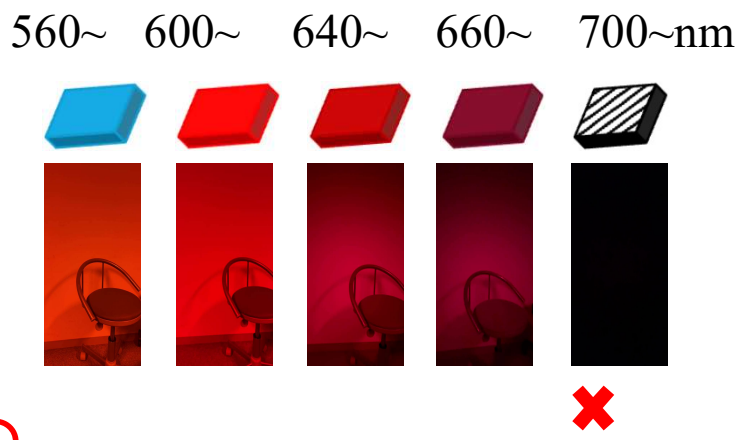
Problem Acquisition rate and wavelength boundaries of R, G, and B values are unknown due to automatic sensitivity adjustment of the camera

Purpose

Study of a measurement method that uses a filter to narrow the range of the R value and increase the acquisition rate of the near-IR value



Adopt filters that can be taken in indoor lighting



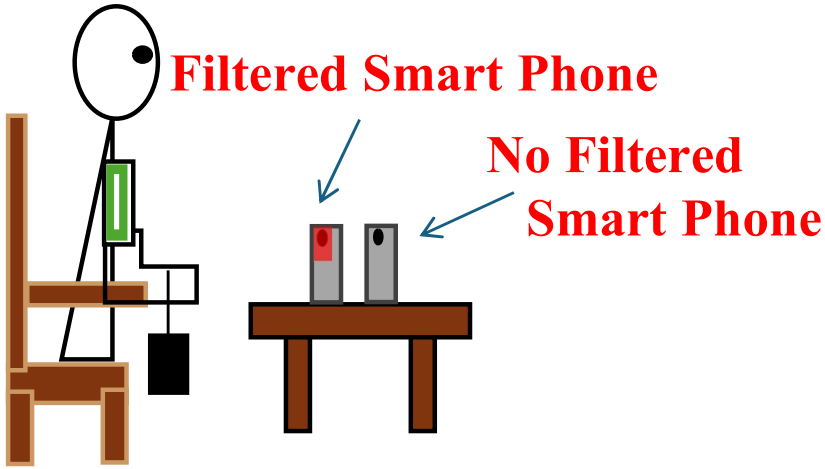
IR component= transmittance **high**

→ **Possibility of high precision measurement** ○

R value of conventional method

Cut off R value of this method

Isometric contraction Experiment



Pass filter(4types)

560~ 600~ 640~ 660~

Terms

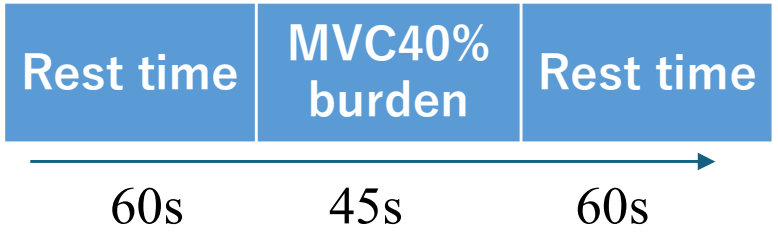
- Number of subjects: 6(20's male)
- Under fluorescent light with stable light intensity
- **Simultaneous shooting with two smartphones**

(Full HD, 30fps)

- Weight load → Maximum exerted muscle strength(MVC)40%

Procedure

Measure MVC 3 times for 10 sec.
Averaged at 2, 5, and 8 seconds

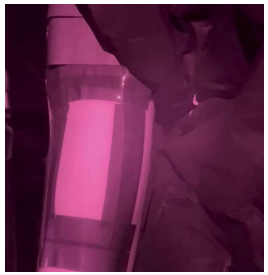


Four times in total with different filters

Measurement area Biceps brachii muscle

Assessment Muscle Activity

Analysis Method



Filtered

No Filtered

Within the green frame(Black area)

Average of component value

Result (B value)

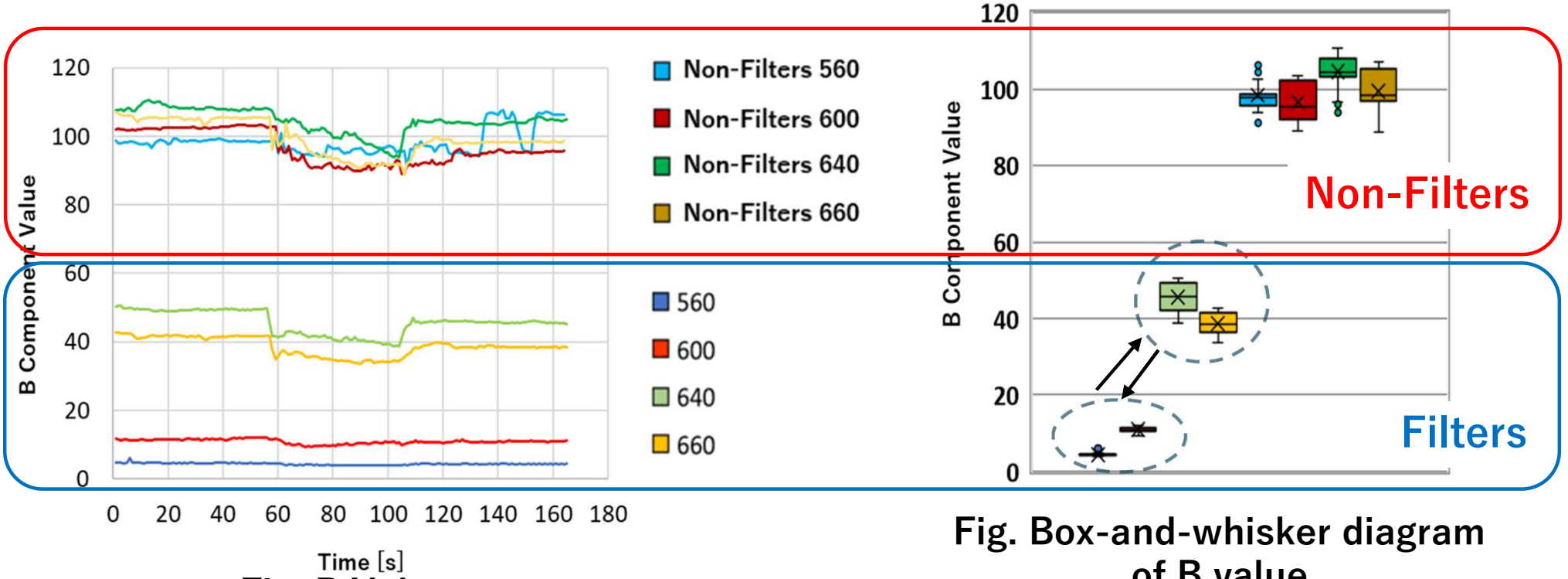


Fig. B Value

Fig. Box-and-whisker diagram of B value

Non-Filters B value : ~epidermis (Hypodermis✕)

During Muscle load ➡Decrease

➡**Light is penetrating into the interior of the skin**

Filters Filter's cut off frequency ↑ ➡ Amount of light transmitting↓

Expectation
560, 600 > 640, 660

Result
560, 600 < 640, 660

➡**Caused by camera's sensitivity adjustment function**

Result (R value)

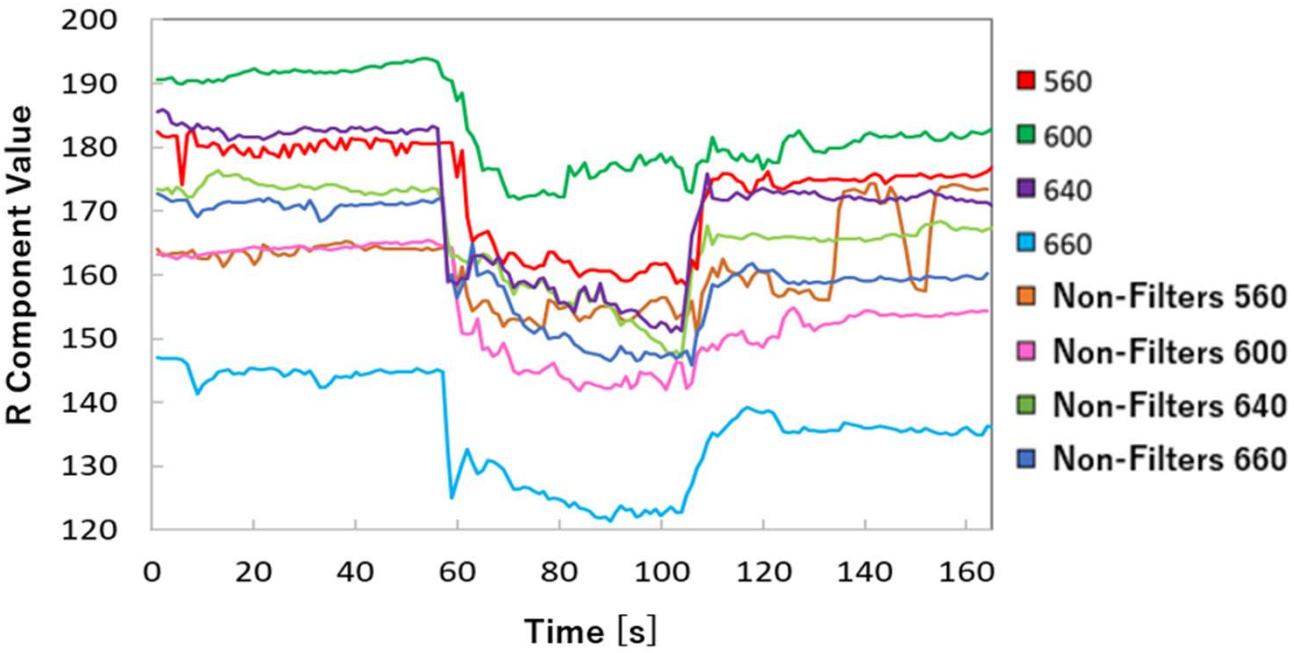


Fig. R Value

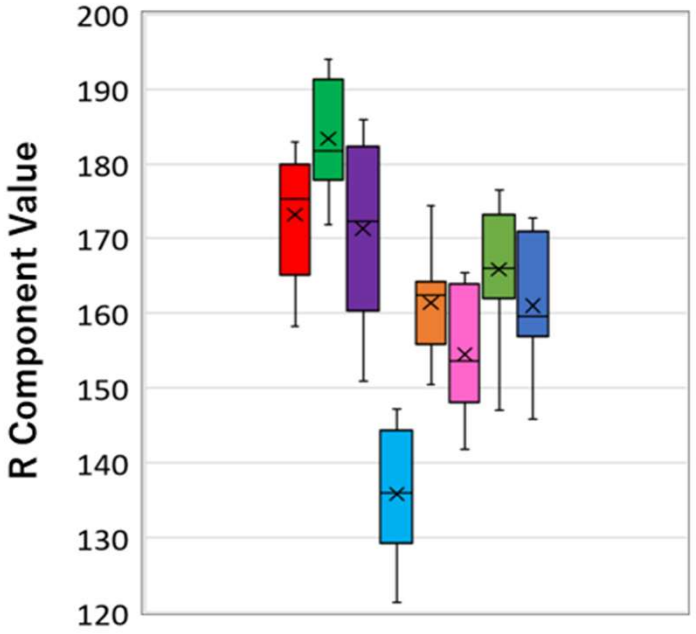


Fig. Box-and-whisker diagram of R value

Similarly to B value…

Filters → Amount of light transmitting↓

Filters > Non-Filters

➡Caused by camera's sensitivity adjustment function

Prevent

Measurement in areas with stable light levels

Summary

Purpose

Investigation of the usefulness of a method for estimating surface skin blood flow dynamics using wavelength component values in the vicinity of near-infrared light wavelengths.

Result

Filtered：B component: Large number of filter cutoffs

➡ B component ≒ IR component

R component: Increased filter blocking rate

➡ Decreased capillary blood flow that can be obtained

Increased deep blood flow

➡ Application to limited uses such as medical care

Problem

- Use of filters under lighting with more stable light levels
  ➡ How light intensity affects measurement accuracy
- Develop a program that does not adjust sensitivity
- Explore filters that maximize the range of blood flow that can be obtained