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# A Novel Wearable type Optical Biometric Devices using Multi-wavelength LED-Photodiodes Array

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**Abstract**

**This paper investigates the possibility of MSP(Multi-spectral Skin Photometrics) as a novel biometric technology to facilitate automatic identification of individuals. MSP using transmission and diffuse reflection difference with variable wavelength provides information about both the surface and subsurface characteristics of the human skin tissue. It is found in this paper that 8 people have their unique characteristics each other under the same wavelength. The experimental results show that the best personal identification accuracy has been acquired with Yellow LED. This novel biometric device exhibited excellent FAR(False Acceptance Rate) of 0.02 and FRR(False Rejection Rate) of 0.0 which is similar value of commercialized biometric devices such as fingerprint, iris scan. From these experimental results, we can see that individuals have his own skin tissue photocurrent pattern and these characteristics could be used as a novel high accuracy personal identification device.**

## 1. Introduction

Biometrics refers to metrics related to human characteristics. Biometrics authentication is used in computer science as a form of identification and access control [1]. It is also used to identify individuals in groups that are under surveillance. Biometric identifiers are the distinctive, measurable characteristics used to label and describe individuals [2]. Biometric identifiers are often categorized as physiological versus behavioral characteristics [3]. Physiological characteristics are related to the shape of the body. Examples include, but are not limited to fingerprint, palm veins, face recognition, DNA, palm print, hand geometry, iris recognition, retina and odour/scent. Behavioral characteristics are related to the pattern of behavior of a person, including but not limited to typing rhythm, gait, and voice [4].

Conventional biometric technology, such as fingerprint, veins etc. could be replicated by identity theft. So, it is necessary to develop personal identification technology based on biomedical signals to avoid identity theft. In this paper, we introduce novel skin tissue optics based MSP(Multispectral Skin Photometrics) biometric technology and show feasibility as an new personal identification devices.

## 2. MSP Module Design

Dermis have several layers, stratum corneum, epidermis, dermis, subcutaneous layer, etc. Diffuse reflected light shows the effects of thickness of skin layers, morphology of skin interfaces, scattering properties due to collagen mix, density, orientation, capillary density, etc. and each of these vary by individual. Figure 1 shows light penetration depth into skin with different wavelength. Red light could penetrate deeply than blue light. The simplified functional block diagram of proposed MSP module is shown in Figure 2. Proposed MSP module consists of LED array, photodiode array, low pass filter, photocurrent amplifier circuits, MCU and PC interface control circuits..

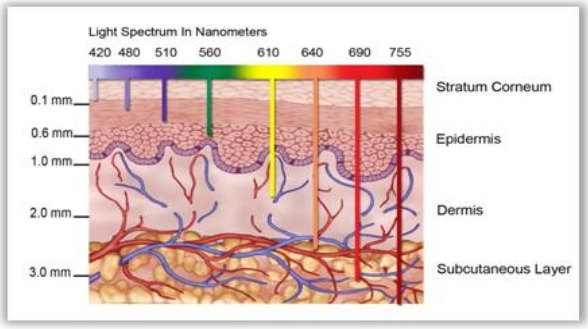


Fig. 1 Light penetration depth into skin tissue with different wavelength

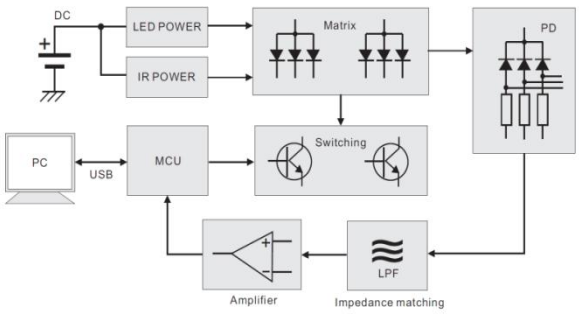


Fig. 2 Functional block diagram of proposed MSP module

## 3. Experimental Results

The implemented prototype MSP module was shown in Figure 3. MSP sensor consists of LED matrix and 7 photodiode array. MSP sensor is attached in human wrist and the photocurrent are measured by each photodiode. In this experiment, we only use 2 IR1 LED as a input light source. . Figure 4 shows the output signals of 7 channel photodiode of MSP module with 2 IR1 LED, which shows comparison test results of individual photocurrent value of 8 people at different photodiode channel. Next, we made some more experiments with R, G, B, Y and IR1 LEDs as light source. From these experimental results, we can see that individuals have his own skin tissue photocurrent pattern and these characteristics could be used as a novel personal identification device.

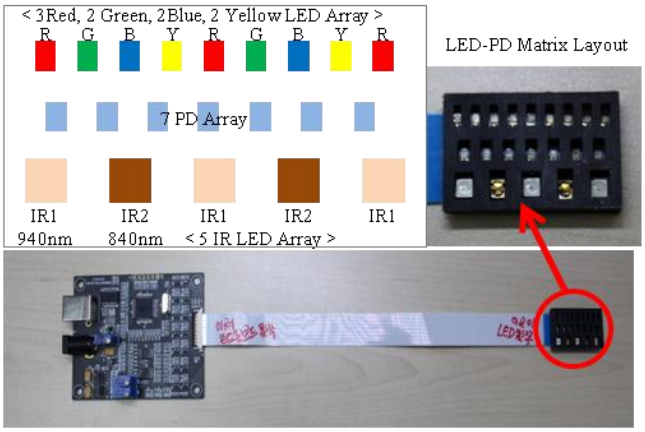


Fig. 3 Implemented prototype of the proposed MSP module and LED-PD matrix layout

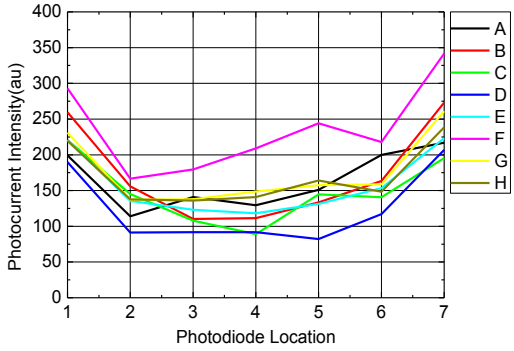


Fig. 4 Comparison of individual photocurrent value of 8 people at different photodiode channel under 2 IR1 LED(left IR1 LED, right IR1 LED) light on. This plot shows 8 people have different skin tissue photocurrent pattern

In general, Positive = identified and negative = rejected. Therefore:

True positive(TP) = correctly identified
False positive(FP) = incorrectly identified
True negative(TN) = correctly rejected
False negative(FN) = incorrectly rejected
Accuracy = (TP+TN)/(TP+FP+FN+TN)
Specificity = TN/(TN+FP)

Table I shows personal identification test results of 8 different people with the proposed MSP module in this work. The best personal identification accuracy has been acquired with Yellow LED. This novel biometric device exhibited excellent FAR(False Acceptance Rate) of 0.02 and FRR(False Rejection Rate) of 0.0 which is similar value of commercialized biometric devices such as fingerprint, iris scan .

Table I Identification Performance

| **LED** | Accuracy | Specificity | FAR | FRR |
|---|---|---|---|---|
| **IR** | 0.945 | 0.941 | 0.059 | 0.029 |
| **Red** | 0.938 | 0.939 | 0.061 | 0.071 |
| **Green** | 0.882 | 0.900 | 0.100 | 0.243 |
| **Blue** | 0.742 | 0.758 | 0.242 | 0.364 |
| **Yellow** | 0.982 | 0.980 | 0.020 | 0.000 |

## 3. Conclusions

The implemented biometric MSP module consists of LED matrix and 7 photodiode array. MSP sensor is attached in human wrist and the photocurrent is measured by each photodiode. In this experiment, we use 5 IR LEDs and Red, Green, Blue, Yellow LEDs as input light source. PC viewer software program is developed and which also serve as user interface control software. We also developed MATLAB based identification algorithm.

The experimental results show that the best personal identification accuracy has been acquired with Yellow LED. This novel biometric device exhibited excellent FAR(False Acceptance Rate) of 0.02 and FRR(False Rejection Rate) of 0.0 which is similar value of commercialized biometric devices such as fingerprint, iris scan. From these experimental results, we can see that individuals have his own skin tissue photocurrent pattern and this characteristics could be used as a novel high accuracy personal identification device.

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