Author's Accepted Manuscript

www.elsevier.com/locate/talanta

Application of a Webcam Camera as a Cost-effective Sensor with Image Processing for Dual Electrochemical - Colorimetric Detection System

Kajorngai Thajee, Pathinan Paengnakorn, Wasin Wongwilaia, Kate Grudpan

PII: S0039-9140(18)30295-9
DOI: https://doi.org/10.1016/j.talanta.2018.03.055
Reference: TAL18489

To appear in: *Talanta*

Received date: 3 February 2018
Revised date: 15 March 2018
Accepted date: 17 March 2018

Cite this article as: Kajorngai Thajee, Pathinan Paengnakorn, Wasin Wongwilaia and Kate Grudpan, Application of a Webcam Camera as a Cost-effective Sensor with Image Processing for Dual Electrochemical - Colorimetric Detection System, *Talanta,* https://doi.org/10.1016/j.talanta.2018.03.055

Application of a Webcam Camera as a Cost-effective Sensor with Image Processing for Dual Electrochemical - Colorimetric Detection System

Kajorngai Thajee[a,b,d], Pathinan Paengnakorn[a], Wasin Wongwilaia[a,c], Kate Grudpan[a,b,c]

[a] *Center of Excellence for Innovation in Analytical Science and Technology, Chiang Mai University, Chiang Mai, 50200, Thailand*

[b] *Department of Chemistry, Faculty of Science, Chiang Mai University, Chiang Mai, 50200, Thailand*

[c] *Science and Technology Research Institute, Chiang Mai University, Chiang Mai, 50200, Thailand*

[d] *The Graduate School, Chiang Mai University, Chiang Mai, Thailand, 50200, Thailand*

Abstract

A webcam camera as an alternative cost-effective colorimetric sensor for the simple dual electrochemical – colorimetric detection system is proposed. Performance test of the system was investigated through electrochemical and colorimetric behaviors of redox reactions of potassium ferrocyanide complex. Image processing with two color systems, RGB and HSV, was applied together with various electrochemical techniques. Color responses obtained from the webcam correlated with electrochemical signals in various electrochemical techniques. The results from the proposed dual detection system agreed well with those obtained using conventional UV-Vis spectroelectrochemical system reported previously. The application of proposed system was demonstrated for studying the redox reaction of catechin and electrochemical and colorimetric behaviors of Fe(II) and Fe(III) mixture.

Keywords: dual electrochemical-colorimetric detection, webcam, RGB, HSV, Fe(II) and Fe(III) mixture, catechin

Introduction

Digital cameras are normally based on either charge coupled device (CCD) or complementary metal oxide semiconductor (CMOS) sensor technology. Both technologies are used for capturing images digitally with some similarities and differences in the signal processing, performances and prices [1]. The advantages of a webcam camera are that it is inexpensive and compact compared to other digital cameras. Therefore, it has been proposed to serve as a cost-effective alternative for a detection system. [2]. It could be cooperated with various analytical systems such as titration[3–5], chromatography[6], flow analysis[7–9], microfluid-based analytical devices[10–12]. fluorescence[13,14], near-IR [15] and flame photometry[16].

Electrochemical technique coupled with colorimetric measurement could provide useful insight for a study of chemical and biochemical redox reactions including quantitative analysis[17,18]. It usually employs a conventional UV-Vis spectrophotometer to monitor a change in color under electrochemical control[19]. Recently, a fiber-optic based spectrophotometer has been adopted as a detector in spectroelectrochemical systems[20–24]. This offers a relatively compact device, however came at relatively high price. Thus, the availability of such device is limited especially in remote places.

In this study, a webcam camera is proposed to serve as alternative colorimetric sensor together with a screen-printed electrode (SPE) for a dual electrochemical - colorimetric detection system. Together with electrochemical detection, a colorimetric change occurred on SPE electrode surface was simultaneously monitored using a webcam camera with an image-processing software for colorimetric data.

A webcam camera employs imaging sensor to capture light and convert it into electrical signal which then would be processed into an image containing digitalized color data. In this study, two color systems were explored. One is RGB system which combine primary light, red (R), green (G) and blue (B) together. This is based on a physiological color perception in human eyes and has a value from 0 to