# Kinect V2를 이용한 모바일 장치 실시간 알림 모니터링 시스템

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# Real-time monitoring system with Kinect v2 using notifications on mobile devices

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## 요 약

실시간 원격 감지 시스템은 많은 감시 상황에서 중요한 가치를 지니고 있다. 실시간 원격 감지 시스템은 누군가가 그의 장소에서 무슨 일이 일어나고 있는지를 알 수 있게 한다. Kinect의 V2는 컴퓨터에게 눈의 역할을 제공하며 컬러와 깊이 이미지, 오디오 입력과 골격 데이터 등 다양한 데이터를 생성 할 수 있는 새로운 유형의 카메라이다.

본 논문에서는 깊이 이미지와 함께 Kinect V2의 센서를 사용하여, Kinect에 의해 덮인 공간에서의 모니터링 시스템을 제공한다. 따라서 Kinect 카메라에 의해 덮인 공간에 기초하여, 최소 및 최대 거리를 설정함으로써, 깊이의 범위를 이용하여 감시하는 대상 지역을 정의한다. 대상 공간에서 추적 개체가 있는 경우, 컴퓨터 비전 라이브러리(Emgu CV)에서 Kinect 카메라는 이미지 전체의 색상을 캡처하고, 이를 데이터베이스로 전송함으로써 인터넷이 있으면 어디서나 사용자가 자신의 모바일 장치를 통해 접속할 수 있다.

## ABSTRACT

Real-time remote monitoring system has an important value in many surveillance situations. It allows someone to be informed of what is happening in his monitoring locations. Kinect v2 is a new kind of camera which gives computers eyes and can generate different data such as color and depth images, audio input and skeletal data. In this paper, using Kinect v2 sensor with its depth image, we present a monitoring system in a space covered by Kinect. Therefore, based on space covered by Kinect camera, we define a target area to monitor using depth range by setting minimum and maximum distances. With computer vision library (Emgu CV), if there is an object tracked in the target space, kinect camera captures the whole image color and sends it in database and user gets at the same time a notification on his mobile device wherever he is with internet access.

## 키워드

Kinect V2, Monitoring System, Depth Image, Emgu CV

## Ⅰ. Introduction

Nowadays, Surveillance system is operated remotely through advanced technology by means of diverse electronic devices like CCTV [1] (Closed-circuit Television) and icam [2] depending on the goals. In some public places, surveillance cameras are installed throughout the city for the prevention of crime as well as for the investigation and proofs of crime for example. Surveillance cameras are usually linked to a centralized database and monitoring station which will save desired information for further use when necessary. Recently, another type of camera, Kinect for windows has been released by Microsoft. Kinect sensor used for interfacing with Xbox one, but can also be connected to and run on a windows computer. So far, there are two versions of Kinect. The kinect for windows v2 sensor improves on the first version

of the device, providing the designated technical specefications but also improved an expended field of view and higher depth fidelity. As the Accuracy of Kinect v1 limits its use for some engineering measurement tasks, Kinect v2 gives better results considering its new technology [3]. The aim of this paper is to present a real time remote monitoring system in certain area covered by kinect's camera field of view. If there is something happened in monitored area, the user is notified on his mobile device(smartphone,tablet…) and a RGB image captured by kinect camera is sent in a remote server database and user can view it on his smartphone or others mobile device wherever with internet access.

## II. Kinect Architecture

Kinect sensor is a popular sensing input device as a natural user interface application for computers and game console(Xbox one). Kinect v2 sensor is used in many different fields of technology as it can sense depth, capture color images, emit infrared, and input audio[4].

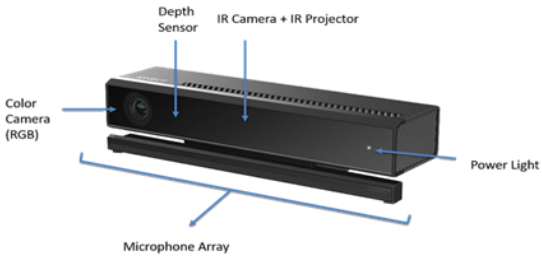


Figure 1. Kinect component

Color camera is responsible for capturing and streaming the color video in order to detect the red, blue and green colors from Kinect with a resolution of 1920x1080 pixels whereas depth sensor generates the depth information of the object in front of the Kinect with a of 512x424 pixels resolution [5]. IR camera and IR work together to produce depth information of objects in front of depth sensor [5]. Another feature to be mentioned is the field of view for depth sensing of 70 degrees horizontally and 60 degrees vertically. The technical specifications provided by Microsoft announce an operative measurement range from 0, 5 m to 4, 5 m. To allow the use of Kinect sensor, the official Microsoft SDK 2.0 (Software Development Kit) is provided for free downloadable. Kinect for windows v2 sensor becomes a very poweful sensor for use in computer vision and human computer interaction technologies. In this paper, kinect is used in surveillance system based on depth sensor and computer vision.

## III.Monitoring system and results

Remote Monitoring refers to accessing and monitoring a device from a distant location to avoid unlawful activities in monitored area let the user to react in the best way.

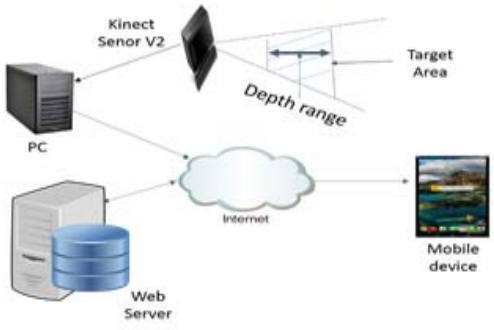


Figure 2. System Design

Based on the raw depth image from Kinect sensor, user can set a target area with a minimum and maximum depth. Therefore, we slice the depth image according to depth range chosen and computer vision system to perform object tracking (as shows figure 2). By simply ignoring data that is out of defined depth range, we get a nice high-contrast image (grayscale image) with white color of tracked object. If an object is identified within the depth range, the sensor takes the whole color image and sends in database based cloud. The user get in real time a notification (figure 5) on his mobile device and can display the image in order to get an idea of what is happened.

Figure 3. Tracked object

Both depth image and color image are displayed on Windows Presentation Foundation (WPF) on controller PC as shows figure 4.

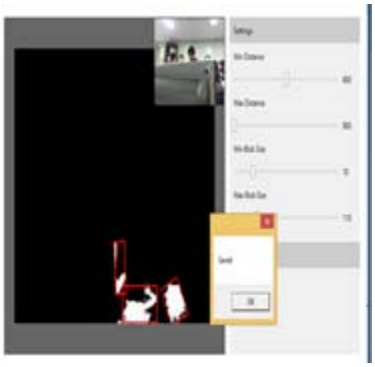

Figure 4. Output on WPF


Figure 5. Notification on Smartphone

Figure 6. Image displayed on smartphone (same as on WPF)

## Ⅳ. Conclusion

We used Kinect V2 to develop a real time monitoring system in a delimited area in its field of view. It gives us a depth image which allows to slice the image into two parts, the target area determined by a set of with minimum depth and maximum depth and the rest part in field of view. Using a computer vision library (EMGU CV), we identified a presence of an object in that area and the whole color image is sent in database server. Finally, the user is notified and can display the image on his mobile device. Detection object technology is used in many domains, here we focused on surveillance system to remotely monitor a preserved area which may include some valuable things to protect.

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