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키넥트와 모바일 장치 알림 기반 온라인 모니터링 시스템

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Online Monitoring System based notifications on Mobile devices with Kinect V2

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요 약

키넥트 센서 버전 2는 컴퓨터 비전과 엑스 박스와 같은 엔유아이 인터페이스로 마이크로소프트에서 출시한 카메라의 일종이다. 이는 높은 프레임 속도로 컬러 영상과 깊이 영상, 오디오 입력 및 스켈레톤 데이터를 취득 할 수 있다. 이러한 다양한 타입의 데이터 정보를 제공해 주기 때문에 이것은 다른 범위의 연구자들을 위한 리소스가 된다. 본 논문에서는 깊이 이미지를 사용하여 우리는 키넥트 범위내에서 특정 영역을 감시하는 시스템을 제시한다. 타켓 영역은 깊이의 최소, 최대 값의 크기에 따라서 그 공간을 모니터링 할 수 있다. 컴퓨터 비전 라이브러리 (Emgu CV)를 사용해서 만약 어떤 오브젝트가 타겟 영역에서 검출된다면 그것을 추적하고 키넥트 카메라는 RGB 이미지를 데이터베이스 서버에 전송한다. 따라서 안드로이드 플랫폼 기반 모바일 애플리케이션을 통해 키넥트 타켓 지역에서 수상한 움직임이 감지되었음을 사용자에게 통지하고 그 장면의 RGB 영상을 표시하기 위해 개발되었다. 사용자는 모니터링 영역 또는 제한 구역과 관련된 다른 경우에서 가치 있는 물건의 대해 최선의 방법으로 반응하고 실시간 통지를 얻는다.

ABSTRACT

Kinect sensor version 2 is a kind of camera released by Microsoft as a computer vision and a natural user interface for game consoles like Xbox one. It allows acquiring color images, depth images, audio input and skeletal data with a high frame rate. In this paper, using depth image, we present a surveillance system of a certain area within Kinect's field of view. With computer vision library(Emgu CV), if an object is detected in the target area, it is tracked and kinect camera takes RGB image to send it in database server. Therefore, a mobile application on android platform was developed in order to notify the user that Kinect has sensed strange motion in the target region and display the RGB image of the scene. User gets the notification in real-time to react in the best way in the case of valuable things in monitored area or other cases related to a reserved zone.

키워드 : 깊이 영상, Emgu CV, 키넥트 V2, 모니터링 시스템

Key word : Depth Image, Emgu CV, Kinect V2, Monitoring System

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Ⅰ. INTRODUCTION

Real-time remote monitoring system has an important role in many surveillance situations. It allows someone to be informed of what is happening in his region of interest such an area within valuable things. 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 console by using gesture and voice, but can also be connected to and run on a windows computer. So far, there are two versions of Kinect. Kinect v1 was launched with XBox 360 console whereas kinect v2 was launched later with an other kind of console XBox ONE. Kinect v1 (fig.1) and kinect v2 (fig.2) have different shapes.

Fig. 1 kinect version 1

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 database server and user can view it on his smartphone or others mobile device wherever with internet access.

Table. 1 Comparison between kinect1.0 and kinect 2.0 for main characteristics

Characteristics	Kinect V1	kinect v2
RGB camera(pixel)	1280x1024	1920x1080
Depth camera(pixel)	640x480	512x424
Max depth distance (m)	4.0	4.5
Min depth distance(m)	0.8	0.5
Horizontal FOV(degrees)	57	70
Vertical FOV(dgrees)	43	60
Tilt motor	yes	No
Skeloton joint define	20	26
Full skeloton tracking	2	6
USB on PC	2.0	3.0

The kinect for windows v2 sensor improves on the first version of the device, providing the designated technical specefications (as shows table 1) 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]. As the first version was using a structured light approach in its sensing principle, the next generation kinect v2 is using Time-of-Flight(TOF) principle [4].

Ⅱ. Kinect v2 Architecture

Kinect sensor version 2 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[5].

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 [6]. Infrared emitter (IR camera and IR projector) allows the sensor to be light-independent viewed. The new depth sensor for kinect v2 has a higher depth, fidelity and a significantly improved noise floor, and by providing 3D visualisation, we are able to see smaller objects and all objects more clear [7].

Fig. 2 kinect v2 components

Depth sensor and Infrared emitter work together to produce depth information of objects in front of kinect sensor. The power light indicates if kinect sensor is on or not. 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 with new facilities, drivers, tools, APIs, device interface, and many sample code in C#, C++, and Java to help the application developers. we used C# and WPF (Windows Presentation Foundation) as user interface for test. Kinect for windows v2 sensor becomes a very poweful sensor for use in computer vision and human computer interaction technologies. Nowadays, kinect sensor has great popularity in the scientific community where researchers are developing a huge amount of innovative applications that are related to different domains or fields such medical applications and heath care, augmented reality, etc.

In this paper, kinect is used in surveillance system based on depth sensor and computer vision.

Ⅲ. System Design 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.

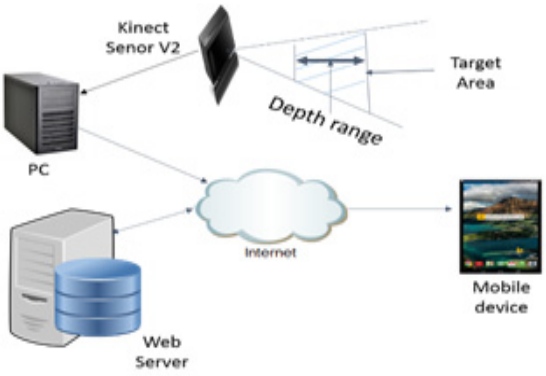

Fig. 3 System Design

In this system, kinect camera is set towards the target area and connected with a PC controller(as shows fig.3). Image taken by Kinect Camera is sent from PC controller to a database server using internet connectivity and the user can get a notification on his mobile device in the real time to view the image.

3.1. Object Detection

Depth and color images are streamed at the same time from kinect sensor. Based on the raw depth image from Kinect sensor, user can set a target area with a minimum and maximum depths. Therefore, we slice the depth image according to depth range chosen and use computer vision system(Emgu CV) to perform object tracking (as shows fig.4) by finding contours and trigger other functions. Emgu CV is a cross platform .net wrapper to open Cv image processing library [8] and

allows open cv functions to be called from .Net comptatible languages such as C# VB etc . Object tracking requires to have a clean grayscale image in order to form a high contrast between the object and the background. 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, Kinect sensor takes the whole color image and sends it to a database server.

Fig. 4 Tracked object

Here, only the presence of object is detected in target area in order to trigger the function of sending RGB image into a database and launch a web server to notify the user. With object tracking, we may also have get the size or the shape of the object for further applications. Object tracking system may be applied differently depending on the purpose.

Both depth image and color image are displayed on Windows Presentation Foundation (WPF) on PC controller as shows fig.5.

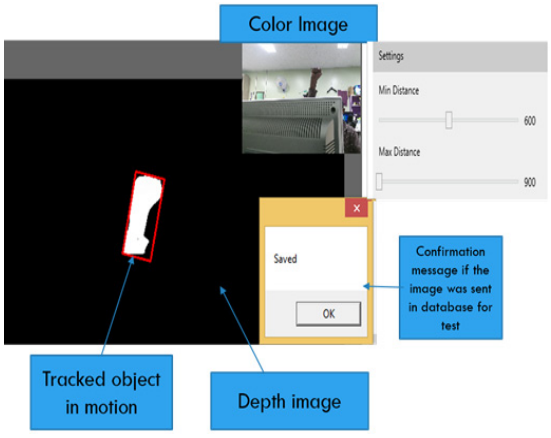

Fig. 5 Outputs on WPF

3.2. Notification System

Google cloud Messaging(GCM) is a free service that enables developers to send notifications between servers and client applications on mobile devices [9].

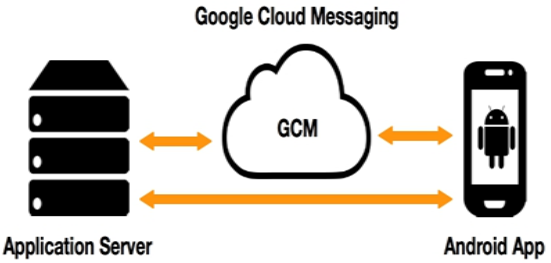

Fig. 6 Google Cloud Messaging system.

Authorizing communication from an application server to GCM requires an API key from Google Cloud server(fig.6). Once client application is installed on mobile device, it gets a registration ID from GCM in order to get notification.

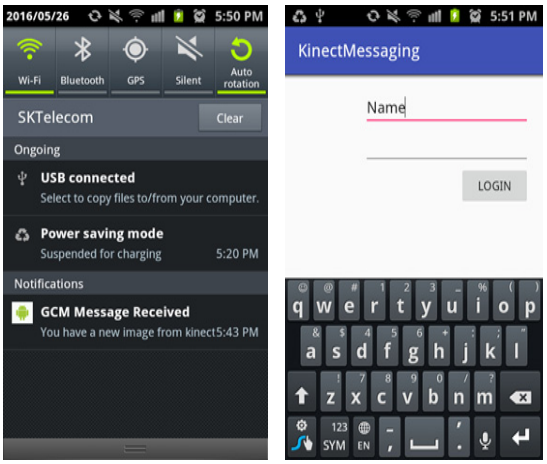

Fig. 7 Notification on Smartphone and Login Screen after a simple click

At same time, the user gets a notification(fig.7) if there is a detected object in the region of interest and the user can display the RGB image on his Smartphone (fig.8).

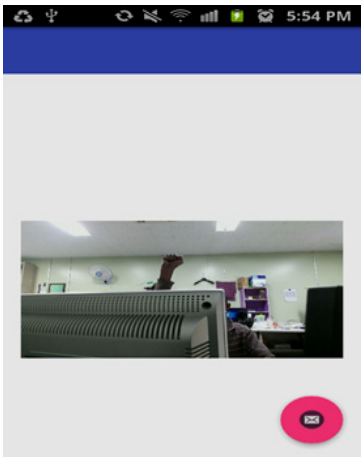

Fig. 8 Image Display on Smartphone(same image on WPF)

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 and maximum depths 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 into a 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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