키넥트 깊이 측정 센서의 가시 범위 내 감지된 사물의 거리 측정 시스템과 그 응용분야

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Distance measurement System from detected objects within Kinect depth sensor's field of view and its applications

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요약

마이크로소프트에서 게임용 자연스러운 사용자 인터페이스를 위해 개발된 깊이 카메라인 키넥트 깊이 측정 센서는 컴퓨터 비전 분야에 있어 매우 유용한 도구이다. 키넥트의 깊이 측정 센서와 그 높은 프레임률로 인해, 본 논문에서는 키넥트 카메라를 사용해 거리 측정 시스템을 개발하였으며, 이를 이동 시 인간과 같이 사물을 감지하는데 주변 환경을 인지하기 위해 시각 시스템이 필요한 무인 차량에 시험하였다. 즉, 키넥트 깊이 측정 센서를 이용해 가시 범위 내 사물을 감지하고 사물에서 시각 센서의 거리 측정 시스템을 개선한다. 감지된 사물을 정밀하게 확인하여 실제 사물인지, 또는 픽셀 노즈(nose)인지 판단해 실제 사물이 아닌 픽셀을 무시함으로써 처리 시간을 줄인다. 이미지 처리를 위한 오픈 CV 라이브러리와 함께 깊이 분할 기법을 활용하여, 키넥트 카메라의 가시 범위 내 사물을 확인할 수 있으며, 해당 사물과 센서 사이의 거리를 측정할 수 있다. 시험 결과에 따르면 본 시스템은 저가 범위 센서인 키넥트 카메라가 장착된 자율주행차에 사용하여 감지된 사물로부터 측정 거리에 이르면 어플리케이션 방식에 따라 프로세스를 처리할 수 있는 것으로 나타났다.

키워드

키넥트 깊이 측정 센서, 사물 감지, 키넥트를 통한 거리 측정, 깊이 분할

ABSTRACT

Kinect depth sensor, a depth camera developed by Microsoft as a natural user interface for game appeared as a very useful tool in computer vision field. In this paper, due to kinect' s depth sensor and its high frame rate, we developed a distance measurement system using Kinect camera to test it for unmanned vehicles which need vision systems to perceive the surrounding environment like human do in order to detect objects in their path. Therefore, kinect depth sensor is used to detect objects in its field of view and enhance the distance measurement system from objects to the vision sensor. Detected object is identified in accuracy way to determine if it is a real object or a pixel nose to reduce the processing time by ignoring pixels which are not a part of a real object. Using depth segmentation techniques along with Open CV library for image processing , we can identify present objects within Kinect camera' s field of view and measure the distance from them to the sensor. Tests show promising results that this system can be used as well for autonomous vehicles equipped with low-cost range sensor, Kinect camera, for further processing depending on the application type when they reach a certain distance far from detected objects.

Key words

Kinect depth sensor, Object detection, Distance measurement with kinect, Depth segmentation

Ⅰ. Introduction

Kinect camera was made by Microsoft corporation to interact with game consoles at the beginning of 2010. The major idea behind was to develop an interface device to interact with consoles in order to avoid hand-controller devices during games to transform player's movements and voices into controls. Kinect camera was released with important capabilities to sense depth, capture color images, emit infraded and input audio [1].The fisrt version was released with Xbox 360 console. The second version was released in 2014 along with Xbox One console and more performances compared to the first one. Even though Kinect was originally developed for tracking human body movements, gestures and spoken commands, it was an attractive tool by its depth sensing for many researchers in computer vision. it is in this perspective to be interested by this kind of depth camera for unmanned vehicles which need to understand its surrounding environment. Therefore, computer vision's today trend is to create autonomous vehicles and machines which are able to understand its physical surroundings via imaging sensors by imitating biological vision system like human natural eyes. Some other technologies have been used for computer vision applications including stereovision which consist of a set of cameras to estimate the depth of objects in front of it but with some limitations about lack of good light and the complexity of the algorithm. Also, LIDAR(Light Detection and Ranging) and RADAR(Radio Detection and Ranging)[2] have been used in high systems because of its accuracy like military services but they are very expensive even more than an entire autonomous vehicle in some cases. Finding the distance between the camera and detected objects within camera's field of view, which is the main purpose of the present research, is an ongoing field of research given the fact that there isn't a perfect solution yet and computer vision prefers to use depth cameras rather image intensity cameras since depth information makes the variety of applications more feasible and robust. In this paper, we chose to make experiences with Kinect sensor, a low-cost depth sensor for detecting objects in its field of view and measuring how far away they are from the sensor. Computer vision have been used in many specific domains such as in medicine when it can help for alerting clinicians assist doctors during results interpretation to reveal some abnormalities on medical images [3] and in surveillance systems in public places like airports and transport stations.

Ⅱ. Kinect V2 Architecture and realated works

Kinect sensor version 2 appears as a popular sensing input device that serves as a natural user interface application for computers and game consoles (Xbox one). Two versions kinect have been released but Kinect for windows version 2 sensor improves on the first version of the device, providing an expended field of view and higher depth fidelity. 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].

Figure.1 kinect v2 components

Depth sensor and Infrared emitter work together to produce depth information of objects in front of kinect sensor. We can find in the literature review some of researchers who have used Kinect v2 in different applications. Tracking an object's 3D location has been possible at low-cost by using Kinect sensor[5] whereas 3D object tracking was reserved before for users who can afford high-cost motion tracking systems such as Vicon system which is priced upwards of $10.000. Authors showed that object tracking can be performed in real time by using depth and color data from Kinect sensor priced cheaply at around $129. Tracking object has many applications in computer vision such as surveillance , pose and facial recognition [6] etc. and this makes Kinect a useful tool in many fields. Lots of applications seem to deal with object tracking but in this paper another parameter is added, distance value from detected objects which can be helpful for unmanned vehicles when they reach at a certain distance

from detected objects.

III. Object detection and Distance Measurement system

The main purpose is to take depths from detected objects for further processing depending on the application. Therefore, once a frame is streamed from kinect sensor, our system can detect the presence objects within its field of view and ignore some pixels which are not a part of a real object in order to minimize processing time.

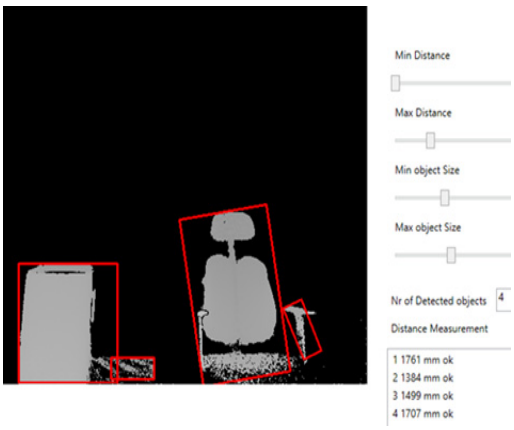

Figure 2. Tracked objects on depth image

Along with detected objects, also their distances are displayed and can be taken in account for making an alert or further processing depending on the type of application.

IV. Depth accuracy and evaluation

Based on our depth results, there is a variation of depth value as frames are streaming from Kinect sensor. In order to assess the impact for that effect, we recorded depth values for one detected object within 30 first frames in different ranges or intervals. Different intervals have been taken (500mm to 1982mm, 500mm to 3069mm and 500mm to 4500mm).

As shows Fig.5, even though there is a variation as frames are streamed one after another, Kinect still a useful device for distance measurement within its field of view and we assume that we can get promising results for our next step to mount Kinect sensor on Robot for obstacle avoidance application at a certain distance from the objects in front of it.

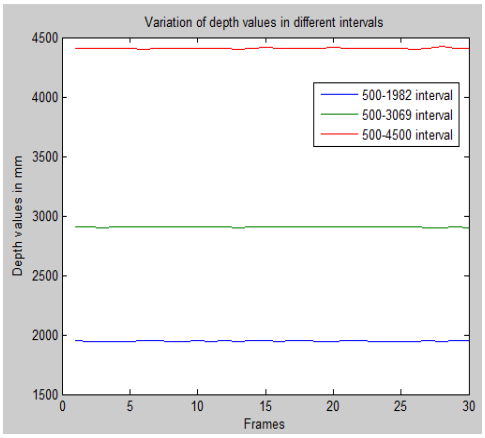

Figure 3. Representation of depth variation in different intervals

V. Conclusion and Future work

In this paper, our goal was to determine the distance from a vision sensor to the detected object in accurate way with a low cost sensor, Kinect sensor. Detected object is made by many pixels which defined its size and therefore, we have to find nearest pixels not all object's pixels, which can be used to get the accurate distance. Our future plan is to make a real situation by equipping kinect depth sensor on autonomous vehicle like robot for obstacle avoidance system at a certain distance from the depth sensor.

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