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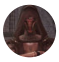

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ABSTRACT
This paper describes modern technique of mapping. This work involved two cases study; in both cases mobile robot navigated manually and used Kinect sensor for built map of indoor environment.

pioneer 3-dx is the robot used in this projects that is programmed by using the Advanced Robotics Interface for Applications (ARIA) that program with C++ package (Visual C++.Net), and ARNetworking software is used for setup Wireless TCP/IP Ethernet-to-Serial connection between robot and PC.

The programs that are used for kinect sensor are OpenNI/NITE to make it work with PC and also we used Skanect software for building 3d map for environment.

Keywords
Pioneer 3-dx (mobile robots), Kinect Sensor

1. INTRODUCTION
Because mapping is an essential step for many projects, many of the approaches used is simple heuristics successively searching for face connected cells or configuration with or without the minimization of a criterion. Some Literatures used modern techniques for building 3D maps like Literature of Shahram Izadi [1]: that is presented KinectFusion as a real-time 3D reconstruction and interaction system using a moving standard Kinect. The contributions are threefold. First, the paper detailed a novel GPU pipeline that achieves 3D tracking, reconstruction, segmentation, rendering, and interaction, all in real-time using only commodity camera and graphics hardware. Second, the paper demonstrated core novel uses for the system: for low-cost object scanning and advanced AR and physics based interactions. Third, the paper described new methods for segmenting, tracking and reconstructing dynamic users and the background scene simultaneously, enabling multi-touch on any indoor scene with arbitrary surface geometries. The system allows a user to pick up a standard Kinect camera and move rapidly within a room to reconstruct a high-quality, geometrically precise 3D model of the scene. To achieve this system continually tracks the 6DOF pose of the camera and fuses live depth data from the camera into a single global 3D model in real-time.

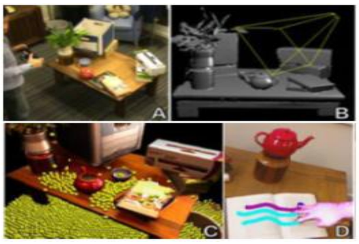


Figure (1) KinectFusion enables real-time detailed 3D reconstructions of indoor scenes

And also Literature of Peter Henry [2]: investigate how RGB-D cameras can be used for building dense 3D maps of indoor environments. This paper performed several experiments to evaluate different aspects of RGB-D Mapping, and demonstrate the ability of system to build consistent maps of large scale indoor environments, and show that the RGB-D ICP algorithm improves accuracy of frame-to-frame alignment, and illustrate the advantageous properties of the surfel "surface element" representation. And Literature of K. Khoshelham [3]: presente a theoretical and experimental accuracy analysis of depth data acquired by the Kinect sensor by present a mathematical model for obtaining 3d object coordinates from the raw image measurements, and discusses the calibration parameters involved in the model. Further, a theoretical random error model is derived and verified by an experiment.

Kinect sensor is new, low cost, sensors that provide depth information for every RGB pixel acquired. Combining this information, it is possible to develop 3D perception in an indoor environment.

Pioneer 3 DX is a mobile robot that is used in this work which has sonar sensors. The data from sonar sensors is the distance between the sonar and object. Pioneer robot contain wibox which is represent An Ethernet serial bridge converts an RS-232 serial connection to a TCP/IP connection available through an 802.11 (Wi-Fi) wireless network, It is mounted on a robot, and connected to the robot microcontroller's serial port and configured to join a certain wireless network as a client station and given an IP address. Software may then connect to a TCP port at that address and send and receive data to/from the robot over the serial port connection.

2. MICROSOFT KINECT
The Microsoft kinect is a special RGB-D camera created for Microsoft's XBOX 360 to be used as a controller substitute and an extra input device for specific games that exploit the use of the Kinect [6]. But because this sensor has a normal USB connector and gives the possibility of depth data for a cheap unit-price, it also found the interest of people to make the kinect available to PC users by making custom drivers. The kinect is able to grab RGB images of 640x480 pixels in 8 bit depth with a bayer color filter and IR images of 640x480 pixels with 11 bit depth [7]. It has a frame rate of 30Hz and an angular field of view of 57 degrees horizontally and 43 degrees in the vertical axis. It needs its own power source other than the USB connector [8], which is provided with the stand alone kit of the Kinect. The base of the Kinect houses an electro motor that allows the Kinect to tilt. Furthermore there is a multi-array microphone built in the Kinect, twoards the sides of the Kinect and it also has an accelerometer (3 dimensions). The depth acquisition technology is named Light Coding that the company PrimeSense has patented [9]. It has an IR Pattern Source, which has a single transparency with a fixed pattern with an IR light source to project a complex pattern of light dots (see Figure (2)) onto an object. The IR camera takes images of the object that

has been illuminated with this pattern and the image data is then processed to reconstruct a three dimensional model of the object using the knowledge of the IR light pattern (see Figure (3)) [6].

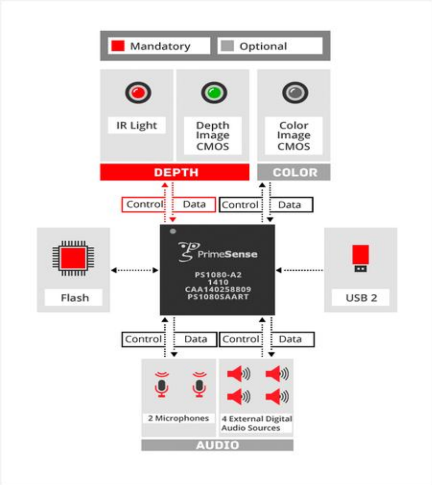


Figure (2) PrimeSense Light Coding Technology Technical Overview

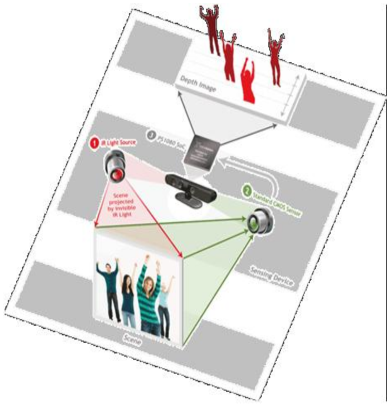


Figure (3) how kinect sensor capture depth and color image of environment

3. 3D MAPPING

As the Kinect allows RGBD data for a cheap unit cost, various people have started to create drivers for the PC. The goal for this thesis is to create a mapping solution using the PC, but there are also other applications for the use of the Kinect. Therefore this paper covers the driver currently available and other possible applications for the use of the Kinect with a PC for create a 3D map.

3.1 OpenNI/NITE

OpenNI is an industry-led, non -profit organization formed to certify and promote the compatibility and interoperability of natural interaction (NI) devices, applications and middleware. With Natural Interaction devices they mean devices that would allow interaction with electronic devices like those we would use with humans, for example using speech and gestures. Devices that would fall under this category would be cameras of any kind of microphones [10].

NITE is middleware developed by Primesense, who have the patent behind the technology implemented in the kinect. The NITE engine has algorithms for user identification, feature detection and gesture recognition, as well as a framework that manages the tagging of users in the scene and the acquisition and release of control between users [9].

It offers C++, C# and Flash API's for Linux and Windows that allows access to RGB and depth derived data, like full body analysis, hand point analysis, gesture analysis and scene analysis (detection of the floor plane, back ground, foreground, people recognition and labeling). It is not clear if direct access to raw RGB and depth data is possible with this software [10].

3.2 Skanect software for 3d mapping

Skanect is a software program use for windows that can capture a full color 3d model of an object. Skanect transforms Microsoft Kinect or Asus Xtion camera into an ultra-low cost scanner able to create 3D meshes out of real scenes in a few minutes [11].

4. EXPERIMENTAL RESULTS OF 3D MAPPING OF CASE1

This case is showed how kinect sensor could build 3D maps for made-up environment with dimensions 3100mm x 2750mm shown in figure (4). In this project Mobile robot is navigated manually by using keyboard of pc.

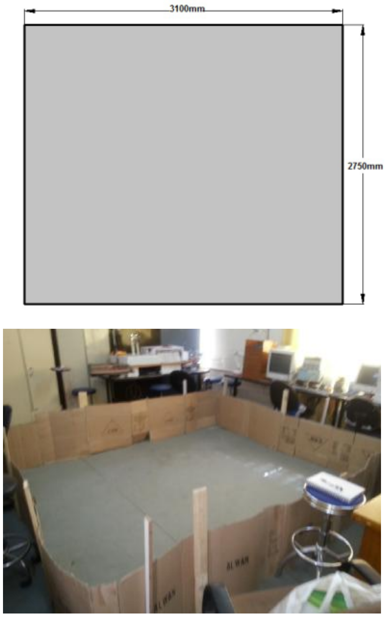


Figure (4) the made-up environment of plan that we are using it for mapping

This project is used kinect with mobile robot for mapping by connecting kinect to laptop and run Skanect by click start on it panel screen of Skanect and then we rotate the mobile robot slowly on itself without moving it in one point inside plan to start mapping.

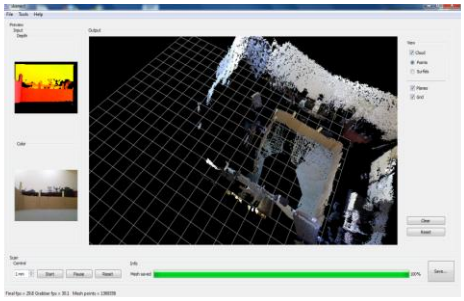


Figure (5) panel screen of Skanect program

After we save the mapping result of Skanct we can open it by using meshlap program and that program deal with 3d image result like our result and also it is easy to control the result show of that program by just hold and draw the mouse in the screen of meshlap and the Figure (6) and figure (7) show how can we see our environment in deferent view angle use meshlap

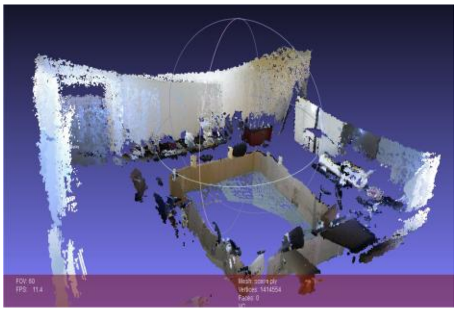


Figure (6) 3d mapping result of plan use kinect sensor

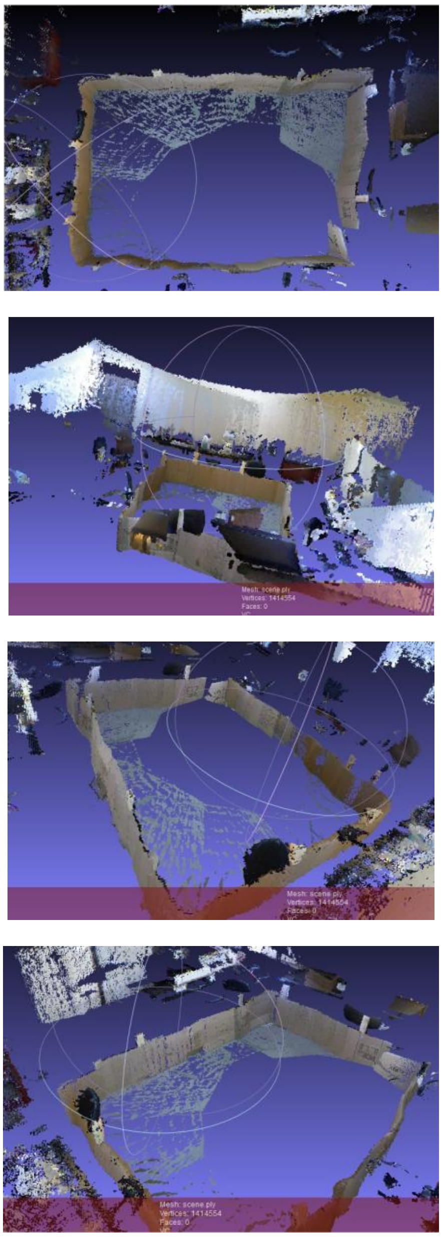
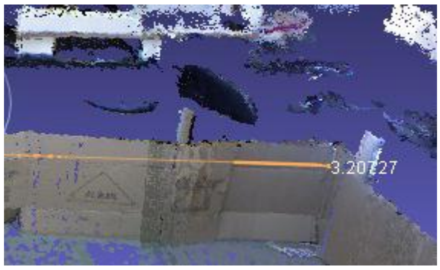


Figure (7) deferent view of result mapping of plan

Meshlap has also deferent techniques one of these technique is can measure distance of any shape in 3D map result shown in figure (8).



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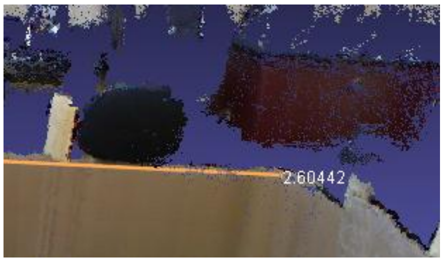

b

Figure (8) dimensions of plan of mapping result are (a) dimension of width of plan and (b) length of plan

5. EXPERIMENTAL RESULTS OF 3D MAPPING OF CASE2

In this case we use kinect sensor with robot for mapping big room with dimension (6 x 9) meters by using three points on this room. This room contains table, chairs, computer, lockers and other things. Mobile robot is used to carry kinect sensor from one point to another. In the beginning, mobile robot with kinect are initialized and send it manually to point one and after mobile robot reaches it, we start mapping by running Skanect program and rotating mobile robot manually with slow speed. After finishing the mapping at this point, we save the result and send the mobile robot to the next poin two and do the same thing we did in the first point.

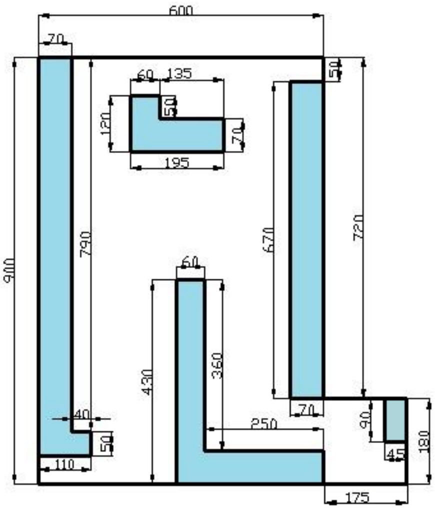

Figure (9) The big room with dimensions design It uses AutoCAD

Figure (10) Pictures of big area

The results of mapping at each point are shown in the following figure:

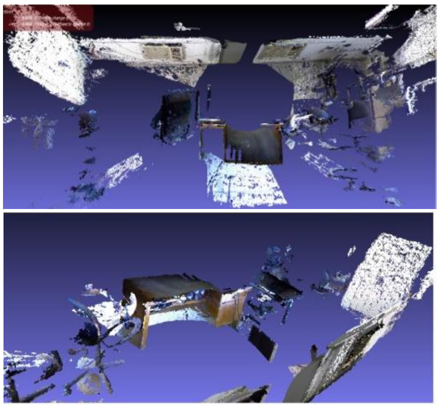

Figure (11) Result of the 3D mapping of big room at point one

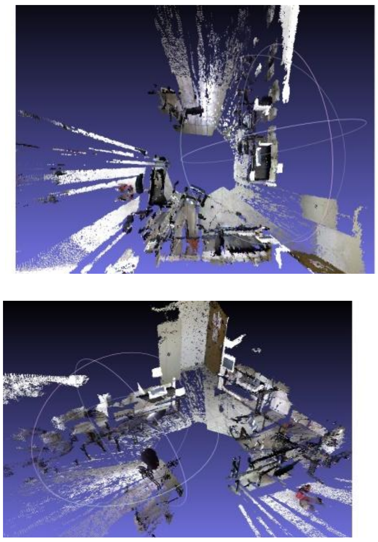

Figure (12) Result of the 3D mapping of big room at point two

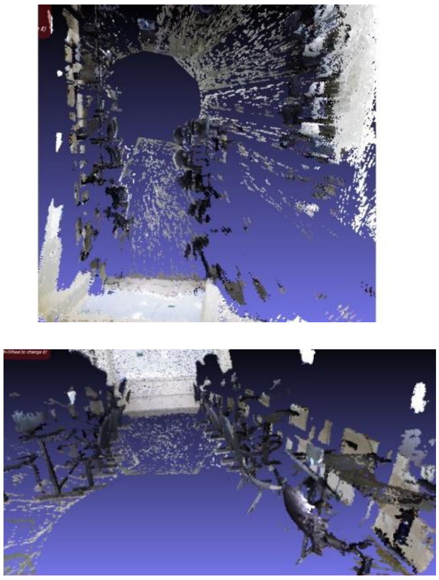

Figure (13) Result of the 3D mapping of big room at point three

6. RESULTS AND DISCUSSION OF 3D MAPPING

The following points summarize the main conclusions of 3D mapping derived from Experiments of work:

(1) The 3D mapping have amazing result of dimensions and details for shape of plan.

(2) The dimensions results of 3D mapping is very close to the true dimensions of environment.

(3) 3D mapping has true color of the environment.

(4) 3D mapping has very little noise.

(5) 3D map can be seen from any angle.

(6) We can distinguish any shape in our 3D map result of using kinect sensor.

(7) Building maps using kinect sensor is easer, more accurate and less cost than using another sensors like sonic and laser sonar.

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