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Virtually Controlled Mini-Car Using Kinect

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ABSTRACT: Kinect is Microsoft's motion sensor add-on for the Xbox 360 gamming console. The device provides a naturaluser interface (NUI) that allows user to interact directly without any intermediate device such as a controller .It consists of a 3-D depth sensor that creates a skeleton image of a player and a motion sensor detects their movements. With the popularity of the voice, gesture and by motion recognition technology, the Kinect human-machine interface (HMI) of personal computers has become a general trend. As a result the application of Kinect control is finding its way into various aspects of life. This paper explains the mini car controlling which is remotely controlled by human body motions through the Microsoft's motion sensor. The components namely used are Microsoft Kinect sensor, embedded controller (ATmega8A), Bluetooth Module (HC-05), Mini-Car Chassis Provided by Dagu, jumper wires and Servo motors. This new form of HMI has widely used for the creation of numerous innovative applications.

KEYWORD: Controller, 3-D depth image, Interface controller, Kinect

I. INTRODUCTION

The Main Heart of the Project is Kinect. The Microsoft Kinect sensor and its software development kit (SDK), the human machine interface of personal computers has achieved a new level where the users directly interact with human body movements. This new form of HMI has quickly spread to various dimensions including education, medical care, entertainment, sports. Traditionally, most Kinect applications employ body movements via the Kinect sensor to control a virtual object in software as a role in games. The recent trend, however shifting from software to hardware-based applications [1].

Initially Kinect is developed for Xbox gaming Console with Remarkable Features. The sensor enables the user to interact in virtual reality by means of body movements, hand gestures and spoken commands. It consists RGB color camera, infrared (IR) emitter, IR sensor to compose a 3-D [2] image by providing 20 node points of human body as a stick in Cartesian Co-ordinate system.

This paper gives a brief overview of the latest research on mini car controlling using Kinect. Till now the machines were used are either automated or remote control. These are remotely controlled by RF, IR and IOT (using Bluetooth and WI-FI modules). In this project, the machines are controlled virtually using a natural user interface (NUI) console "Kinect".

II. RELATED WORK

Microsoft has introduced the Kinect and the specified SDK.The latest SDK Version compatible with Xbox 360 Kinect is Kinect SDK V1.8 and Microsoft has developed the Toolkit for it.It consists of all the API classes like skeleton class, voice recognition class and depth class. In this project skeleton class API is used. The skeleton class consists of 20

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nodes (human body read as 20 nodes which joints are connected under rectMode).U can get clear idea by referring “Beginning with Kinect programming” described in the references and other references under reference section.

III. TECHNICAL DETAILS

A. *Introduction to Microsoft Kinect*

The Microsoft Kinect is a set of sensors developed as an Interactive Console the Xbox 360 & Xbox one too. Kinect has an RGB camera and a dual infrared depth sensor with a projector and CMOS IR Receiver (Sensor). The RGB camera has a resolution of 640X480 pixels and coming to the Infrared Camera, It is the basic Cause of Depth Imaging and Skeleton Building, Which is used in developing the code. Using image, audio and depth sensors it can detect movements, identifies speech of players and also capable of interacting through human body motions [3].

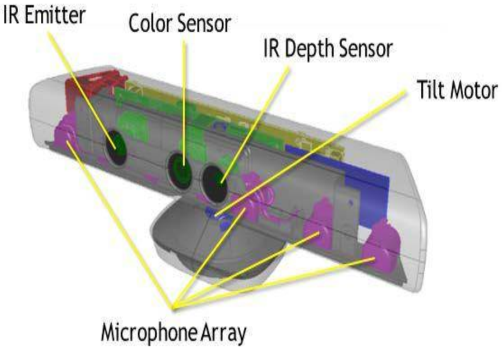

Fig 1. Kinect Sensor. 1. RGB camera 2. Depth Sensor 3.Microphone Arrays 4. Tilt motor.

The central camera is color camera which is a RGB camera that can identify a user’s id or facial features and can also be used in augmented reality games and video calls. The two sensors make up the depth component of Kinect -an infrared projector and a monochrome CMOS sensor. These are used for gesture recognition and skeleton tracking. The purpose of microphone arrays is not just to let the Kinect device captures sound and also locate the direction of audio waves and it recognizes the voice irrespective of the noise and the echo present in the environment and the tilt motor is used to adjust the Kinect position according to the view. Kinect Deploying According to the present Project and its specifications shows below.

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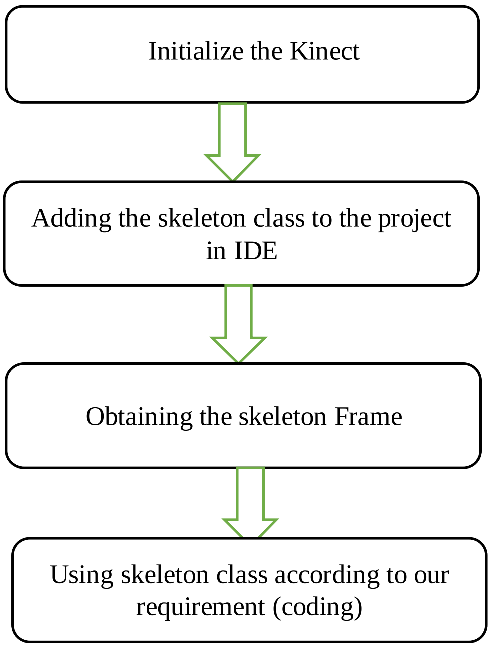

Fig 2**.** Kinect Skeleton live stream flowchart

Table1. Kinect Sensor Specifications

Features	**Xbox 360**
Field of view(FOV)	57.5° horizontal by 43.5° vertical
Resolvable Depth	0.8m – 4.0m
Color stream	640X480X24bpp RGB@30fps 640X480X16bpp YUV@15fps
Tilt Motor	Vertical only
Data path	USB 2.0 / 3.0

B. *Kinect drivers and SDKs*

At first, Microsoft didn’t introduce any software tools to Interface the Kinect with PC, Many developers came forward and Introduced Several Interfacing SDK’S. Later Microsoft Came with its own SDK tools to enable Kinect to interact with personal computer. It’s basically An Open Source Platform and Developers Can Use Those References In it Like Skeleton Tracking, Speech Recognition etc... To play with Kinect. This Brought a Major Breakthrough. For, the Xbox Kinect 360 the latest SDK is V1.8. Which consists of the basic open source Projects (this will be WPF Applications) are available in C++, C# and visual basic language.

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SDK enables developers to create applications that support gestures and voice recognition. The following are the supported operating systems for development.

Windows 7
Windows embedded 7
Windows 8
Windows 8.1
Windows 10

C. *Kinect skeleton tracking*

A program can use the depth information from the sensor to detect and track the shape of human body. The Kinect SDK will provide programs and skeletal position information that can be used in games and many other applications. This skeletal tracking in the Kinect SDK can track 6 skeletons at the same time. For which 4 of the bodies only simple location is provided but 2 will be tracked in detailed. For those 2 bodies the SDK will provide the position in 3-D space of 20 joint node positions.

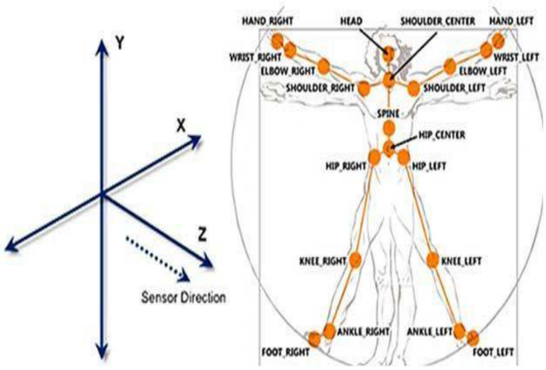

Fig 3**.** Shows the joint position and skeleton data

D. *Bluetooth Module*

HC-05 module is an easy to use Bluetooth SPP (serial port protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced data rate) 3Mbps modulation with complete 2.4GHz radio transceiver and base band .It uses CSR Bluetooth 04-external single chip Bluetooth system with coms technology and with Adaptive Frequency Hopping (AFH).It has a footprint as small as 12.7mmx27mm.It's hardware specifications are typically -80dBm sensitivity, up to +4dBm RF transmit power, low power 1.8V operation,1.8to3.6V I/O, LED, UART interface with programming baud rate, integrated antenna and a edge connector. Some of the software features are it has a default baud rate 38400,Data bits 8, stop bit 1 and no parity and supported baud rate are 9600, 19200, 38400, 57600 ,115200 ,230400,4608 and it has an auto-reconnect in 30 min when disconnected as a result of beyond the range of connection .

E. *Mini-Car chassis*

DAGU Mini-Car chassis is the latest robot platform from Dagu. It has a features of 2 gear motors with 65mm wheels and a rear caster (rolling movement of an object) and 4XA4 battery holder with barrel jacket termination. Some of the specifications are voltage 4.5V, gear box 4.8-7.2V, current 190mA (max. 250mA), torque 800gf.cm, stall current 1A and provides plastic rims with solid rubber tires.

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F. *Arduino*

Arduino is an Open Source Electronics Platform with Integrated Micro-Controller on it. Since it is open platform many companies came forward to develop Arduino Boards with Integrated Sensors and Other Ways. Here, since there is a need of motors for the movement of mini-car, Arduino mini-motor control Board is used for reducing Circuit Complexity and this is provided by DAGU.

Arduino AVR (Advanced virtual RISC) board bridge motor control developed from “Dagu” .The microcontroller used here is Atmega8A, in Atmega8A.It is a 16 pin IC. Some of the features of controller are high performance, low power, frequency 16MHZ, input voltage 5.4~9V, low dropout voltage 250mV @ 500mA,450mV@1A, the memory segments are
8kBytes of self –programming flash memory, EEPROM 512Bytes ,SRAM 1Kbyte , i/o ports ,timers and registers and it provides data retention i.e., it stores data for 20 years at 85°C/100years at 25°C. Some of the Board specifications are On-board 5-9V regulator power supply and dual channel DC motor driver up to 2A per channel. It supports up to 8 servos.

G. *Arduino motor drivers*

The Arduino controller is fitted inside the car to receive the control signals from PC and to control 2 motors through Bluetooth Communication. As the Virtual Driving the Motor Speed is Varied According to the user. To detect the human skeleton joint movement’s one can remotely control the car to go forward, backward and to turn left, right. The Arduino controller interfaces with the Bluetooth Module in which the transmitting and receiving pins of Arduino are connected to the TX & RX pins of the Bluetooth Module. The Communication is through the Bluetooth USB Dongle with the Bluetooth Module which provides the Data to the Arduino Board.

H. *Ultrasonic sensor*

Ultrasonic sensor HC-SR04 is used to measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for the sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, the distance is calculated. It may limit to some distance according to the medium and if the density of the medium is high, the distance of the wave transmitted is less and it depends on the refractive index of the medium.

IV. BLOCK DIAGRAM

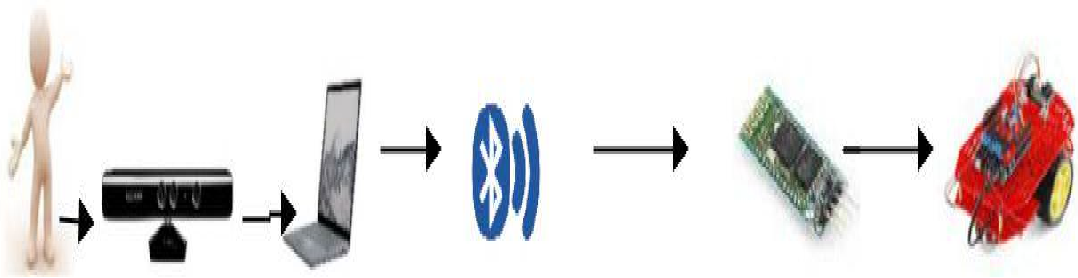

Fig 4.Block diagram of Kinect controlled car.

The above block diagram explains the Kinect controlled car. The instructions from Human are read by the programmed Kinect. The Kinect reads the body movements of the person for every 600ms and this interval is given in the program.

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The instructions from Kinect are then passed to Arduino via Bluetooth communication. The instant instructions for every 600ms, Arduino mini motor driver controls the car according to the human Virtual Driving gestures. The velocity of the car vary according to the relative distance between hip node and hand node position.

Let x is the position of the hip, which is fixed and y is the position of hand and this position referred in Cartesian co-ordinate system which is shown further.

Velocity of mini-car = [(y-x)/600] m\sec

And the velocity value of the mini-car is limited to 4.5m\sec and this can be varied in the code according to our requirement and this also depends on max. Load velocity of the mini-car and the support given by motor.

V. JOINT ORIENTATION

It is a local axes representation hierarchical rotation based on a relationship defined by a bones on skeleton joint structure. This node positions are referred in terms of Cartesian coordinates by the Kinect RGB camera and this will help in framing the code for the project.

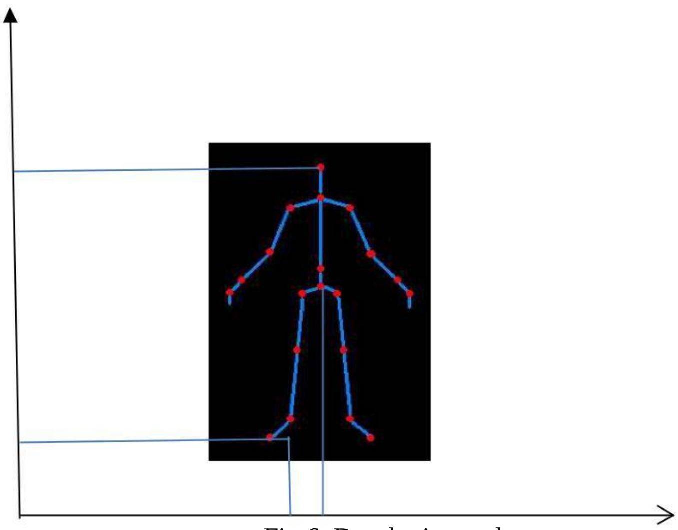

Fig 6. Developing code

The code developing includes the skeleton node positions in Cartesian coordinate system reference and this help in framing the code easier.

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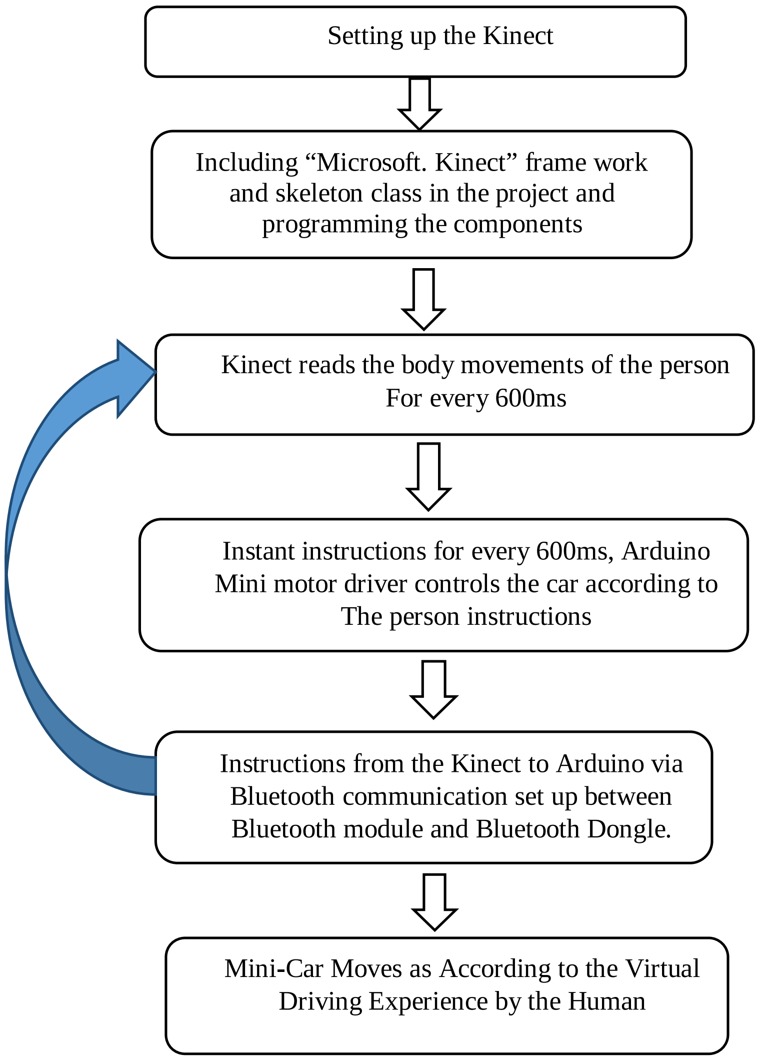

Fig 5.kinect to mini car configuration flowchart

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Table 2.Virtual Car Controlling Gestures

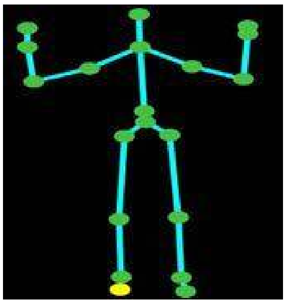
Human gesture	Car commands
Raise the both hands	Go forward
Turn the right hand	Turn left
Turn the left hand	Turn right
Both hands down	Stop

The turning of car depends on the relative linear velocities of the left and right wheels which in turn depends on the Cartesian co-ordinates of the above skeleton frame (according to code).

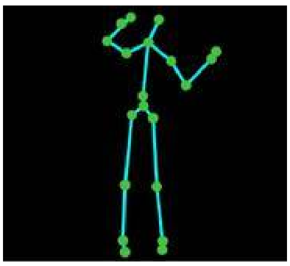
VI. CONCLUSION, RESULT AND FUTURE WORK

In this project, we propose a virtual controlling of a mini-car that uses skeleton tracking information provided by the Kinect. The experimental results are shown by human body skeletal positions. This provides virtual interactions directly with machines without any intermediate devices which results in human machine interface. The Results of the project are shown below

Gesture for car to go forward



Gesture for car to turn right



Gesture for car to turn left

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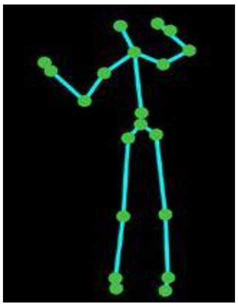

The above figures are the skeleton tracking from the Kinect and virtual motion of a car.

In the future, there is a hope in development of the space expedition in other planets in which scientists can virtually experience the expedition and they can take care necessary objects .Also, can be sent to the place where people can't go and can break their curiosity.

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