

# **Design and Fabrication of Mobile Robot Control by Using FFAST and Kinect Sensor**

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**ABSTRACT:** This paper deals with a user-friendly and lightweight project which demonstrates the prototype of a robot controlled through human gestures. The project revolves around Kinect-assisted natural gesture-based approach to robot control. The robot has basic movement capabilities which can move around through its mobility platform. The project comprises of Arduino Microcontroller, Motor Drive Unit, Servo motors, and the software for programming the device. An external supply for robot functioning has to be given to the movement of the robot. The Motor drive in the device will use a 9v power supply to run the motor. This project presents a real-time remote robot control and its teleoperation control using Kinect-based skeleton tracking. We use a middleware called Flexible Action and Articulated Skeleton Toolkit (FFAST) which facilitates full-body control. It senses the person standing in front of the Kinect Sensor as a skeleton and senses the movements of body joints using Kinect's Depth Map. The FFAST is pre-programmed to send signals based on our Gesture and the signals are sent to the serial port of Arduino through Laptop. The Arduino is programmed to work based on signals from serial connection. Thus the gesture control of the robot is achieved through this technique.

**KEYWORDS:** Imitation, depth-imaging, Kinect, Robot, gestures etc.

## **I. INTRODUCTION**

Recent advancement in Human-Robot interaction has drawn attraction on people and robots are becoming popular among the common people. Today's manufacturing Industries depends mainly on the industrial robots to perform their tasks for robots reliability and accuracy than manpower. The launch of XBOX gaming console with Kinect Sensor has attracted the hobbyists to use the sensor for various applications. Many advanced projects have also been done using this sensor. We are much interested in using this sensor in our project. We also use a middleware called FFAST as mentioned above to gain easy control of our robot.

## **II. DESIGN CONSIDERATIONS**

The concept was initially developed by the XBOX's Kinect gaming platform and the idea was to control a toy car using gestures. On surfing on the internet, we found the FFAST architecture which translates the gestures into equivalent output or keystrokes. It was used by gamers to take gestural control of their favorite games.

The task was to develop a project which demonstrates the prototype of a gesture controlled robot. Using FFAST our required gestures was set and the equivalent keystrokes for the gestures were programmed. The challenge was to wirelessly transmit those keystrokes to the robot's prototype.

The goal of this project was to provide proof of this concept. However, the limited budget of the project does not allow us for a commercial grade robot to be developed. Many components in the design of this system are modular and can be redesigned or replaced. This allows for a more versatile and robust final product to be developed.

# International Journal of Innovative Research in Science, Engineering and Technology

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## III. OVERVIEW

Our project consists of two major components. First is the base station, to which the Microsoft Kinect and a mobile robot with Arduino microcontroller and other components. This component is responsible for converting kinematic gestures to control signals, and communicating these signals to the robot. We also use a middleware called FAAST for our robot control operation.

### A. ABOUT KINECT SENSOR



Fig.1. Xbox 360's Kinect sensor

The basic parts of the Kinect are:

- RGB camera
- 3D depth sensing system
- Multi-array microphone
- Motorized tilt

Kinect has an RGB camera and 3D Depth sensing system to capture 3D motion. The 3D Depth sensing system has IR camera and IR projector which is used for acquiring depth information. It also contains a LED light, a three-axis accelerometer, and a small servo controlling the tilt of the device.

### B. ABOUT FAAST

FAAST is a software which acts as middleware between the Kinect and end-user applications. It supports Kinect sensors using the Microsoft Kinect for Windows SDK and the NITE skeleton tracking library. The software splits each skeleton tracker into separate modules. A generic skeleton data structure is read by each module from its respective tracker. Thus, FAAST can support future software libraries and devices by adding new modules.

Once FAAST reads a skeleton from the sensor it processes its data in an action recognition module. Based on the actions performed by the user, the application calls a module that sends simulated keyboard and mouse events to the active window. The application provides user interface that allows the user to create custom gestures and bind the actions performed to specific emulator events. Specifying any number of gestures and its equivalent actions is possible in this application.

## IV. EXPERIMENTAL SET-UP AND EXPERIMENTATION

Our project comprises the following systems.

- ❖ Microsoft Kinect Sensor
- ❖ Arduino Microcontroller
- ❖ Motor Drive Unit
- ❖ DC Motors

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- ❖ Arduino IDE
- ❖ Power Supply

## A. MICROSOFT KINECT SENSOR

The Kinect sensor contains a color camera, a depth sensor and a four-microphone array that provide facial and voice recognition, full-body 3D motion capture capabilities.

## B. ARDUINO MICROCONTROLLER

Arduino is an open-source electronics prototyping platform and it is composed of a microcontroller, an IDE, and a programming language. It serves as a tool for making interactive applications, designed to simplify this task for beginners. But it is still flexible enough for experts to develop complex projects.



Fig.2.Arduino

## C. MOTOR DRIVE UNIT

We have used a motor driver shield (Adafruit shield) for controlling the motors. The shield has L293D IC in-built. The L293 and L293D are quadruple high-current half-H drivers.

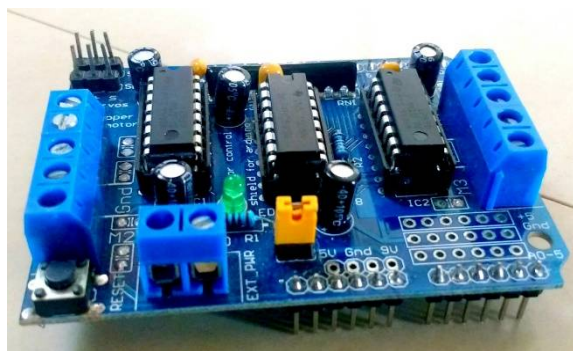


Fig.3.Adafruit Motor Shield

## D. MOTORS

Two motors are used for our mobile platform. They are built along with gear to provide traction to the robot. They are coupled with small tires.

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## E. PLATFORM

We have built a platform for the robot by ourselves. We made room for all of our microcontrollers and we fixed both motors along with the wheels. We have also fixed a castor wheel for the stability of the robot.

## F. ARDUINO IDE

The Arduino IDE is basically a program designed to facilitate software development. It includes a source code editor and a compiler that translates user's code into machine-readable instructions and it allows users to easily write your own Arduino sketches and upload them to the board with a single click.

## V. SOURCE CODES OF ARDUINO

Below is the code developed for this project fed to the Arduino. It relies on the built-in Arduino serial libraries.

```
#include <AFMotor.h>
AF_DCMotor motor1(3);
AF_DCMotor motor2(4);
void setup()
{
  // Start up serial connection
  Serial.begin(9600); // baud rate
  Serial.flush();
}
void loop()
{
  String input = "";
  // Read any serial input
  while (Serial.available() > 0)
  {
    input += (char) Serial.read(); // Read in one char at a time
    delay(5);
  }
  if (input == "stop")
  {
    motor1.run(RELEASE);
    motor2.run(RELEASE);
  }
  else if (input == "front")
  {
    motor1.setSpeed(200);
    motor1.run(FORWARD);
    motor2.setSpeed(200);
    motor2.run(FORWARD);
  }
  else if (input == "back")
  {
    motor1.setSpeed(200);
    motor1.run(BACKWARD);
    motor2.setSpeed(200);
    motor2.run(BACKWARD);
  }
  else if (input == "left")
```

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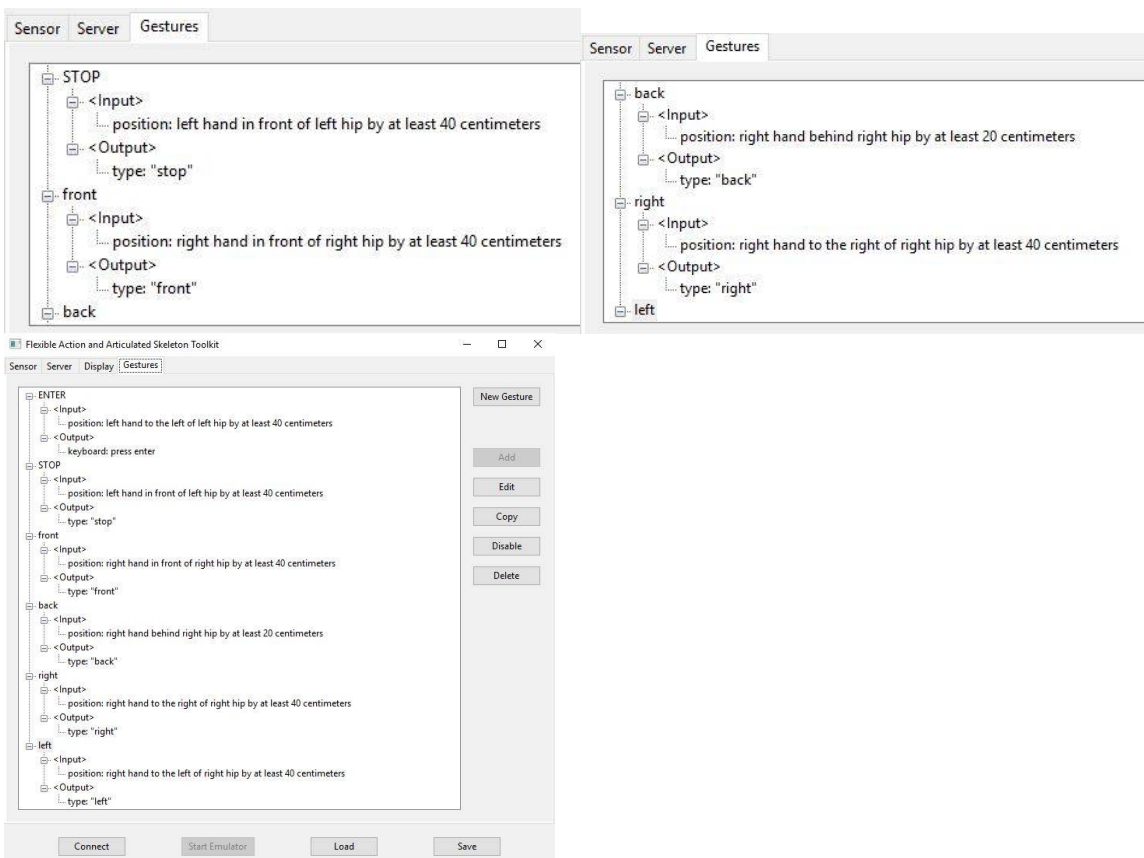
```

{
motor1.setSpeed(200);
motor1.run(FORWARD);
motor2.setSpeed(100);
motor2.run(FORWARD);
}
else if (input == "right")
{
motor1.setSpeed(100);
motor1.run(FORWARD);
motor2.setSpeed(200);
motor2.run(FORWARD);
} }

```

## VI. CONFIGURING FAAST

We have configured FAAST so that it translates the user's body motion into equivalent keyboard events.



Snapshots of our configuration for our project is shown above. After configuring FAAST as shown we would start the emulator and the Arduino's serial monitor is made as the current window. The FAAST would translate our motion to equivalent keyboard events as defined and enters the output to the serial monitor and our robot moves based on the serial commands given to it.

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Vol. 8, Issue 5, May 2019

## VII. CONCLUSION

Our study has presented an easy way to control any sort of robot, computer games etc. by any person without having any prior training and the input gestures can be changed at any instant for one's comfort and our project might be useful for the differently abled person to take control of anything with their capable gestures.

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