RESEARCH ARTICLE OPEN ACCESS

Development of a Robotic Vehicle and Implementation of a Control Strategy for Gesture Recognition through Leap Motion device

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Abstract:

The concept of this paper deals with the development of a robotic vehicle and the implementation of a control strategy through gesture recognition (Leap Motion Sensor), by means the natural movement of the forearm and hand. Our experiment shows that our method based on Leap Motion Controller tracking data can recognize hand gesture accurately when no occlusion happens.

Keywords— **Autonomous Mobile Robot, Gesture recognition, Leap Motion Sensor, zigbee transreceivers.**

I. Introduction

The development and construction of a prototype of robotic vehicle and the implementation of a control strategy for gestures recognition through the natural movement of the forearm and hand. Gesturing is a natural part of human communication and becomes more and more important in AR/VR interaction. The Leap Motion Controller is a new device developed for gesture interaction It can detect palm and fingers movements on top of it. The tracking data which contains the palm and fingers position,direction, velocity could be accessed using its SDK. To Convert image processing into gesture controls with the use of programming language and to show the gesture control strategy of a control system through a graphical user interface, that allows the user to interact with the system.

2. RELATED WORK

The performance in selection task of leap motion controller is compared with a common mouse device [Bachmann et al. 2015]. FittsâA˘ Z law is introduced in the´ evaluation system. It indicates the Leap Motion Controller performance in general computer pointing tasks is limited compared with a mouse device given the error rate of 7.8

The Leap Motion Controller has a wide range of application. It has been used for stoke rehabilitation by people from The Intelligent Computer Tutoring Group in the University [Bracegirdle et al. 2014]. Another important application is hand gesture recognitions. Many gesture recognition methods have been put forward under difference environments.

Hand Motion Understanding system developed by [Cooper et al. 2011] utilize colour-coded glove to track hand movement. The tracking system requires users to wear gloves which reduces the user experiences.

Kobayashi et al. proposed a control system of a robot arm based on gesture recognition. In the experiment have used an industrial robot and have analyzed the different trajectories followed during displacement of the robotic arm. While Lei et al. study the similarity between the position of a human and its imitation, performed by a robot.

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3.Comparison of Gesture Control Devices

The main objective in the development of the application has been to ensure that the actions of the robotic vehicle should be similar to its real equivalent. But considering the influence that cause the movement performed on the system. Thus, it can be achieved by appropriate adjustment of the movements. The recognition of the different hand gestures is developed through the Leap Motion device and a peripheral equipped with infrared sensors (IR) that recognizes the movement of the forearm, hand and fingers simultaneously, These variables are processed by the computer in order its decomposition in simple and basic movements. Later this information is sent to the robotic vehicle. The control is performed by an PIC16F877A, who receives the different commands from the computer, via serial communication, and transmits the information to each of the involved in the movement.

Device	Leap motion sensor	Wii Remote	Asus Xtion Sensor
Accuracy	High	Small	Medium
architecture	2monochrome cameras 3 IF LED	accelerometer IF LED	RGB and IF camera
Operating area	0.6m	6m	3m
Complexity of use	Easy	Easy	Medium
Weight	45g	201g	1kg

Asus Xtion Sensor

This device is for the development of games and interactive applications. It incorporates a motion sensor that allows the gestures detection and complete capture of the human body in real time. Thus it includes an RGB camera, an infrared sensor,depth detector and a microphone.

Wii remote

This is based on a remote control and sensor bar. It has the capability to detect movement in space and the ability to select objects on the screen. It was created to be used with one hand, in a very intuitive manner. By means the optical sensors and accelerometer it is possible to know both position, velocity or acceleration along its three axes.

Leap Motion Sensor

We have selected the Leap Motion Sensor because its accuracy is superior to other gesture devices available in the market. Its small operating area does not cause a problem, since control is developed with the movement of hand and forearm According to its manufacturer it can reach 200 frames per second through its infrared cameras and accuracy up to 0,2mm. Its view field is 150 degree with 0.6m interactive 3D space approx with the inverted pyramid shape centred on the device. Power supply together with the data transfer is done via the USB port.

4. APPROACH

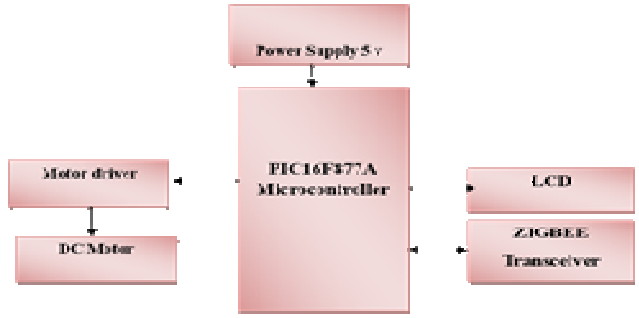
Existing System

In the existing system, humans control a robot using remote control. A wireless data glove is used to control a robot. Sensors mounted on the glove send signals to a processing unit, worn on the users forearm that translates hand postures into data. An RF transceiver, also mounted on the user, transmits the encoded signals representing the hand postures and dynamic gestures to the robot via RF link

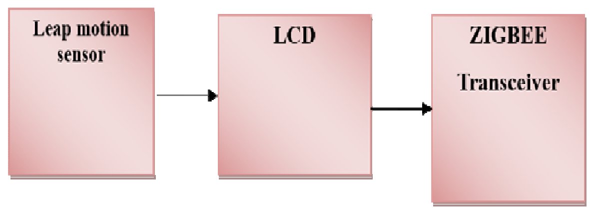
Proposed System

In this proposed system, we are introduced controlling robotic module using leap motion sensor and ZIGBEE. A mobile robot can be controlled by translating the hand gestures into commands via leap motion controller. In this project the hand gestures are observed and transferred to the computer by using commands. ZIGBEE is used for transferred the commands from pc to robot.The main technology behind leap is natural user interface, gesture recognition and motion control. Leap Motion device a wide variety of applications have been developed. The most popular are those that allow a computer control through the different hand movements. The recognition of the different hand gestures is developed through the Leap Motion device and a PC through OTG cable that recognizes the movement of the forearm, hand and fingers.

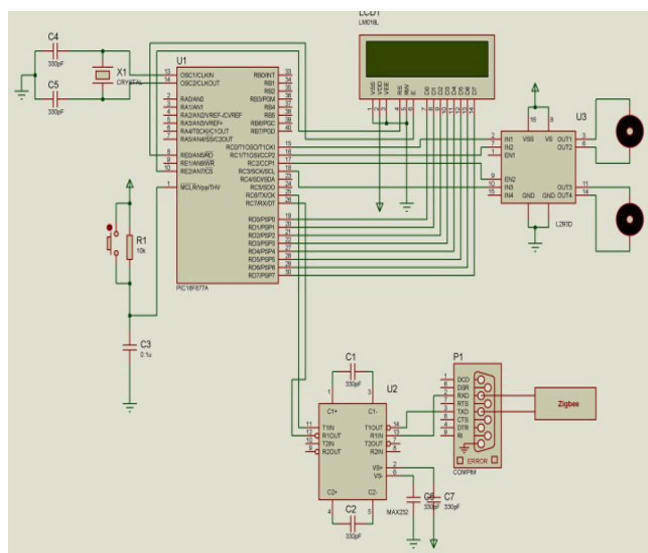
Block Diagram of Robotic Module



Block Diagram of PC Module

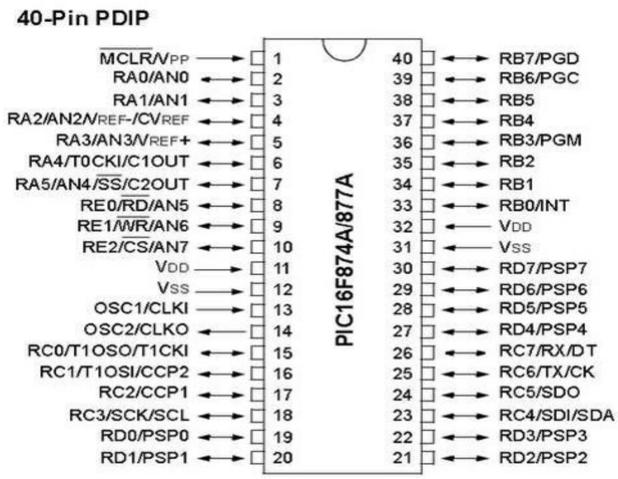


A. Description of robotic module



PIC16F877A Microcontroller

PIN diagram of PIC16F877A Microcontroller



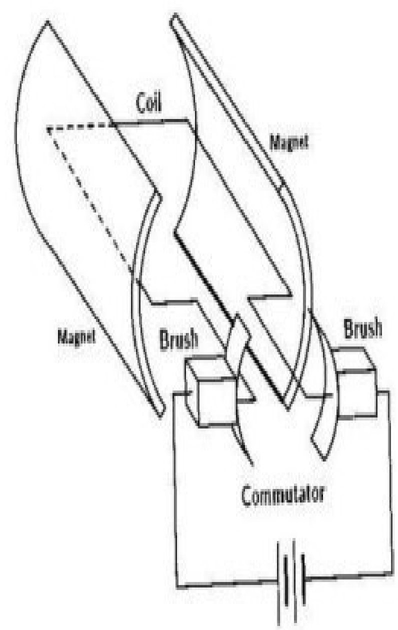
PIC microcontrollers are based on advanced RISC architecture. In this architecture, the instruction set of hardware gets reduced which increases the execution rate (speed) of system. PIC microcontrollers follow Harvard architecture for internal data transfer.

1) Core Features

- High performance RISC CPU
- Only 35 single word instructions to learn
- All single cycle instructions except for program branches which are two cycle
- Operating speed: DC - 20 MHz clock input
- operating speed: DC - 200 ns instruction cycle
- Pin out compatible to the PIC16C73B/74B/76/77
- Interrupt capability (up to 14 sources)
- Eight level deep hardware stack
- Power-on Reset (POR)
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code protection
- Power saving SLEEP mode

DC Motor

The specific type of motor we are addressing is the permanent magnet brushed DC motor (PMDC). These motors have two terminals. Applying a voltage across the terminals results in a proportional speed of the output shaft in steady state. There are two pieces to the motor: 1) stator and 2) rotor. The stator includes the housing, permanent magnets, and brushes. The rotor consists of the output shaft, windings and commutator.



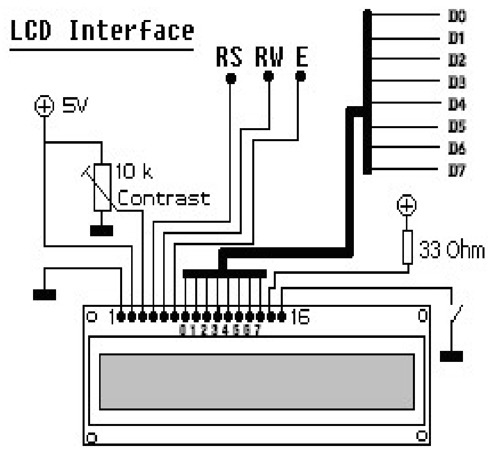
LCD Operation

In recent years the LCD is finding widespread use replacing LEDs (seven-segment LEDs or other multisegment LEDs). This is due to the following reasons:

- The declining prices of LCDs.
- The ability to display numbers, characters, and graphics. This is in contrast to LEDs, which are limited to numbers and a few characters.

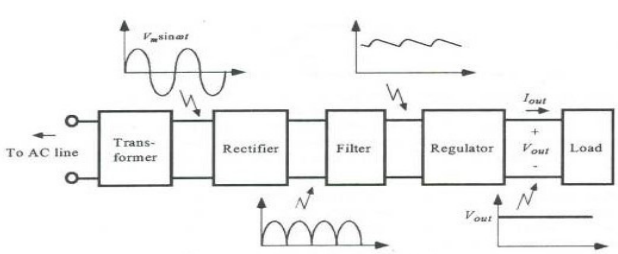
- Incorporation of a refreshing controller into the LCD, thereby relieving the CPU of the task of refreshing the LCD. In contrast, the LED must be refreshed by the CPU (or in some other way) to keep displaying the data.

- Ease of programming for characters and graphics



Power Supply

The input to the circuit is applied from the regulated power supply. The AC input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to a rectifier. The output obtained from the rectifier is a pulsating d.c voltage. So in order to get a pure DC voltage, the output voltage from the rectifier is fed to a filter to remove any AC components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant DC voltage.

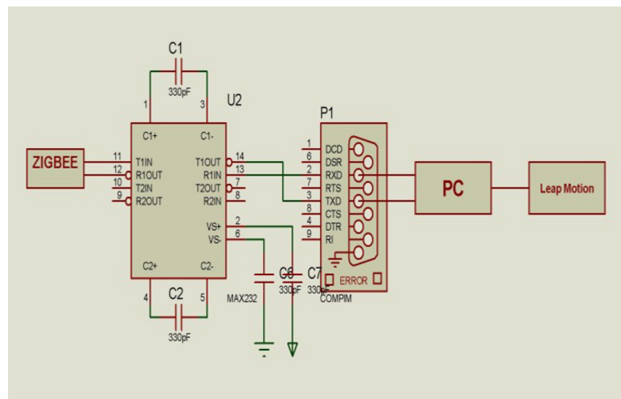


Components of a regulated power supply

B. Description of PC module

Leap motion controller

Leap motion controller is new interactive devices mainly aiming at hand gestures and finger position detection developed by Leap Motion. The internal structure of Leap Motion Controller, There are three Infrared Light emitters and two cameras which receive the IR lights. The Leap controller generates, on a frame by frame basis, information regarding a user hands as well as information pertaining to already recognized´ gestures. A frame typically contains the position of objects, and in the case of a hand, the frame also contains physical properties such as the width and length of the hand and arm as well as the width and length of each digit and the four bones associated with each digit.



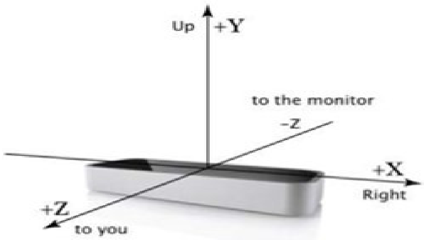
In addition to these properties, the Leap recognizes certain movement patterns as gesture. Leap motion provides preprocessed data through their Application Programming Interface. This data is accessed by a Frame object querying by per frame.The origin tracking data is calculated in Leap Motion coordinate systems. The Leap Motion Controller uses a right handed system and millimeters as the unit. We implemented our demo based on Unity. The Unity uses a left hand system and meters as the unit. So the z-coordinates are opposite in Leap Motion Controller coordinate system and Unity system.The frame object accessed through LeapProvider is in unity coordinate systems and use meters as the unit.

- Palm position Ppos, normal PN and velocity Pv.

- Hand direction PD.

- Fingertips position , direction FDi and velocity where i starts from 0 to 4 representing thumb, index, middle,ring and pinky respectively.

- Arm direction



Axis system on the leap motion sensor device.

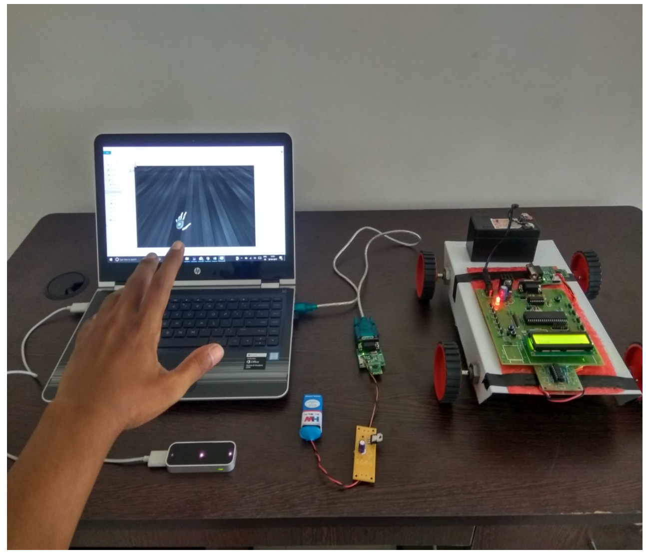
C. Gesture Features

Based on previous data we collected from Leap Motion Controller API, The build features to recognize hand gestures. These features could mainly be divided into two parts. One parts are associated with static gestures containing the positions and directions.The others are used to identify dynamic gestures.

Static gestures are mainly built based on palm and fingers relative distances. We calculated two types of distances. One type is distances between fingertips and palm center . The other type is distances between two fingers which are adjacent. For example distance between thumb and index, distance between index and middle examples of static gestures we could effectively recoginize.

- The other gesture features are built based on number of fingers displayed like for example
- 1-Forward
- 2-Backward
- 3-Turn right
- 4-Turn left
- 5-To stop

Dynamic Gesture features mainly use the velocity of fingertips and palm to detect the movement patterns. Compared with the static gestures, dynamic gestures are much more complicated.



DISCUSSION

The control strategy through Leap Motion device, based on gesture recognition, it has enhanced the relationship with the user-robotic vehicle interface. It also allows greater control ability and it facilitates its use. Thus, it has been developed a robotic vehicle prototype, which has the capability to operate in three dimensions (3D) simulating of the human forearm. The initial objectives have been resolved a satisfactory manner. Thus it was obtained as a result a prototype that has exceeded initial expectations.

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