ISSN 2278-3091

International Journal of Advanced Trends in Computer Science and Engineering, Vol. 3 , No.1, Pages : 590– 595 (2014)
Special Issue of ICETETS 2014 - Held on 24-25 February, 2014 in Malla Reddy Institute of Engineering and Technology, Secunderabad– 14, AP, India

Hand Gestures Controlled Speed and Direction of Mobile Robot

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Abstract: Human Machine Interaction Is One Of Advanced Growing Field In Present Days. In This Project We Designed A Mobile Robot Which Is Used In Security Systems. This Robot Is Equipped With A Wireless Camera On It. The Main Goal of This Project Is to control The Speed and Direction of Robot Using Different Hand Gestures. We Used Freely Movable Accelerometer for Detecting The 3 D Space (Co-ordinate Spaces) . The Different Hand Gestures Result Changes In Accelerometer 3D Coordinate Values. We Formulated The Relation Between Hand Gestures And Accelerometer And Designed A New Way Of Communicating Robot With Hand Gestures In Different Modes. We Are Able to Control the Speed and Direction of Robot Using Different Hand gestures Defined and Also the Position of Camera Placed on the Robot Which Is rotatable In 360 degrees Is Also Controlled By Hand Gestures. We Used Zigbee Wireless Communication Between Robot And Accelerometer Placed At Human Hand.

Keywords: Gestures Controlled Robots, Human-Machine Interaction,Robots.

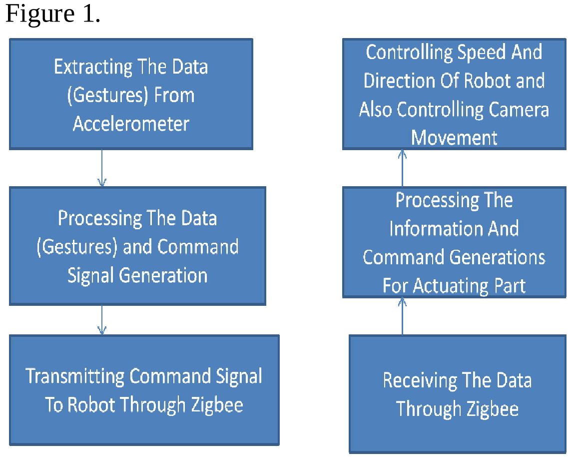
1. INTRODUCTION

There Are Many Ways Humans Are Communicating With Machines ,In This Context Machine Refers To A Robot or Any Device Or Something Which Is Including Some Sensing Part ,Processing Part And Mechanically Equipped With Some Material. Humans are anxiously working on finding new ways of interacting with machines. A gesture is a form of non-verbal Communication in which visible bodily actions communicate particular messages. It comprises of sound, light variation or any type of body movement. Based upon the type of gestures, they have been captured via Acoustic (sound), Tactile (touch), Optical (light), Bionic and Motion Technologies through still camera, data glove, Bluetooth, infrared beams etc.

Motion Technology has succeeded in drawing the attention of researchers from different parts of the world. For past two decades, researchers from around the world have shown keen interest in gesture technology and its possibilities in various fields making it a powerful tool for Humans. Researchers [1] proposed vision-based interface that included gesture recognition through camera to provide geometrical information to the robots. They developed mobile robot systems that were instructed through arm positions but those robot systems couldn't recognize gestures defined through specific temporal patterns. Other limitation faced by the cameras was the poor illuminations at night and in foggy weather. Motion technology facilitates humans to interact with machines naturally without any interventions caused by the drawbacks of mechanical devices. Using the concept of gesture recognition, it is possible to move a robot accordingly [2]. Gyroscope and Accelerometers are the main technologies used for human machine interaction that offer very reasonable motion sensitivity, hence, are used in large array of different applications [3].

2. SYSTEM OVERVIEW

The goal is to create a methodology that helps users to control a robot with a high-level of abstraction from the robot language. Making a demonstration in terms of high-level behaviors (using gestures, speech, etc.), the user should be able to demonstrate to the robot what it should do, in an intuitive way. The Basic Flow of System is Shown Figure 1.



Basic Flow Of System

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Fig 1:Basic Flow of System

2.1 CAPTURING GESTURES USING ACCELEROMETER

An accelerometer is a device that measures proper acceleration. The proper acceleration measured by an accelerometer is not necessarily the coordinate acceleration (rate of change of velocity). Instead, the accelerometer sees the acceleration associated with the phenomenon of weight experienced by any test mass at rest in the frame of reference of the accelerometer device. For example, an accelerometer at rest on the surface of the earth will measure an acceleration g= 9.81 m/s^2 straight upwards, due to its weight. By contrast, accelerometers in free fall or at rest in outer space will measure zero. Another term for the type of acceleration that accelerometers can measure is g-force acceleration [4].

The Accelerometer We Used Is Multi Axis And Analog Device. It Gives 3 Dimensional Data In Analog Form We Convert This Analog Data Into Digital Form. The 3-Dimensional Coordinates Values Are Used To Differentiate Between Different Gestures. The Figure 3 Shows How Accelerometer Is Placed On Hand. The Variations In Hand movements Results Changes In 3 D Coordinate system. We Can Further Gather These Changes And Process In Processor To Recognize The Different Gestures By Hand.

Fig 2: accelerometer

Fig 3: Accelerometer Attached To Human Hand

The Data From Accelerometer is Ranges From 46 To 126.This Range Of Values Depends On Prescalar Value Used In Converting Analog To Digital Conversion. The Range Of Values Of X,Y Axis Shown In Fig 4.

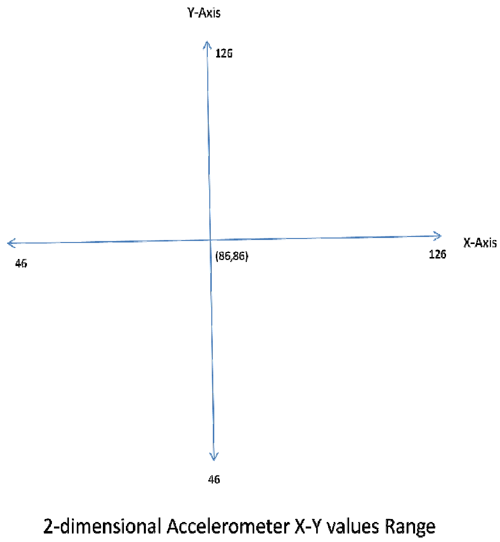

Fig 4: Range Of Values from X, Y Axis In Accelerometer

2.2 DATA PROCESSING IN MICROCONTROLLER

Microcontroller Is a Heart Of This Project, It Process The Data From Different Inputs Based On The Data Processed It Will Generate Associated Command Signals. The Data Which We Get From Accelerometer Is Now Processed Using ATMega16 [6] Microcontroller Development Board. We Write An Algorithm In Microcontroller To Process The Data From Accelerometer, Based On These Data Microcontroller Generates Associated Command Signals To Robot. Microcontroller Simply Process the Data from Accelerometer to Define Different Gestures Signals.The Development Board Which We Used Shown In Figure5.

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Fig 5:Microcontroller Development Board

2.3 DATA TRANSMISSION TO ROBOT THROUGH ZIGBEE COMMUNICATION

ZigBee is a specification for a suite of high level communication protocols used to create personal area networks built from small, low-powerdigital radios. ZigBee is based on an IEEE 802.15 standard. Though low-powered, ZigBee devices can transmit data over long distances by passing data through intermediate devices to reach more distant ones, creating a mesh network. ZigBee is a low-cost, low-power, wireless mesh network standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications. Low power usage allows longer life with smaller batteries. Mesh networking provides high reliability and more extensive range. ZigBee chip vendors typically sell integrated radios and microcontrollers with between 60 KB and 256 KB flash memory. ZigBee operates in the industrial, scientific and medical (ISM) radio bands: 868 MHz in Europe, 915 MHz in the USA and Australia and 2.4 GHz in most jurisdictions worldwide. Data transmission rates vary from 20 kilobits/second in the 868 MHz frequency band to 250 kilobits/second in the 2.4 GHz frequency band[5].

Fig 6:Zigbee Transceiver

We Used Zigbee in This Project To Make A Wireless Communication Between Robot And Accelerometer Placed At Human Hand.

At Receiving End The Data Is Received Through Zigbee Transceiver. The Data Then Processed In Microcontroller; Based On Different Command Signal the Actuation Part in Robot Is Controlled.The Zigbee Transceiver Is Shown In Fig 6.

2.4 BLOCK DIAGRAM

The Block Diagram Of Entire System is shown In Fig 7(Transmitting End) and Fig 8(Receiving End).

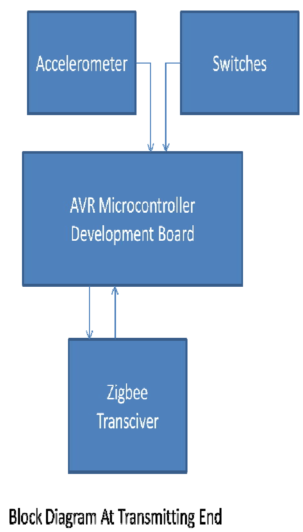

Fig 7:Block Diagram At Transmitting End

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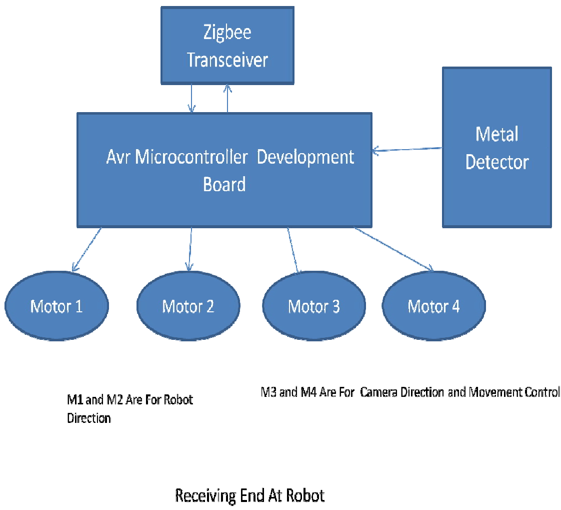

Fig 8: Receiving End at Robot

2.5 WIRELESS CAMERA

We Used JMK WS-309AS Wireless Camera, We Are Able To Get A Perfect Data Transfer From Camera To Receiver. The Data Received Is Streamed In Laptop/Personal Computer.

Fig 8: Wireless Camera

2.6 ROBOT CONSTRUCTION

The Mobile Robot [7] We Constructed Is Shown In Fig .The Robot Is Equipped With Wireless Camera. Angles, We Used Two D.C 60 R.P.M Motors For Controlling The Camera Movement By Which We Are Capable Of Collecting The Images At Different Angles. To Capture The Images Of Environment At Different The Robot Direction And Speed Control Is Done By Another 2 Motors of 150 R.P.M Attached To Robot. The Direction And Speed Of Both Motors Decides The Robot Action And Speed.

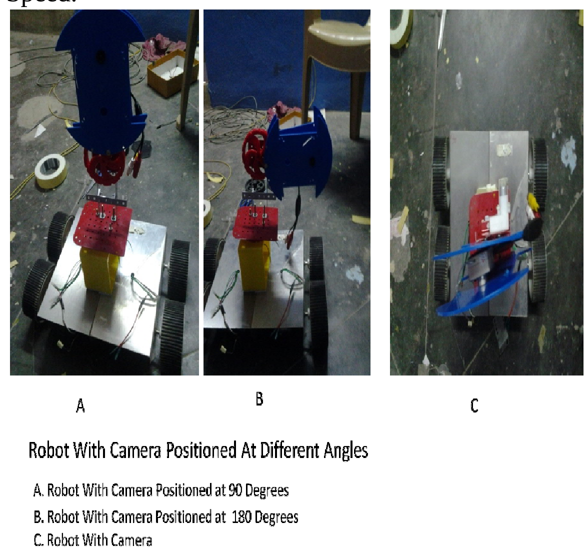

Fig 9: Robot with Camera, Camera Positioned at Different Angles

Mobile Robot We Designed Can Perform Various Actions, It Can Perform 9 Types Of Actions Based On The movement of Motors Connected To Robot. We Used 150 R.P.M D.C Motors In Constructing This Robot.

3. OUR WORK AND RESULTS

We Designed an Algorithm To Control The Speed And Direction Of Robot Through Hand Gestures. In This Project We Operate The Robot In 3 Modes Using Hand Gestures.

Mode 1: In This Mode the Predefined Gestures Are Used to Control Only Direction of Robot. Angular Differential Drive is Not Obtained In This Mode.

The Different Gestures For Controlling The Robot In Mode1 Is Shown In Figure. The Associated X, Y Coordinate Values For Different Robot Action And Movement Of Motors Are Shown In Table 1. The Hand Gestures For Different Actions Are Shown In Fig 10.

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S.NO	Robot Action	Motor 1 Direction	Motor 2 Direction	X	Y
1	Forward	Clock-wise	Clock-wise	85-95	120-126
2	Backward	Anti-Clockwise	Anti-Clockwise	85-95	45-55
3	Forward Left	Stop	Clockwise	55-65	70-85
4	Forward Right	Clockwise	Stop	110-115	70-85
5	Backward Left	Stop	Anti-Clockwise	60-70	110-115
6	Backward Right	Anti-clockwise	Stop	110-120	110-115
7	Right Spin	Clockwise	Anti-Clockwise	120-126	85-95
8	Left Spin	Anti-clockwise	Clockwise	45-55	85-95
9	Stop	Stop	Stop	85-90	85-90

Table1.Robot Actions Based On X,Y Values

A.Stop Action

B.Forward Action

C.Backward Action

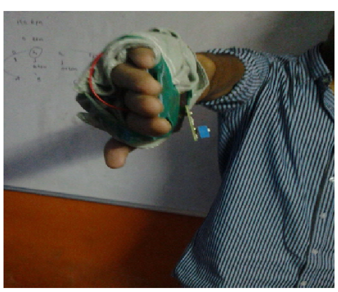
D.Forward Right Turn

E.Backward Left turn

F. Forward Left Turn

G. Backward Left

H. Right Spin



F. Left Spin

Fig 10 Gestures Defined For Different Actions Of Mobile Robot

Mode 2:

This Mode Is For Angular Differential Control Of Robot. The Gestures Recognized In This Mode Are Not Only Used For Directions Of Robot, We Can Also Control The Speed Of Motors By Which We Can Obtain Angular Turns Of Robot. The Data We Obtained By Accelerometer Consists of X, Y Co-ordinate Values. First Value Indicates The X-Axis Value And Next Value Indicates The Y-Axis Value. Based On These Two X,Y –Axes Values ,We Are Going to Control The Direction And Speed Of Motor In A Linear Way. For Differential Speeds and Differential Motion of Robot. For Differential Controlling We Are Going With Two Other Extra Parameters angular Velocity and Angular Radius Which We get From Converting Cartesian Form To Polar Form, The Parameters Are (R,Ø). Based On These Parameters The Speed Of Different Motor [8] Is Controlled Through Pulse Width Modulation,

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When The Speed Of These Two Motors Are Controlled We Can Get Diffential Motion Of Robot.

Maximum Speed of Motor =150 R.P.M

Speed of Motor Is Directly Proportional To Angle between X and Y-Axis Duty Cycle of Motor Is Controlled By Angle between X And Y Axis. Based On The Relationship Between X, Y Coordinates Values We Decided The Duty Cycle.

$X1=|86-X|$

$Y1=|86-Y|$

Duty Cycle For Motor 1=(X1/4)*10

Duty Cycle For Motor 2=(Y1/4)*10

Mode 3: This mode is for Camera Movement Control. The Gestures Recognized In This Mode Are Used To Control Camera Direction And Movement. In This Mode Also We Use Pulse Width To Control The Speed Of Motor Which Is Connected To Camera, So That We Can Achieve Angular Motion For Camera Position.

The Switching Between Modes Is Done By Switches Connected At Transmitting End. We Used WinAvr Compiler For Coding.

4. CONCLUSION

We Tested Our Project In Each Mode; We Got Good Results In Each Mode. The Accuracy Of Gestures Recognition Should Be Improved. This Kind Of Projects Are Applicable In Field Of Security Systems ,Boarder Security ,Surveillance Systems Where We Can Send Robots To Detect The Presence Of People, Objects Present In The Environment.

5. FUTURE WORK

Future Work Includes Improving Gestures Recognition Accuracy For Human Machine Interaction. We also focus on improving The Stability of Robot to Handle Objects, To Travel in Any Surface.

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