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An Intelligent Approach to Humanoid Robot Imitation using Accelerometer

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Abstract

Robots have Artificial Intelligence. The Artificial Intelligence may vary from one to another. Some Robots do action based on the gestures produced by Human. In this project, we have designed a Robot which is based on Human movements. Four MEMS accelerometers are connected with the two hands and legs of the particular person. This project consists of three stages. They are 1) Signal sensing, 2) Signal analysis and 3) Signal control. When the person moves his hand, leg etc. in up or down, the accelerometer connected with the particular organ identifies the movement and accordingly it sends signal to the microcontroller and signal sensing stage is done. In signal analysis the microcontroller analyses the signal and accordingly it controls the Robotic motors. The signal control is done by the robotic motors. The Robotic motors move the arm, leg of the Robot according to the particular person's movement. Thus the Robot can move its hand, leg like the particular human being.
Keyword- Accelerometer, Humanoid Robot, Human Imitation

I. INTRODUCTION

This system we implements motion imitation interaction between a humanoid robot and a human. To achieve the implementation, three main processes are required. The first is the human motion data acquisition; the second is the motion data modification; and the last is the ankle angle adjustment on the supporting foot (or feet) of the humanoid robot. In these three processes Fuzzy compensator and image processing techniques are used.

The major drawback is the humanoid robot can't imitate the human motion, if any of the color mark is disappeared and also all the imitation by the human should have to be performed in front of the webcam. So in future, for avoiding these we have make use of accelerometer. Using accelerometer, there is no need the human to imitate in front of camera and also no problem regarding the color marks will occur. In [1] a glove with some flexion and some pressure sensors are pasted on to obtain the hand gestures of a human for controlling some robots. Especially, human-like motion and gestures of a robot are main contributions to its appearance, which has a strong influence on a user. An arm robot is successfully built to perform some tasks, such as object grasping, by measuring the motions of a human arm, in [2] and [3]. These interactions deal with some parts only. Also this interaction can be extended to a whole humanoid robot. If the humanoid robot human, then we may teach the robot make perform various complex human motion s like walking gymnastics, dancing [4], Kong-Fu show [5], etc. About six cameras and image processing were applied to recognize the 38 marks pasted on the human body in [5] so that the robot could imitate a human practicing gong-Fu ―Tai Chi.‖ [6] performs similar studies. In [7], the various human hand motions in real time is imitated by the humanoid robot using only one camera which helps to recognize the skin color of both the human's hands. Thus we have to modify this acquired data of human motion to guarantee the balance of the robot foot to attain stability when it performs the motion imitation. A stable motion trajectory is made up as a result of data.

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/s2 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.

Accelerometers have multiple applications in industry and science. Highly sensitive accelerometers are components of inertial navigation systems for aircraft and missiles. Accelerometers are used to detect and monitor vibration in rotating machinery. Accelerometers are used in tablet computers and digital cameras so that images on screens are always displayed upright. Single- and multi-axis models of accelerometer are available to detect magnitude and direction of the proper acceleration.

II. BLOCK DIAGRAM AND WORKING OF THE SYSTEM

The block diagram below shows the MEMS Accelerometer. These five sensor modules work continuously to overcome all the defects of the existing system.

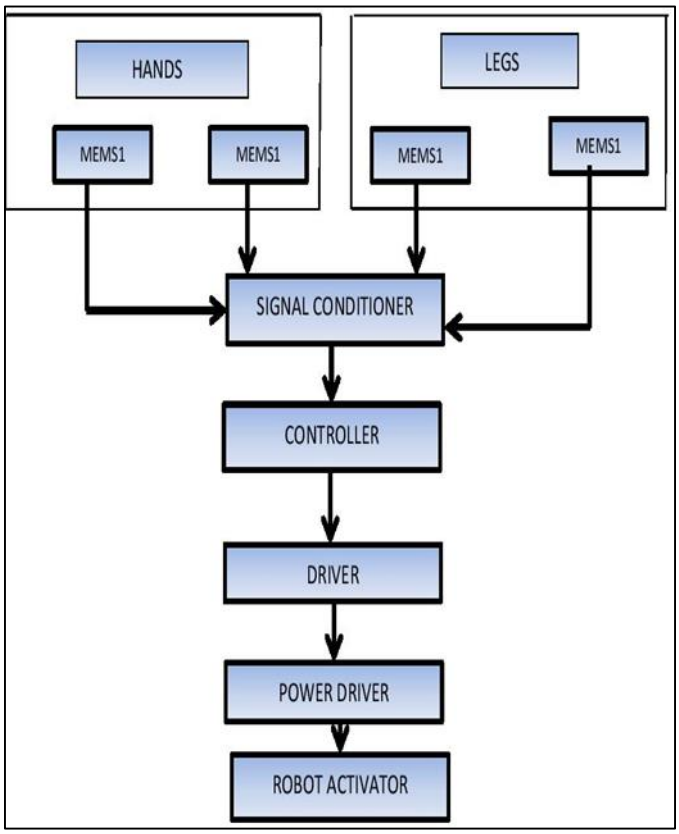

Fig. 1: Block Diagram

There are four MEMS sensor modules, one for right hand, one for left hand, one for right leg and one for left leg motions. Each MEMS sensor for the modules consists of ADC. It converts the analog signals to digital signals and given to the PIC microcontroller. These are inbuilt ADC. The acceleration and the position of the sensor signals of the body motions are printed in the LCD modules.

The working of this system can be classified by three stages. They are

1) Signal sensing
2) Signal analysis
3) Signal control

When the person moves his hand, leg etc. in up or down, the accelerometer connected with the particular organ identifies the movement and accordingly it sends signal to the microcontroller and signal sensing stage is done. In signal analysis the microcontroller analyses the signal and accordingly it controls the Robotic motors. The signal control is done by the robotic motors. The Robotic motors move the arm, leg of the Robot according to the particular person's movement.

When the position of the hands or legs is in equilibrium the corresponding values are displayed in the LCD. When the position of the body parts are changed due to the motion the value displayed in the system is changed. The each motor holds 12v/6v. Thus each of the hands and legs gets 2 signals. Ie each motor gets 2V.Drivers is npn or pnp which converts to 12v. There are 8 relays that decide the working of motor, The 4 motors works at 6V.

III. HARDWARE DESCRIPTION

The hardware part includes the following.

1) MEMS Accelerometer
2) Conditioner
3) Controller
4) LCD
5) Driver & Power Driver
6) Robot Activator

1) MEMS Accelerometer

An accelerometer is an electromechanical device that measures acceleration forces. These forces may be static, like the constant force of gravity pulling at our feet, or they could be dynamic - caused by moving or vibrating the accelerometer. There are many types of accelerometers developed and reported in the literature. The vast majority is based on piezoelectric crystals, but they are too big and too clumsy. People tried to develop something smaller, that could increase applicability and started searching in the field of microelectronics. They developed MEMS (micro electromechanical systems) accelerometers.

2) Signal Conditioner

In electronics signal conditioning means manipulating an analog signal in such a way that it meets the requirements of the next stage for further processing. Most common use is in analog-to-digital converters. In control engineering applications, it is common to have a sensing stage (which consists of a sensor), a signal conditioning stage (where usually amplification of the signal is done) and a processing stage (normally carried out by an ADC and a micro-controller). Operational amplifiers (op-amps) are commonly employed to carry out the amplification of the signal in the signal conditioning stage.

3) Microcontroller

The microcontroller we used here is PIC 16F877.The output from the signal conditioner is sent to the microcontroller. Acceleration and the position of the sensor signals of the body motions are printed in the LCD modules. The position of the hands or legs is in equilibrium the corresponding values are displayed in the LCD. When the position of the body parts are changed due to the motion the value displayed in the system is changed. The microcontroller analyses the signal and accordingly it controls the Robotic motors.

4) LCD

Signal isolation must be used in order to pass the signal from the source to the measurement device without a physical connection: it is often used to isolate possible sources of signal perturbations. Also notable is that it is important to isolate the potentially expensive equipment used to process the signal after conditioning from the sensor.

Magnetic or optic isolation can be used. Magnetic isolation transforms the signal from voltage to a magnetic field, allowing the signal to be transmitted without a physical connection (for example, using a transformer). Optic isolation takes an electronic signal and modulates it to a signal coded by light transmission (optical encoding), which is then used for input for the next stage of processing.

5) Drivers and Power Drivers

The microcontroller analyses and sends the signal and it controls the Robotic motors. The each robotic motor holds 12v/6v. Thus, each of the hands and legs gets 2 signals, each motor gets 2V. Drivers here used are npn or pnp transistors which converts to 12v. There are eight relays and four motors decide the working of motor. The four motors works at 6V. The Robotic motors move the arm, leg of the Robot according to the particular person's movement.

6) Robotic Activator

The Robotic activator includes robotic motors and relays. An electric motor uses electrical energy to produce mechanical energy, nearly always by the interaction of magnetic fields and current-carrying conductors. The reverse process that converts mechanical energy to produce electrical energy is accomplished by a generator or dynamo. Traction motors used on vehicles often perform both tasks.

IV. RESULTS AND DISCUSSION

Fig. 2: Humanoid Robot

When the person moves his hand, leg etc. in up or down, the accelerometer connected with the particular organ identifies the movement and accordingly it sends signal to the microcontroller and signal sensing stage is done. In signal analysis the microcontroller analyses the signal and accordingly it controls the Robotic motors. The signal control is done by the robotic motors. The Robotic motors move the arm, leg of the Robot according to the particular person's movement. Thus the Robot can move its hand, leg like the particular human being.

The Fig 2 shows the designed humanoid robot that imitates human motions. Based on the motion of the accelerometer fitted on the human demo, its initiates motion and makes the movements imitation.

Robots have replaced humans in the assistance of performing those repetitive and dangerous tasks which humans prefer not to do, or are unable to do due to size limitations, or even those such as in outer space or at the bottom of the sea where humans could not survive the extreme environments.

There are concerns about the increasing use of robots and their role in society. Robots are blamed for rising unemployment as they replace workers in some functions. The use of robots in military combat raises ethical concerns. The possibility of robot autonomy and potential repercussions has been addressed in fiction and may be a realistic concern in the future.

Fig. 3: Humanoid Robot and Human Demo fitted with accelerometer on hands

Fig 3 shows the humanoid robot demo and the human demo which the accelerometers are fitted in hands. The two accelerometers are fitted on both right and left hands can be seen in the figure. Then signal sensing, signal analysis and the signal control is done and the humanoid robot thus performs motion imitations as shown.

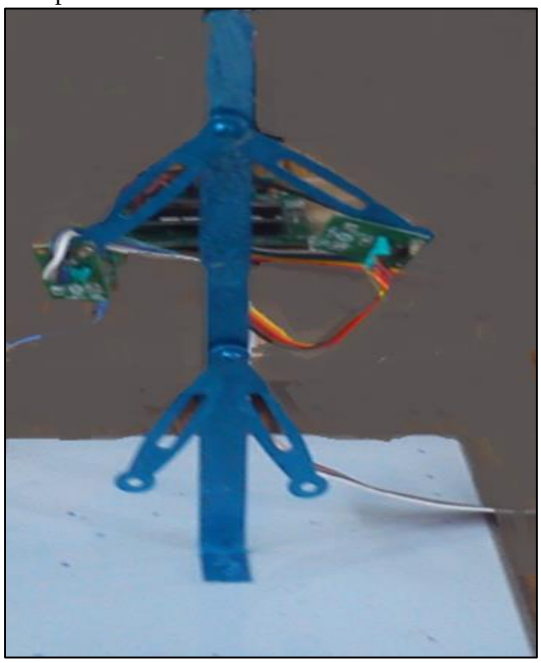

Fig. 4: Human Demo fitted with accelerometer on hands

Fig 4 shows the human demo. In the both hands two accelerometer are connected. This is a wired connection as shown. The wires are connected to the humanoid robot. The output from the signal conditioner is sent to the microcontroller. Acceleration and the position of the sensor signals of the body motions are printed in the LCD modules. The position of the hands or legs is in equilibrium the corresponding values are displayed in the LCD. When the position of the body parts are changed due to the motion the value displayed in the system is changed. The microcontroller analyses the signal and accordingly it controls the Robotic motors.

Signal isolation must be used in order to pass the signal from the source to the measurement device without a physical connection: it is often used to isolate possible sources of signal perturbations. Also notable is that it is important to isolate the potentially expensive equipment used to process the signal after conditioning from the sensor.

Fig 5 shows the circuit board including the PIC microcontroller and the LCD module. PIC16F877 is the microcontroller used here. LCD screen is used to represent the motion. Also Fig.6 shows the pictures for the robot which imitates gymnastics motion.

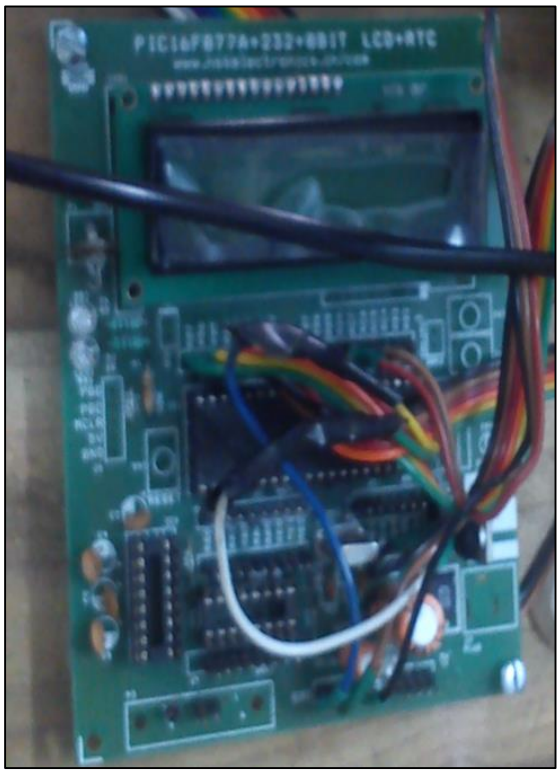

Fig. 5: expanded view of Microcontroller and LCD Modules

Fig. 6: pictures for the robot to imitate gymnastics motion

V. CONCLUSION

The Artificial Intelligence using humanoid robots may vary from one to another. Some Robots do action based on the gestures produced by Human. In this project, we have designed a Robot which is based on Human movements. Four MEMS accelerometers are connected with the two hands and legs of the particular person. This project consists of three stages. They are 1) Signal sensing, 2) Signal analysis and 3) Signal control.

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