

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

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

## Human Machine Interaction By Hand Gesture Using A Wireless Link

Vigneshkumar.P<sup>1</sup>, Prabhakaran.G<sup>1</sup>, Boopathi.R<sup>1</sup>, Natarajan.P<sup>2</sup>

Assistant Professor, Dept of EEE, Selvam College of Technology, Namakkal, India<sup>1</sup>.

UG Scholar, Dept of EEE, Selvam College of Technology, Namakkal, India<sup>2</sup>.

**ABSTRACT:** Robotics is one of the present trends in the era of computing in today's system automation industry and control. To facilitate a feasible solution to this requirement, we have implemented a system through which the user can give commands to a wireless robot using gestures. Through this method, the user can control or navigate the robot by using gestures, thereby interacting with the robotic system. The existing schemes provide a wireless communication link to interface human gesture recognition with the robotic arm. It takes the input from the sensors, which responds to hand gesture, and processed in the transmitter section controller. In this project the sensors that sense the maximum hand gesture movements and communicate with the sections quite faster which uses Zigbee module. Robotic arm will resemble the human hand and starts the movement almost at the same time as the user starts to perform hand gesture.

**KEYWORDS:** PIC Microcontroller, Gesture Recognition, Hand gesture, Robotic ARM.

### I. INTRODUCTION

More recently, industries have introduced more flexible forms of automation in the manufacturing cycle. Programmable mechanical manipulators are now being used to perform such tasks as spot welding, spray painting, material handling, and component assembly. Since computer controlled mechanical manipulators can be easily converted through software to do a variety of tasks.

Robots are generally used to perform hazardous, highly repetitive, and unpleasant tasks. Most robots are set up for an operation by the teach-and-repeat technique. In this mode, a trained operator (programmer) typically uses a portable control device (a teach pendant) to teach a robot its task manually. The programming and controlling of movements of robotic arm through the use of robot teach pendant is still a difficult and time consuming task that requires technical expertise. Therefore, new and easier ways for robot programming are required. The main aim of this paper is to develop a methodology with a high level of abstraction that simplifies the robot programming. In this paper we proposed an sensor - based gesture recognition system to control an industrial robot in a natural way. A trained system was used to recognize gestures and postures.

### II. SYSTEM OVERVIEW

Human gesture can be captured using a variety of hardware devices. The head, hands and body can be localized in space using trackers, video techniques, gloves or suits. Trackers are devices that allow one to directly measure the position and orientation of a body part in space. Gloves and suits allow one to measure the relative positions and angles of body components.

Gloves measure hand and finger angles and movements of the fingers relative to the hand. Most can be equipped with fingers relative to the hand. Most can be equipped with a position tracker in order to follow global hand position<sup>[1]</sup>. Numerous sensors are needed and the resulting data rate can be high. Various measurement technologies can be used, including optic fibers, Hall Effect, resistance variation or accelerometers. Gloves have been used as pointing devices, but they offer a much richer form of interaction through hand posture recognition and dynamic

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gesture interpretation. The main problems encountered are repeatability, precision and reliability. Almost every glove needs calibration before each use, since the manner in which it is fitted onto the user’s hand greatly affects the measurements. Sensor technologies used in gloves have been applied to body posture recognition using “data suits”, but this field is still fairly immature.

### III. SYSTEM MODEL

Transmitter section shown in figure1 consists of flex sensor and a Zigbee module used to sense and transmits the gesture movement. The CC2500 is a low-cost 2.4 GHz transceiver designed for very low-power wireless applications. The circuit is intended for the 2400- 2483.5 MHz ISM (Industrial, Scientific and Medical) and SRD (Short Range Device) frequency band. The RF transceiver is integrated with a highly configurable baseband modem. The modem supports various modulation formats and has a configurable data rate up to 500 kBaud. C2500 features a low-IF receiver. The received RF signal is amplified by the low noise amplifier (LNA) and down-converted in quadrature (I and Q) to the intermediate frequency (IF). At IF, the I/Q signals are digitised by the ADCs. Automatic gain control (AGC), fine channel filtering, demodulation bit/packet synchronization are performed digitally. It provides extensive hardware support for packet handling, data buffering, burst transmissions, clear channel assessment, link quality indication, and wake-on-radio.

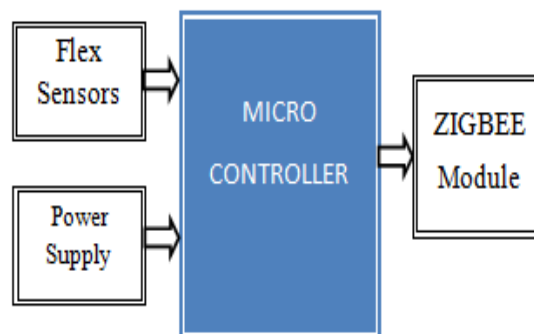


Fig. 1 Block Diagram of Transmitter Section

The power supply must be properly decoupled close to the supply pins. Note that decoupling capacitors are not shown in the application circuit. The placement and the size of the decoupling capacitors are very important to achieve the optimum performance.

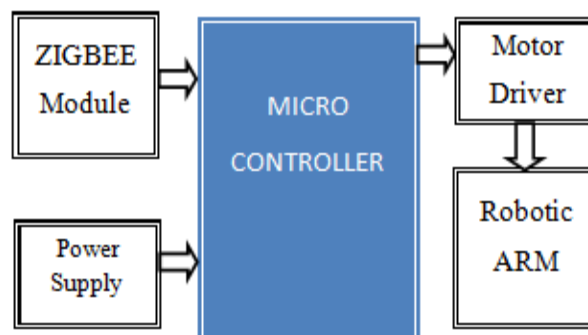


Fig. 2 Diagram of Receiver Section

Receiver section shown in figure2 consists of Driver circuit, the robotic arm and a Zigbee module which receives the signal and corresponding robotic arm function is carried out. The DC Gear motor, consisting of a DC electric motor and a gearbox, is at the heart of several electrical and electronic applications. Precision Micro drives have been designing and developing such high quality mini DC gear motors in an easy-to-mount package for a

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range of products and equipment. Our miniature gear motor work smoothly and efficiently, supporting these electrical and electronic applications. These geared motors have reduction gear trains capable of providing high torque at relatively low shaft speed or revolutions per minute (RPM). Precision Micro drives DC geared motors reduce the complexity and cost of designing and constructing applications such as industrial equipment, actuators, medical tools, and robotics.

Precision Micro drives have engineered a range of planetary and spur gear motors suitable for many future and existing applications. The main characteristics of these gear motors are miniature form factors, offering significant strength, torque, and other technical capabilities that these applications require<sup>[2]</sup>. Their linear performance characteristics make them suitable for many applications requiring a controlled performance. Whether you are looking for automotive, medical, or domestic applications, DC Gear motors from Precision Micro drives not only offer the variable speed and torque control required in each of these applications. They also possess quality characteristics of reliability, ruggedness, and compactness. The operations performed by Precision Micro drives geared motors appear simple and effortless. However, they are highly sophisticated devices, and some units are encapsulated in housings to prevent exposure to moisture and dust.

## A. *Robotic ARM*

A robotic arm is a type of mechanical arm, usually programmable, with similar functions to a human arm, the arm may be the sum total of the mechanism or may be part of a more complex robot. The most common manufacturing robot is the robotic arm<sup>[3]</sup>. The computer controls the robot by rotating individual step motors connected to each. Unlike ordinary motors, step motors move in exact increments. This allows the computer to move the arm very precisely, repeating exactly the same movement over and over again. The robot uses motion sensors to make sure it moves just the right amount.

## B. *PIC Microcontroller*

Peripheral Interface Controllers (PIC) is one of the advanced microcontrollers developed by microchip technologies. These microcontrollers are widely used in modern electronics applications. A PIC controller integrates all type of advanced interfacing ports and memory modules. These controllers are more advanced than normal microcontroller like INTEL 8051. The first PIC chip was announced in 1975 (PIC1650). As like normal microcontroller, the PIC chip also combines a microprocessor unit called CPU and is integrated with various types of memory modules (RAM, ROM, EEPROM, etc), I/O ports, timers/counters, communication ports, etc. PIC16F877A devices have a host of features intended to maximize system reliability, minimize cost through elimination of external components, provide power saving operating modes and offer code protection. PIC16F877A devices have a Watchdog Timer which can be shut-off only through configuration bit. It runs off its own RC oscillator for added reliability.

The Analog-to-Digital (A/D) Converter module has five inputs for the 28-pin devices and eight for the 40/44-pin devices. The conversion of an analog input signal results in a corresponding 10-bit digital number. The A/D module has high and low-voltage reference input that is software selectable to some combination of VDD, VSS, RA2 or RA3. The A/D converter has a unique feature of being able to operate while the device is in Sleep mode. To operate in Sleep, the A/D clock must be derived from the A/D's internal RC oscillator.

## C. *Sensors*

Flex sensors shown in figure4 are the sensors that change in resistance depending on the amount of bend on the sensor. They convert the change in bend to electrical resistance – the more the bend, the more the resistance value. They are usually in the form of a thin strip from 1" – 5" long that vary in resistance. Flex sensors are analog resistors. Inside the flex sensor are carbon resistive elements within a thin flexible substrate. More carbon means less resistance. When the substrate is bend the sensor produces a resistive output relative to the bend radius.

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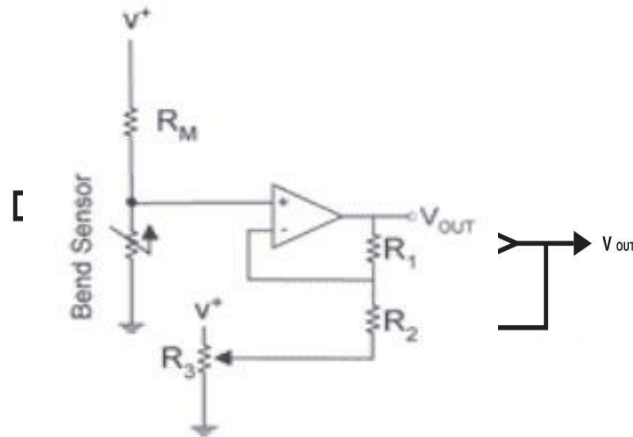


Fig.3 Basic flex sensor circuit

Flex sensors are analog resistors. They work as variable analog voltage dividers. Inside the flex sensor are carbon resistive elements within a thin flexible substrate. More carbon means less resistance.

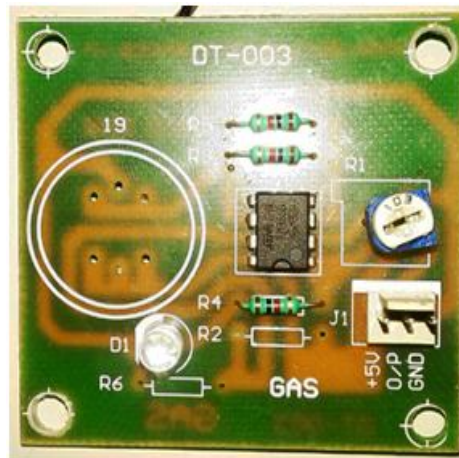


Fig. 4 Flex sensor used

When the substrate is bent the sensor produces a resistance output relative to the bend radius. With a typical flex sensor, a flex of 0 degrees will give 10K resistance will a flex of 90 will give 30-40 K ohms.

The Flex point flex sensor is somewhat different from the simple flex sensors. The Bend Sensor lists resistance of 30-250 K ohms. It has a much bigger range of resistance. The impedance buffer in the Basic Flex Sensor Circuit shown in figure3 is a single sided operational amplifier, used with these sensors because the low bias current of the op amp reduces error due to source impedance of the flex sensor as voltage divider. Suggested op amps are the LM358 or LM324. You can also test your flex sensor using the simplest circuit figure5, and skip the op amp.

It might be useful to note that these companies will do custom jobs, including screen-printing these special carbon-based inks on various materials.

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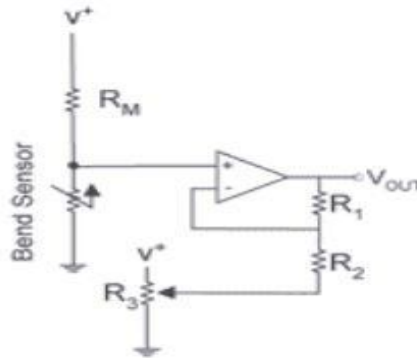


Fig. 5 Driver Circuit for flex sensor

Adjustable buffer figure 6 is a potentiometer that can be added to the circuit to increase the sensitivity.

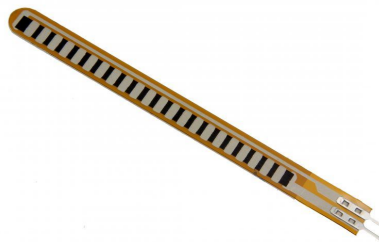


Fig. 6 Adjustable buffer circuit

Variable Deflection Threshold Switch figure 7 is an op amp is used and outputs either high or low depending on the voltage of the inverting input. In this way you can use the flex sensor as a switch without going through a microcontroller.

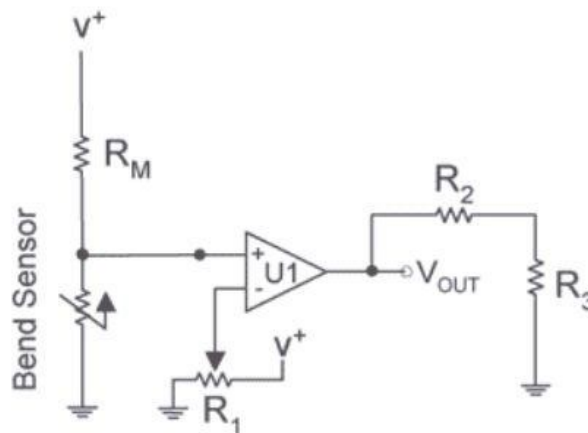


Fig. 7 Variable deflection threshold switch

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Resistance to Voltage Converter shown in figure8 uses the sensor as the input of a resistance to voltage converter using a dual sided supply op-amp. A negative reference voltage will give a positive output. Should be used in situations when you want output at a low degree of bending.

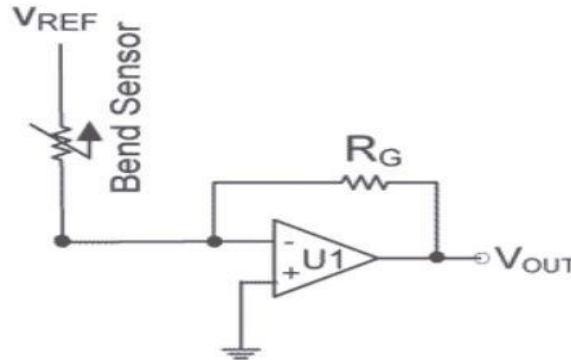


Fig. 8 Resistance to voltage converter

### D. Data Glove

There are two types of technique for gesture recognition. First is the vision based technique and other is glove based technique<sup>[6]</sup>. Glove based techniques having some advantages over the vision based techniques. Using data glove is a better idea over camera as the user has flexibility of moving around freely within a radius limited by the range of wireless connecting the glove to the computer, unlike the camera where the user has to stay in position before the camera. The cause of light, electric or magnetic fields or any other interruption does not affect the performance of the glove. The movement data glove helps users to interface with the practical world.

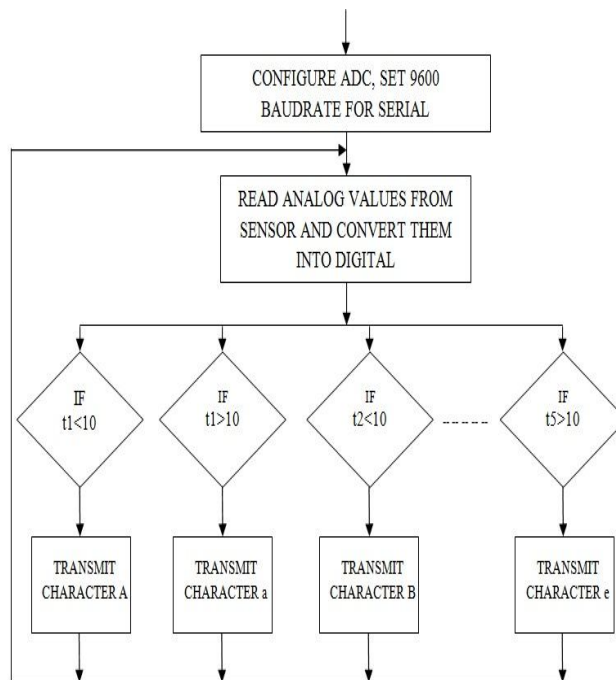


Fig. 9 Transmitter Flow Chart

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## IV. GESTURE RECOGNITION

Flex sensor is used for gesture recognition. Flex sensor is a device that measures the motion of finger and produces different voltage levels<sup>[4]</sup>. The change in motion causes the mass which produces an electrical charge that is proportional to the force exerted upon it. Since the charge is proportional to the force and the mass is a constant, then the charge is also proportional to the amount of bend. And we are using five flex sensors to control the finger movement<sup>[5]</sup>. Transmitter flow chart shown in figure9 gives the function of transmitter section which utilizes sensory inputs.

They convert the change in bend to electrical resistance - the more the bend, the more the resistance value. The output of flex sensors are analog in nature, to convert these analog signals into digital form, we are using in-built ADC of PIC micro controller. Here, the PIC micro controllers continuously read data from flex sensors, and convert them into digital form. This digitized data is compared with the data which is already taken in the flex sensor analysis part. And for every gesture movement some characters are assigned. In this project we are using five flex sensors to control the finger movement.

Flex sensors are sensors that change in resistance depending on the amount of bend on the sensor. They convert the change in bend to electrical resistance - the more the bend, the more the resistance value. The output of flex sensor are analog in nature, to convert these analog signals into digital form, we are using in-built ADC of PIC microcontroller

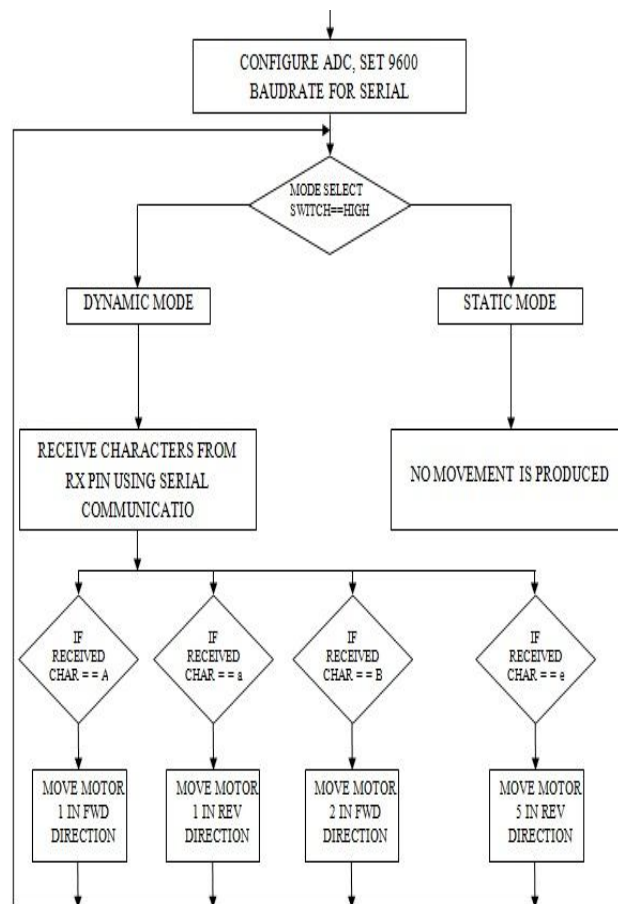


Fig. 10 Receiver Flow Chart



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This digitized data is compared with the data which is already taken in the flex sensor analysis part. And for every movement some characters are assigned. Now, in the comparison phase digitized data is compared with the pre-defined ranges, and for matched range corresponding character will be transmitted through Zigbee transmitter.[4], [5]. Receiver flow chart shown in figure10 gives the function of robotic arm based on the received character.

## V. CONTROLLING MECHANISM

To control different movements of robotic arm we are using PIC16F877 microcontroller board. Zigbee communication modules are set to 9600 baud rate to receive data. PIC continuously checks the mode select switch pin, if the pin is high, then the system will work in Dynamic mode i.e. System will give the movements for current receiving values, if there is no received character then no movement will takes place<sup>[7]</sup>. If the mode select switch is LOW, then the system enters into static mode, in static mode again controller reads the train mode pin, if this pin is HIGH then system enter into training where movements will takes place for received characters. If train mode pin is LOW then simply system executes nothing.[6],[7],[8].

## VI. SYSTEM RESULT AND DISCUSSION

The result shows that the data is transferred to the Robotic ARM over the serial communication under the wireless medium. The inputs from the sensor are processed in transmitter side and send the processed data wirelessly through Zigbee module. In simulation process part resistance is connected as input to the controller and based on the change value the corresponding signal is executed. The signal from the transmitter is processed here and based on the value it receive the corresponding motor control process is carried out. Then the microcontroller reads the data that is received and performs the corresponding motor controlling operation. Driver IC drives the motor corresponding to the microcontroller output. The motor can then interfaced to the robotic arm to perform robotic arm control process.

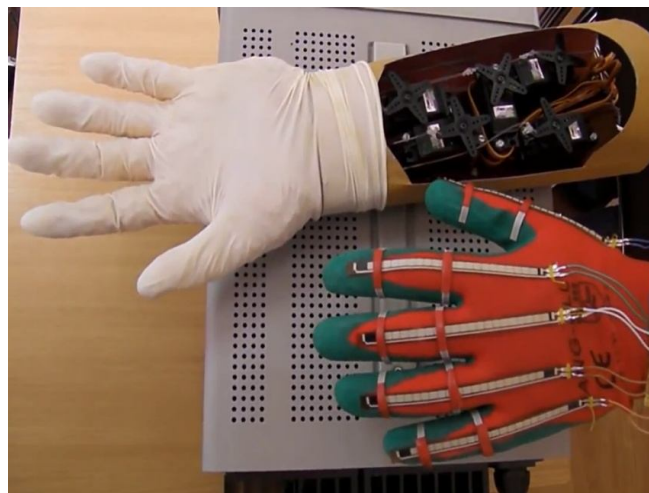


Fig.11 Final output scheme of hand gesture recognition and implementation

## VII. CONCLUSION

In this paper, flex sensor was selected to be the input device of this system, capturing the human finger behavior to control the robotic arm movement. When compared with other common input devices like teach pendant, this approach using sensors over wireless medium is easier to work because of its sensing capacity with the fast movement of human posture. Using this system, a non-expert robot programmer can control a robot quickly and in a natural way that it replicates the human behavior. The low price and short set-up time are other advantages of the system.



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