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RESEARCH ARTICLE

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IMPLEMENTATION OF MOTION CONTROLLED ROBOTIC ARM

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ABSTRACT

Now a day's Robotic Systems are occupying a place in various industries such Automobile, Textile, Product Assembling, etc. This will be very helpful to do the work faster and in precise manner with fewer efforts. Taking these features of Robots into account, we can also use such systems in an environments that are most dangerous and worst to human being, such as Nuclear Plants or Research Labs, Bomb Diffusion, Poisonous Chemical/Gas plants, Mining, etc. This can save human lives and reduce labour problems. For handling, such kind of situations there should be proper interaction between human and the robotic system as robots cannot take decisions on their own. Solution to this can be achieved by controlling the robots according instructions provided by human, in real time, to the robots. In most of the areas, robots are controlled using manual switches or directly programming the robots to do the specific tasks repeatedly. The main objective of our project is to design and develop the Robotic Arm that is used to move using wireless system by recognizing human's actual hand motion that makes the maximum use of robot to help people do their work in an efficient way in their day to day life.

Keywords: Robotic Arm, ARM7, Flex Sensors, Accelerometers, Embedded C.

INTRODUCTION

The project aims to develop Robotic Arm, whose movements can be controlled by moving the controlling person's arm. The Robotic Arm mimics the movements of the controller's arm.The movements of the user's arm are sensed by using a set of accelerometers attached to the joints of his arm. As the position of the arm changes, the corresponding parameters have also changed. The movement of the user arm will decide the corresponding movement of the robotic arm. The communication between transmitter and receiver takes place through RF modules.

For this we are using 2 separate units:-

1. Handheld unit
2. Robot Unit

1 Handheld unit:

Here the handheld device has 2 accelerometers, which give us linear acceleration in X, Y and Z directions. Using the accelerometer the handheld device will decode the hand gestures. Using the look up table in controller, we can decode the exact gesture done by the user like Up, Down, Forward, Reverse, Left and Right etc. In addition, we are using Flex sensor to recognize the movements of fingers Pick and Place. The controller will decode the movement using variable resistance .The handheld unit will then send the decoded gestures to the robot unit using a wireless RF module.

2 ROBOT unit:

The controller will receive the commands sent by the Hand Held unit via RF receiver. The controller will then decode these symbols and run the DC Motors accordingly. We have interfaced DC motors, which will move the robotic arm's shoulder and arm parts in Forward, Reverse, Left, and Right. Then, depending upon the accelerometer reading and According to the Flex movement the Robotic arm's shoulder, arm and fingers will move in real time.

PROPOSED SYSTEM:

BLOCK DIAGRAM:

A] Handheld unit:

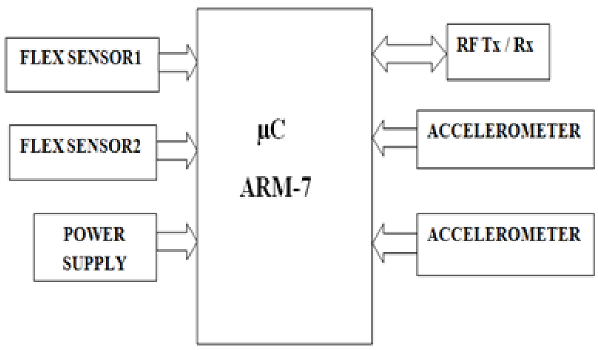

Fig.1

Accelerometer:

One of the most common inertial sensors is the **accelerometer**, a dynamic sensor capable of a vast range of sensing. Accelerometers are available that can measure acceleration in one, two, or three orthogonal axes. They are typically used in one of three modes:

- As an inertial measurement of velocity and position;
- As a sensor of inclination, tilt, or orientation in 2 or 3 dimensions, as referenced from the acceleration of gravity (1 g = 9.8m/s^2);
- As a vibration or impact (shock) sensor.

In our project, we are using two units of accelerometer to detect the rotation and tilts of arm and shoulder part.

Flex Sensor:

Flex sensor are sensor that change in resistance depending on the amount of bend in sensor. They convert the change in bend to electrical resistance-more the bend more the electrical value. They are usually in the form of thin strip-1''-5'' inch long that vary in resistance. They can be made unidirectional or bidirectional.

Flex sensor working:

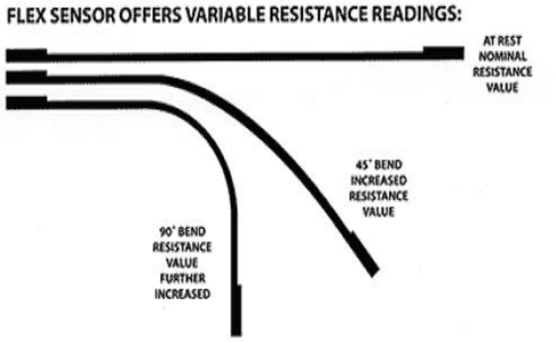

Fig. 2

Flex sensor are analog resistor. They work as variable analog voltage resistors. Inside the flex sensor is carbon resistive elements within a thin flexible substrate. More carbon means less resistance. When the substrate is bending, the sensor produces a resistance output relative to the bend radius.

ARM 7 Controller (LPC2138):

LPC 2138 is a low power device. The ARM7TDMI-S is a general-purpose 32-bit microprocessor, which offers high performance and very low power consumption. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles, and the instruction set and related decode mechanism are much simpler than those of micro programmed Complex Instruction Set Computers. This simplicity results in a high instruction throughput and impressive real-time interrupt response from a small and cost-effective processor core.

It has the features like,

- Multiple serial interfaces including two UARTs (16C550), two Fast I2C-bus (400kbit/s),SPI and SSP with buffering and variable data length capabilities.
- Two 8-channel 10-bit ADCs provide up to 16 analog inputs, with conversion times as low as 2.44 ms per channel.
- Two 32-bit timers/external event counters (with four capture and four compare channels each), PWM unit (six outputs) and watchdog.
- Low power Real-time clock with independent power and dedicated 32 kHz clock input.
- Up to forty-seven 5 V tolerant general purpose I/O pins.
- Power saving modes include idle and Power-down.

B] ROBOT unit:

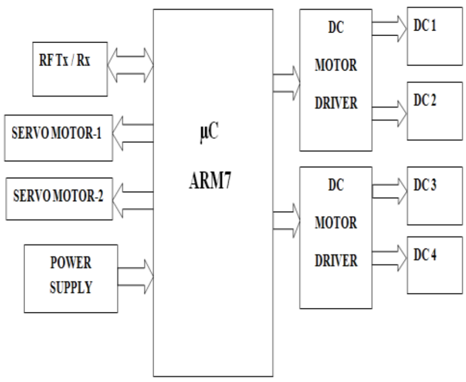

Fig.3

RF Tx/Rx:

XBee Modules were engineered to meet ZigBee/IEEE 802.15.4 standards and support the unique needs of low-cost, low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of critical data between devices. The modules operate within the ISM 2.4 GHz frequency band and are pin-for-pin compatible with each other. Devices that have a UART interface can connect directly to the pins of the RF module as shown in the figure below.

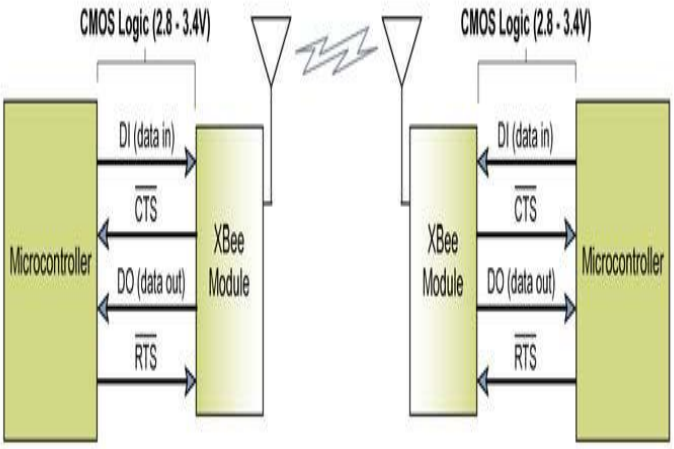

Fig. 4

DC Motor Driver IC (L293D):

The Device is a monolithic integrated high voltage, high current four channel driver designed to accept standard DTL or TTL logic levels and drive inductive loads (such as relays solenoids, DC and stepping motors) and switching power transistors.To simplify use as two bridges, each pair of channels is equipped with an enable input. A separate supply input is provided for the logic, allowing operation at a lower voltage and internal clamp diodes are included. This device is suitable for use in switching applications at frequencies up to 5 kHz.

L293D is a typical Motor driver or Motor Driver IC which allows the DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motors with a single L293D IC. Dual H-bridge *Motor Driver integrated circuit* (*IC*).

Circuit Diagram For l293 d motor driver IC controller:

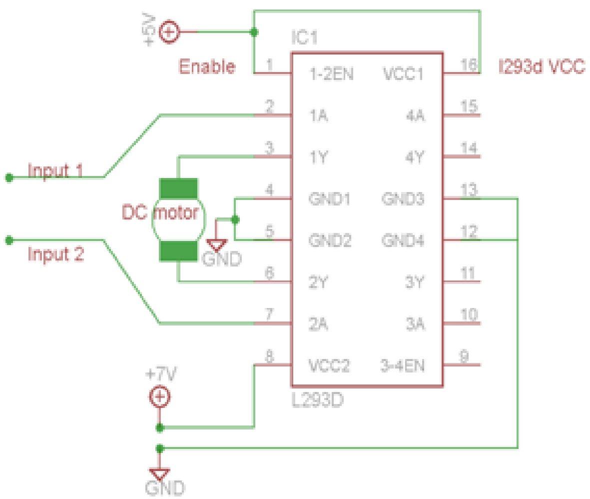

Fig.5

Table 1: Truth Table of Motor Driver

ENABLE	DIRA	DIRB	Function
H	H	L	Turn right
H	L	H	Turn left
H	L/H	H/L	Fast stop
L	either	either	Slow stop

Let's consider a Motor connected on left side output pins (pin 3,6). For rotating, the motor in clockwise direction the input pins have to be provided with Logic High and Logic Low.

In a very similar way the motor can also operate across input pin 15,10 for the motor on the right hand side.

REQUIREMENT OF PROPOSED WORK :

1. Hardware Requirement:

- ARM7 Micro Controller- LPC2138
- (Application Unit)
- 16X2 LCD
- Flex Sensor
- Accelerometer
- L293d Motor driver IC
- 12V DC Geared motors
- Servo motors
- Power Supply etc.

2. Software Requirement:

- ExpressPCB
- Keil for programming of controller
- ·Flash Magic for program downloading

IV MECHANICAL ASSEMBLY:

Robotic Arm:

We have implemented robotic arm in our robot. The arm is able to pick only lightweight item. As well as the arm will do other movement given in the table below. We can operate arm by actual movements of the user's hand. Like when we move the wrist up/down and arm will move up and down respectively and so on. These functions will be done using microcontroller, motor driver IC and motors (DC as well as servo).

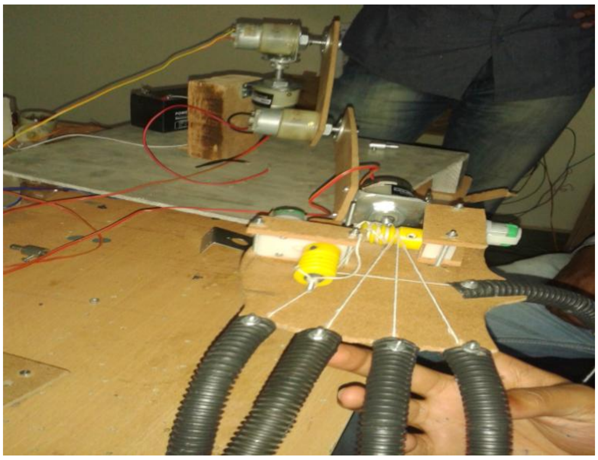

Fig.6

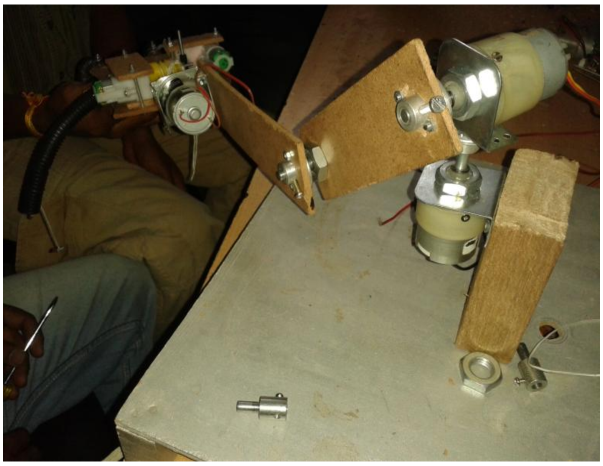

Fig.7

Geared Motor Assembly :

Geared the motors that operate using gears are used because they are bidirectional. That means with these motors we can move our robot in both directions (forward and reverse). Here 4 motors (12v,10rpm) are used to move a robotic arm as well as shoulder part in different directions.

The Fig.8 shows the rotational angles of the Robotic arm assembly, we suppose to implement. As shown in the figure, the shoulder part is capable of moving on up-down, right-left and in rotational directions. Similarly, a movement of thearm and wrist part is also shown.

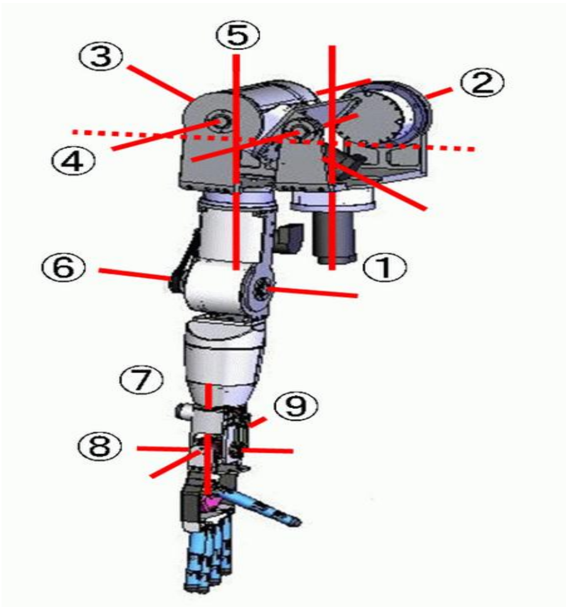

Fig.8

EXPECTED RESULT:

After successful implementation of the complete Robotic Arm assembly with sensors placed on user's hand, it should mimic all the movements done by controlling person. This is summarized as in Table 2.

Human hand motion	**Robotic arm**
Shoulder Up	Shoulder part Up
Shoulder Down	Shoulder part Down
Shoulder Right	Shoulder part Right
Shoulder Left	Shoulder part Left
Arm Up	Arm part Up
Arm Down	Arm part Down
Rotation of wrist	Rotation of wristassembly
Fingers are curled	Fingers are curled

Table 2.

ADVANTAGES & LIMITATIONS:

Advantages: -

- It allows interactivity in real-time between operator and Robotic Arm.

- Can be used in remote rural areas so as to carry out operations.
- Precise control of tools during operation.
- Reduction of no. of peoples needed in the field.

Limitations:

- Robots are not as suitable for making complicated decisions.
- The precision of touch requires a lot of advance design.
- The interfaces are basically not portable and they have a limited workspace
- Auxiliary controls are required to move the workspace of the device to a new location.
- Full working of the robot is dependent on the range of RF transceiver low power module. i.e. up to 100 meters.

APPLICATIONS:

1. Military operations such as Bomb Diffusion, War Fields to save lives of militants.
2. In Chemical Plants.
3. In Atomic Research Labs, Atomic Power Plants.
4. In Mines.
5. In Material Handling.

CONCLUSION

Motion Controlled Robotic Arm system is helpful to control the Robotic Arm in real time, according to the actual motion of user of the system, so that there is no need of skilled operators to operate such system. This will be helpful to control the hazardous situation from a remote distance accurately that can save human lives. Such system can be used to handle critical situations if designed precisely.

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