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Implementation of Virtual Human for Military Application

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***Abstract**: With the advancement in technology we can control almost any gadgets or equipments with appropriate hardware and software. This paper deals with haptic technology to control the locomotion of the robot. Haptics is the concept used to interact with the virtual world by means of touch. Here we make use of MEMS (accelerometer) which relies on the same, for controlling various actions of the robot and thus increases the telepresence. Robotics has been a staple of advanced manufacturing for over half a century. The military field has a lot of challenging tasks under harsh environment but with the help of robots, it can be tackled easily in such conditions. This System eliminates huge losses due to terrorism and antisocial elements which can save human life. The robot has the ability to move; shoot based on gesture commands and also detects the presence of human nearby. The hardware is divided into two major sections, the control room side and the mechanical model. Control room side consists of MEMS which receives the input coordinates from the hand gesture, and this processed information is transmitted to the robotic side which will be placed in the military arena. It is also enabled with an IR camera that acts as an eye for the robot.*

Keywords: MEMS, Haptics, Tele-presence, Accelerometer, IR camera.

I. INTRODUCTION

Looking back into the past decades, robotic devices were making it on the headlines and on the front pages of the newspapers, marking themselves as the milestone in discovery. But now, it's so difficult to believe how things have changed. Technology has become powerful and embedded strongly in our daily tasks. Like changing the TV channel, turning on the AC and even we have come to witness the IoT-based house which will control all the elements in a room automatically. The crucial part comes when we have to use these advancements in a way such that it doesn't deprive our ability but also can come handy during tough times. Gestures [1] are an important means of a human being to express their thoughts in the best possible way. So when we send this along with haptic technology and some software, we can operate devices with our hand gestures. Pondering over this situation, it is smart to use this prototype in military field or a war zone, when stealth and secrecy have to be established. One of the fields of science that deals with touch and interaction between virtual realities are Haptics. MEMS-based accelerometer embedded on the glove is worn which will detect distinct hand gestures (movements).

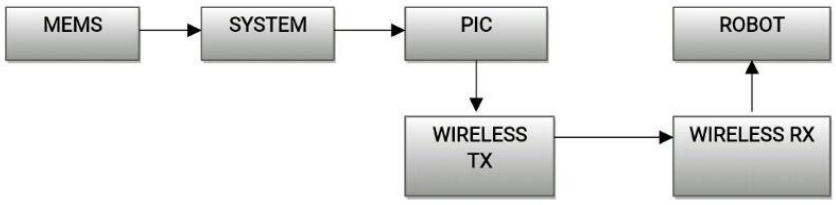

Figure.1 Basic Block Diagram of system

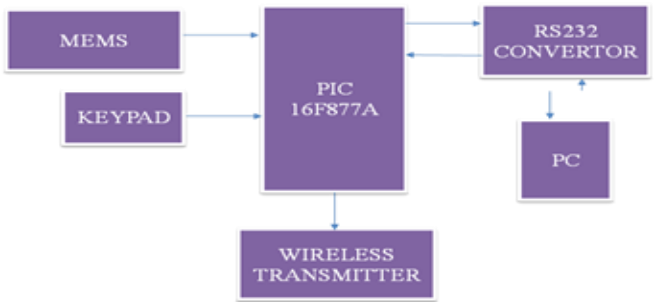

Figure 2: Transmitter side of the system

Here the accelerometer detects the gesture for various orientation of the hand, with respect to three different axes and the microcontroller is used to collect output from the accelerometer and a PC with the appropriate VB[2](visual basic) is used for displaying the corresponding information. The communication between PIC16F877A, RF module and transceiver (computer/Module) is via SPI (serial peripheral interface), and for the transceiver, a pair of CMOS encoder and decoder IC's are used for wireless transmission.

In figure 2, the MEMS device is attached to a glove that is worn by the military official in the control room. Based on the input given to the device the coordinates of the particular hand gesture is sent to the microcontroller which is later proposed and sent to the PC.

Here a program in visual basic will act as the detector of a particular threshold beyond which a specific set of action will take place. This information is processed and sent to the encoder for additional protection during transmission. Furthermore, this is decoded at the robot side and the controller present there is programmed on the basis of these threshold values. These signals consist of commands such as Halt, Crawl Forward, Run Forward, Retreat, Flank Left/Right, etc.

II. FUNCTIONAL BLOCK DIAGRAM & CIRCUIT DIAGRAM

The entire model is divided into 2 parts, namely the control room and the robotic device. On the control room side, which is where the commands are transmitted by an official is equipped with the MEMS-based glove. These instructions are carried out as depicted in this flowchart.

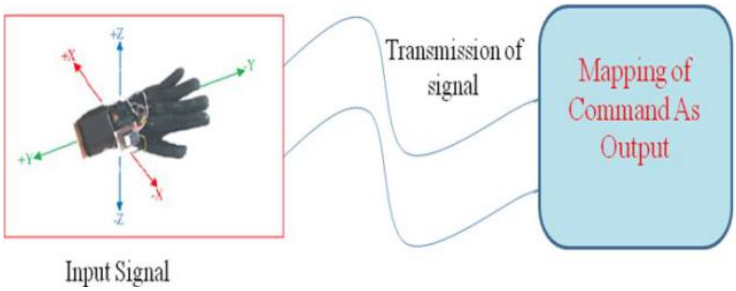

Figure 1: Transmission of signal

After providing 5V DC supply to the MEMS controller present in the glove compartment, the coordinates will be transferred to a 10 bit ADC present in PIC microcontroller. The whole conversion takes place on a single board from analog to digital and finally to serial data that will be transmitted to the PC.

The interface between the PC and the board is RS232 (International standard). The data are transmitted back and forth at a speed of 9600 bits per second such that individual coordinates take up to 3200 bits per second.

This information based on the coordinates are converted to appropriate degree value and fed as input to a Visual basics program on the PC. It acts as a comparator such that when a particular threshold value is met then the corresponding logic is carried out on the receiver side (robot). Also for convenience, colors have been used to indicate different levels of axis points.

Since MEMS is a really powerful system that can be programmed for more than 100 various micron movements, we have implemented sliced images in a picture box on VB background which is been protected with individual password for each of the military officials. An orderly flow of tasks takes place as depicted in the block diagram below.

The receiver part i.e., the robot consists of PIC16F877A, wireless receiver, H-bridge, DC motor, battery, IR camera [5], PIR sensor [6], magnetic sensor [6], solenoid and wheels. The IR camera performs a major role in providing the visual aid for navigating the robot when placed in the military filed. The material used for the robot's physical structure is FRB sheet.

FRB stands for flexible resin bonding and we use this particular material because it has good mechanical strength, high insulation (thermal and electrical). The thickness of the sheet is 6mm. This sheet is made up of a mixture of wood, resin, glass and fabric. The wood gives the required strength for bearing the load on the body, glass helps in giving sharpness while resin and fabric give the flexibility to the sheet. These are the few reasons why we have made use of FRB sheets for the body of the robot.

The DC motor used here is of 6v. We make use of two 6v DC motors summing up to give a total output of 12v supply for the robot. It has torque rate of 30rev/min. The motor we make use is a self-geared motor and has a shaft of 6mm. The data transmitted from the wireless receiver is received by the wireless receiver HT12E. From the receiver the data is fed to the PIC16F877A, here the IC is a pre-programmed IC. Hence on receiving the data, it passes on the instruction to the H-Bridge and Solenoid accordingly.

The supply for the whole receiver side is given by the battery. We make use of two 6v batters summing up to give 12v dc output. It gives an output current of 4.5 amps/hr. once the battery is charged then it can be used continuously for ten hours. The wireless transmitter i.e., HT12E consists of 8 pins, 2 pins for ground, 2 pins for Vcc, 2 pins for data, 1 pin for antenna and 1 pin for NC. In the 2 pins for data one pin is for analog data and the other pin is for digital data. In the digital data in pin, we receive the data from the transmitter side. This data contains the value of the axis of the gesture movement which is fed to pre-programmed PIC16F877.

The PIC16F877A has similar components connected to it as in the transmitter part, the only difference here in the receiver part is that the IC is pre-programmed. The IC converts the received digital data into analog commands and the output is fed to the H-Bridge. H-bridge acts as an automatic DPDT switch, which can control the function of 2 wheels synchronously.

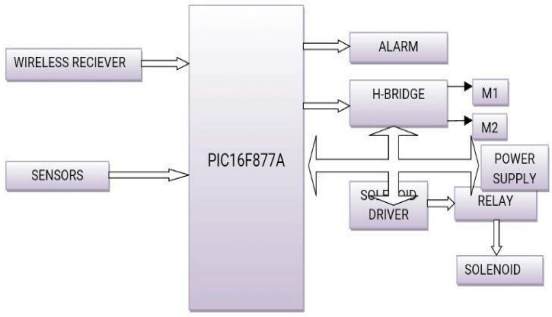

Figure 4: Receiver side of the system

.Additionally the PIR sensor is connected that has the ability to extract the radiating temperature present in the surrounding. Furthermore, a magnetic field sensor is used for detecting high magnetized gadgets, weapons or any magnetic field present in the vicinity, by triggering the buzzer attached to the robot side.

A long solenoid coil which is electromagnetic ion nature is used as a shooter gun [4] for this device. In the case of self-defense, we can use the structure which is highly feasible since it is easily obtained by winding a copper coil over a PVC tube that acts as an insulated base. So when current is sent the coil it will get magnetized. It has an individual power rating of 50 Watt and is capable of throwing pellets or stones at high force.

III. HARDWARE DESCRIPTION

A. MEMS

MEMS [8] (Micro-Electro-Mechanical System)-based accelerometers are used for achieving analog inputs that measure the proper acceleration using sensors. Sensing technologies make use of physical parameters from the environment, such as temperature, pressure, force and light. One needs to have a good knowledge in mechanical, electronics and the materials used for fabricating MEMS. It can measure a 3-axis value which is given as the input to the microcontroller ADC pins for getting a digital output of the detected gesture /angle. The accelerometer is used for measuring a range of voltage change according to the change in direction; even though an electronic process is carried out.

Figure 5: MEMS

B. MICROCONTROLLER (PIC16F877A)

PIC 16F877A is one of the most advanced microcontrollers .The name PIC16F877A describes the microcontroller, i.e. "16" tells it is from the 16th family, "F" tells that uses flash memory, "877A" is the model number while "A "stands for advanced. It consists of 5 input/output ports namely Port A, Port B, Port C, Port, D, Port E. Port A consists of 6 pins. Port E consists of 3 pins while Port B, C, D consists of 8 pins each. Port A and E can be used for input/output and Port B, C; D is used for digital input/output. Every Port consists of two buffers i.e. TRIS Buffer and DATA Buffer. The operating voltage of PIC16F877A is 5V and the operating frequency is 20MHz. Flash program memory is 8KB i.e. 14-bit words, Data memory is 368 bytes and the EEPROM Data memory is 256 bytes. It is also called as 10-bit ADC with a maximum splitting range of 1024 bytes/second. It has an inbuilt watchdog timer which will reset the controller if there is any delay in the work or instruction. This particular microcontroller is widely used for the industrial grade as it is cheap and can be used for wide range of applications, also because of its high quality, and ease of availability.

C. RS232

RS-232 is an International standard for serial communication transmission of data. In this paper the RS232converts the 5V from the IC to 20 V for the system input and vice versa. Inside it consists of a quad-puller which helps in converting 5v-20v and vice versa (which is done by voltage divider network). .The intermediate link between the PIC IC and the system is provided through MAX232.

D. DC MOTOR

We used a DC motor of 30 rpm that works with 12VDC supply. A stepper motor to offers the similar amount of torque as a DC motor; where the DC motor offers peak torque rating and more flexible speed curve. Though the stepper offers a full torque the DC is preferred as the torque can be controlled; as in our project, the starting and the running torques are different.

E. PIR SENSOR

PIR (Passive infrared sensor) is a pyroelectric device that detects motion by measuring changes in the infrared levels emitted by surrounding objects. This motion can be detected by checking for a high signal on a single in/out the pin. It is a single bit device which operated on 3.3-5v and <100ua of current. It is made up of a crystalline material that generates an electric charge when exposed to infrared radiation. It contains a special filter called a Fresnel lens which focuses on infrared signals onto the element.

F. IR CAMERA

A hybrid IR-enabled camera made up of CMOS technology will be employed which has a hybrid circuit to sense ambient lights and activates the IR radiation as and when required. This also has an inbuilt audio receiving MIC and both AV will be converted into a wireless signal. It is compact Sized and lightweight (300g) and a Thermal Sensitivity <0.1ºC. The FLIR i3 thermal imager is a point and shoots infrared camera [6] that is affordable to take a thermographic image at high-quality resolution.

Figure 6: IR Camera

IV. SOFTWARE DESCRIPTION

A. VISUAL BASICS

Visual Basic is a third-generation event-driven programming language and integrated development environment (IDE) from Microsoft which enables the programmer to create an application using the components provided. It is highly compatible with different versions of windows operating system and it is highly optimized to support rapid application development ("RAD"); More particularly easy to develop graphical user interfaces and to connect them to handler functions provided by the application. Hereby our program executed with the help of this software on the control room side is shown below

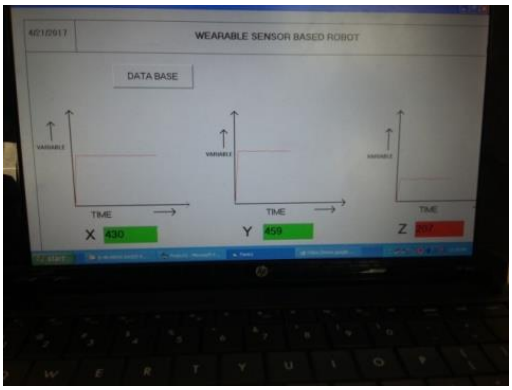

Figure.7 Output display on Visual basics

B. EMBEDDED C

Embedded C is a set of language extensions for the C Programming language by the C Standards committee to address commonality issues that exist between C extensions for different embedded systems. It includes a number of features not available in normal C, such as fixed-point arithmetic, named address spaces, and basic I/O hardware addressing. Using this, the threshold based commands are programmed to the microcontroller which is responsible for the actions on the robot side.

V. IMPLEMENTATION AND RESULT

As both the hardware and software here in this project plays a significant role, for which they rely on the logic as depicted here in the table below:-

TABLE I
CO-ORDINATES AND ITS ACTION

S. No.	Coordinate axis	Action
1.	X	Forward
2.	Y	Reverse
3.	Z	Rotate

Based on these corresponding values of the threshold limits the action will be carried out on the control side by the robot. The control room side along with the robotic field device is shown below:

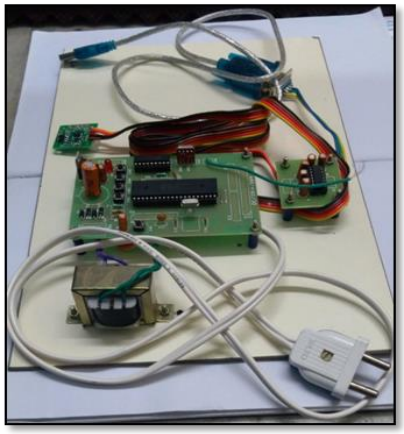

Figure 8: Control room side Hardware part

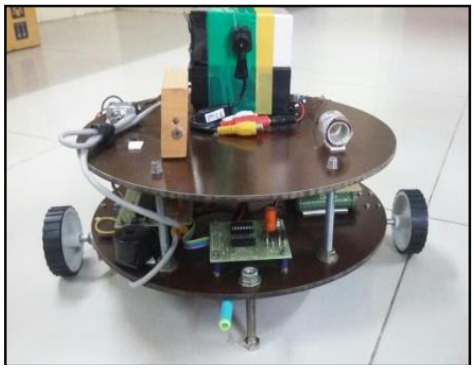

Figure 9: Robotic field device

CONCLUSIONS

We have accomplished in designing a prototype for the purpose of aiding the military generals with difficult tasks that can be performed with secrecy and eliminates the losses of lives. The main reason why military robots are now widely used is because if a military robot is destroyed by the enemy we can just build a new one, and there's not a human loss. Another benefit is that it can be built and programmed to do a certain task and will do it way better than how a human would do it given the challenging ambience. Since MEMS concept is really fast we can implement various other functions and also with the help of RSSI technique we can achieve a high degree of stealth, while entering into the enemy territory. The MEMS device is especially used here since it is highly resistant to shock and vibration. It also has the capability of withstanding extreme climatic conditions like (snowfall, etc.).Another key element would be the controller which we have used. PIC16F877A which is industrial graded and also due to its more advanced level of A/D conversion, lesser number of peripheral devices will be required. This project is designed with extreme care and perfect synchronization.

VII. FUTURE SCOPE

As mentioned earlier the future scope of the project is highly versatile, that various other implementations can be done to it. Like for instance these robots used in the military can be employed with the integrated system, including video screens, sensors, gripper, and cameras. RSSI (Received Signal Strength Indicator) is a common name for the signal strength in a wireless network environment which is a measure of the power level that an RF client device is receiving from an access point. With the help of this, we can have our own robot tracking map rather than user GPS positioning. It is wise to use such a technique, especially in the military zone in order to avoid being traced or tracked. However by using the GPS for positioning co-ordinates will be easily known but not in the case of RSSI, it will make use of self-generated positioning technique which will thereby facilitate in preventing the enemy to track our device. The password protection which is currently been established with the help of IOT can be upgraded to retina scanner and fingerprint sensor with appropriate interfacing devices. Other physical attributes that could be implemented to the existing system would be an arm with additional sensors that could detect and explode in-ground mines or improvised explosive devices.

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