DTMF and Gesture controlled Multipurpose Robot

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Abstract— **Robotics is an interesting field where everyengineer can showcase his creative and technical skills.. This paper summarizes a the feasibility of implementing Dual-Tone, Multi-Frequency (DTMF) as an alternative mean of robotic communication to Radio Frequency (RF). The Gesture module system design is divided into 3 parts namely: Accelerometer Part, Robotic Arm and Platform. It is basically and Accelerometer based system which controls a Robotic Arm wirelessly using a, small and low-cost, 3-axis (DOF's) accelerometer via RF signals. The Robotic Arm is mounted over a movable platform which is also controlled wirelessly byanother accelerometerOne accelerometer is mounted/ attached on the human hand, capturing its behavior (gestures and postures) and thus the robotic armmovesaccordingly and the other accelerometer ismounted on any of the leg of the user / operator. The different motions performed by robotic arm are: PICK and PLACE / DROP, RAISING and LOWERING the objects. Also, the motions performed by the platform are: FORWARD, BACKWARD, RIGHT and LEFT.**

Keywords- DTMF module, Accelerometer, DOF, IP, RF Module

I. INTRODUCTION

As interest in robotics continues to grow, robots are increasingly being integrated into everyday life. The results of this integration are end-users possessing less and less technical knowledge of the technology. For example, consider the application of mobile robots in the health care industry, where the intended end users are patients themselves. In this case, the need for simplified, reliable, and user-friendly robot designs is of almost importance. Mobile phones today became very popular an essential entity for one and all and so, for any mobile based application there is great reception.

Wireless controlled robots utilize RF circuits. However, the use of RF contributes to enhancing the already mysterious nature of robotic technology, which had limitations like limited range, limited frequency ranges and controls. But a mobile Phone controlled robot can hold up these limitations.

A. DTMF TECHNOLOGY

DTMF (Dual Tone Multiple Frequency) is a concept used in mobile phones to dial numbers. DTMF Tone is generated by two frequencies (low frequency and high frequency) .The two frequencies are arranged by matrix format and when user presses the keys the two frequencies will get shorted and will generate a tone, that tone is detected by DTMF decoder. DTMF Encoder is used to generate DTMF tones in mobile and will decode the tone and gives a 4 bit binary output and this output is the source of input to the Robot. A DTMF Decoder which gives a 4 bit binary output can perform 16 operations, but as mobiles have only 12 keys only 12 operations can be performed. Another drawback of DTMF decoder is that anyone who knows the receiver mobile number can access the Robot,

B. GESTURE CONTROL TECHNOLOGY

This recognition technique made it possible to implement an accelerometer based system to communicate with an industrial robotic arm wirelessly. In this particular project the robotic arm is powered with ARM7 based LPC1768 core. MEMS is a three dimensional accelerometer sensor which captures gestures of human-arm and produces three different analog output voltages in three dimensional axes. And two flex sensors are used to control the gripper movement.

Few variants are Keypad Controlled, Voice Control, Gesture Control, etc. However, mostof the industrial robots are still programmed using the typical teaching process which is still a tedious and time-consuming task that requires technical expertise.

II. LITERATURE REVIEW

A. DTMF TECHNOLOGY

The human mind always needs information of interest to control systems of his/her choice. In the age of electronic systems it is important to be able to control and acquire information from everywhere. Although many methods to remotely control systems have been devised, the methods have the problems such as the need for special devices and software to control the system. The DTMF tone generatedwhen the user pushes mobile phone keypad buttons or when connected to a remote mobile system

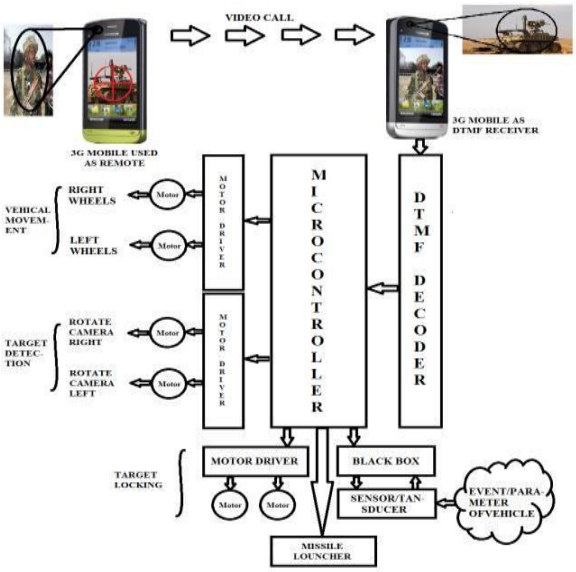

Fig.1 Block Diagram of DTMF System

Digit	Freq Low	Freq High	D3	D2	D1	D0
1	697	1209	0	0	0	1
2	697	1336	0	0	1	0
3	697	1477	0	0	1	1
4	770	1209	0	1	0	0
5	770	1336	0	1	0	1
6	770	1477	0	1	1	0
7	852	1209	0	1	1	1
8	852	1336	1	0	0	0
9	852	1477	1	0	0	1
0	941	1336	1	0	1	0
*	941	1209	1	0	1	1
#	941	1477	1	1	0	0
A	697	1633	1	1	0	1
B	770	1633	1	1	1	0
C	852	1633	1	1	1	1
D	941	1633	0	0	0	0

B. DTMF module decoder output

The M-8870 decoder IC contains an inbuilt operational amplifier. The signals from the microphone pin are fed in to inverting input of the Op amp through a series of resistance (100kΩ) and capacitance (0.1 µF). The non inverting input of Op-amp is connected to a Reference voltage (pin4 - VREF) is connected to the non inverting input of the Op-amp. The output voltage is taken from the pin 3 (GS) .The reference voltage VREF is Vcc /2. The feedback signal is fed in to the inverting input pin 2 through a resistor (270kΩ).

The output of Op Amp is passed through the filter network. The filter network contains switched capacitors, which divides the DTMF tones into low and high frequency signals. Filtered frequencies will pass through the frequency detector and code detector

C. GESTURE CONTROL TECHNOLOGY

Finger Gesture Recognition System based on Active Tracking Mechanisms

The prime aim of the system (based on the above mentioned recognition methodology) proposed by the author is to make it feasible to interact with a portable device or a computer through the recognition of finger gestures. Apart from the gestures, speech can also be other mode of interaction because of which this system can form part of a so-called Perceptual User Interface (PUI). The system could be used for Virtual Reality or Augmented Reality systems.

D. Accelerometer-based gesture recognition

This Gesture Recognition methodology has become increasingly popular in a very short span of time. The low-moderate cost and relative small size of the accelerometers are the two factors that make it an effective tool to detect and recognize human body gestures. Several studies have been conducted on the recognition of gestures from acceleration data using Artificial Neural Networks (ANNs).

III. TECHNICAL REQUIREMENTS

The technical requirements chosen as a basis for the efficient functioning of the system are as follows**:**

Microcontroller: ATmega 328 microcontroller is used as the hardware platform. It is the controlling unit, to which all other components (Accelerometers, Motors, RF modules etc.) are interfaced. Two such microcontrollers are used in this project, one at the Transmitting end and one at the Receiving end.

RF Module: RF stands for Radio Frequency. This module consists of further two parts: Transmitter (Tx) and Receiver (Rx). It is available in different operating frequencies with different operating range. An Encoder Circuit and a Decoder Circuit is used along with the Transmitter and Receiver respectively in order to transmitand receive the message/signal.

The native communication task between the Robotic Arm, Platform and the different hand and leg gestures of the user is done by this module via RF signals. One such RF Module is required in this project. The RF Module used in this project works on the frequency of 315MHz with an operating range of 400-500 meters.

Accelerometer: An accelerometer measures gravitational force or acceleration. By tilting an accelerometer along its measured axis, one can read the gravitational force relative to the amount of tilt. Most accelerometers available today are small surface mount components, so you can easily interface them to a microcontroller. There are three axes that can be measured by an accelerometer and they are labeled as X, Y and Z. Each measured axis represents a separate Degree of Freedom (DOF) from the sensor—thus a triple axis accelerometer might be labeled as 3 DOF. In this project, only 2 axes namely X and Y are used. The accelerometer used in this paper is ADXL3xx

Communication System

This part is the heart of the entire project. Without an effective and reliable communication system, no system / project can work. Similar is the case with this project also. The RF Module, details of which are mentioned under Section 3.2, is the only communication equipment required in this project. This Module is used to transmit the different hand and leg gestures made by the user (encoded in the form of 4-bit digital data) wirelessly to the receiver [14], which decodes the received 4-bit digital data and according to which the arm, gripper and platform moves. The block diagrams shown in Figure 7 & Figure 8 depict the entire communication system of the project. The Linker (Circle, named "A") in Figure 7 and Figure 8 is used to show the connection (flow of signals) between the Transmitter End and the Receiver End.

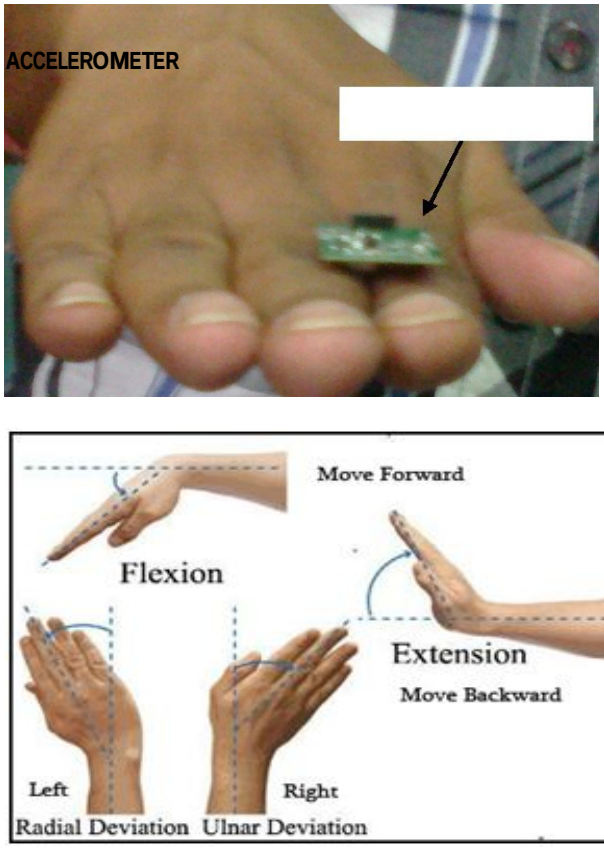

Fig.2 Hand gesture recognition

Gesture Recognition: To take advantage of the temporal component of gestures, we chose to use an HMM-based recognizer. An HMM recognizer classis time sequences of features. For each new data point in a continuous stream of measurements, our HMM recognizer determines which gesture is currently being executed. In this section, we will present the process of data reduction and gesture spotting, as is illustrated in Figure 4. For readers unfamiliar with HMMs, we refer to Rabiner and Juang [10] for an excellent tutorial on evaluation, estimation, and decoding using HMMs as applied to the problem of speech recognition.

Gesture spotting using an HMM

After preprocessing the data, the gesture spotter takes a sequence of codewords and determines which of the six gestures the user is performing, or \none of the above" if no gesture is being executed. The six gestures we chose to recognize consist of:

OPENING: Moving from a closed st to a at open hand

OPENED: Flat open hand

CLOSING: Moving from a open hand to a closed state.

POINTING: Moving from a at open hand to index finger pointing, or from a closed state to index finger pointing

WAVING LEFT: Fingers extended, waving to the left, as if directing someone to the left

WAVING RIGHT: Fingers extended, waving to the right

IV. Comparision with the Existing System

The major advantage of our system over other systems is that it provides real time palm gesture recognition, leading to an effective and natural way for controlling robots. Additional advantages are:

The implemented system is much more cost effective than the existing systems. As it does not involve any hardware requirement or configuration, there is little or no cost for the system's implementation. Moreover, ordinary webcams on PCs or laptops can be used for capturing gesture inputs.

As mentioned earlier, it does not involve any specific hardware for gesture inputs - a normal webcam on laptop or PC can be used for gesture recognition. This system can be installed on any of these usable devices for gesture recognition. This provides flexibility to the user and the system is portable.

V. Conclusion and Future Work

Due to the growing demand for natural Human MachineInterfaces and robot intuitive programming platforms, a robotic system that allows users to control an industrial robot using arm gestures and postures was proposed. Two 3-axis accelerometers were selected to be the input devices of this system, capturing the human arms behaviors.

When compared with other common input devices, especially the teach pendant, this approach using

accelerometers is more intuitive and easy to work, besides offering the possibility to control a robot by wireless means. Using this system, a non-expert robot programmer can control a robot quicklyand in a natural way. The low price and short set-up time are other advantages of the system. Nevertheless, the reliability of the system is an important limitation to consider.

The ANN's shown to be a good choice to recognize gestures and postures, presenting an average of 92%of correctly recognized gestures and postures. The system response time (160 milliseconds) is another important factor. Future work will build upon the improvement of the average of correctly recognized gestures. One approach might be the implementation of a gyroscope into thesystem,in order to separate the acceleration due to gravity from the inertial acceleration. The use of more accelerometers attached to the arms is another possibility.

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