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Gesture Controlled Robot using MEMS Accelerometer for Eradication of Weeds

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Abstract

Robots are playing a vital role in today's industrial automation and monitoring system. As technology developed these robots have increased their applications and functionality. Working robots will cooperate to the people makes the work more effortless and uncomplicated. This paper provides 4 different gestures for controlling the robots, i.e., forward, backward, left, right. For cutting weeds a gripper concept using buttons is anticipated. These movements are given by the user using MEMS accelerometer. The MEMS accelerometer will be set to the hand. Whenever the hand moves in some direction, the mechanical movement of the hand will be recognized by MEMS. MEMS translate this mechanical hand movement into equivalent electrical signals and send it to the PIC microcontroller. The PIC microcontroller at the transmitter side sends control signals to the receiver side through RF TRANSCEIVER. The controller at the receiver area receives these signals and gives direction to the robot. This type of robot is used in the crop filed to cut the weeds as per the user command.

Keywords: Accelerometer, MEMS-Micro Electro Mechanical System, PIC Microcontrollers, RF TRANSCEIVER

1. Introduction

In today's age robotic has the fundamental key for new invention. The development of human-machine communications on an everyday basis has made the people to utilize the technology. Instead of giving rational methodology physical methods have been welcomed by everyone. Coding to some 100's of pages requires more instance, capital and power so to overcome that gesture recognition is enhanced. Using gesture recognition coding can be easily made by everyone. For gesture recognition many active devices such as a "trackball, wiimote, joystick and touch tablet" are in practice[1]. Some of the devices are used for giving motion recognizer but gesture recognition has the foremost utility. So gesture recognizer like accelerometers with 3-axes is extensively used. Gesture can be captured by wearing gloves or having wrist band attached with the MEMS whereas using vision system and data glove is very expensive hence not utilized. To have a balance of precision data collection, "Micro Inertial Measurement Unit" is developed for recognizing the gestures in 3 dimensional axis x, y, z[2].

Gesture can be recognized by following approaches comprises of "template-matching, arithmetical toning, vocabulary lookup, linguistic matching, and neural arrangement". But in this paper the gesture recognition models are based on the signal succession[3] and pattern toning[4]. The gesture values are mapped by extracting a simple characteristic based on signal succession of acceleration, for achieving high efficiency and accuracy[5]. For this type of methodology the MEMS accelerometer is used to give the hand gestures. MEMS acronym micro electro mechanical system which has 3 axis of x, y, z and a power supply port with ground is fabricated[6]. MEMS use the knowledge which is known as "micro-fabrication knowledge"[7]. It has "cavity, holes, channels, membranes,

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cantilevers and furthermore imitates motorized parts". The highlighting of MEMS is silicon fabrication acquires moisture[8].

The enlargement of micro technology has many features like size, efficiency and capital. For a large scale device micro fabrication is used because of its smallness, applicability and lessening of material utilization. Micro technology and electronics have great scope of innovation. MEMS can be mounted on the PIC microcontroller wirelessly. PIC16F877A is the microcontroller proposed in this methodology which has inbuilt ADC conversion. By using MEMS many succession of external components can be eliminated. "Gaining data, storage of data, data filtering, statement interfacing and networking" are included hence it is called elegant included MEMS[9]. MEMS equipment not only makes the utensils much lesser but also makes them much improved.

The chief inspiration for this investigation is to make the human-robot interface more flexible and simpler for the user. For a real time example the weeds in the agricultural field can be removed with the help of these MEMS hand gestured robot. Section 2 represents the related works, Section 3 represents the overview of the system, proposed system details are given in Section 4, Section 5 represents the implementation, Section 6 presents the results and conclusion and Section 7 discusses about the future scope.

2. Related Works

Robots are widely used in machineries, industries, medical field etc which are automated robots. Even in agriculture robots are used to perform mission like fruit picking, ploughing and harvesting. But these robots are pre-defined where mechanism and performance are already assigned. By these robots there is a possibility of occurring malfunction. If a robot went erroneous that will cause many damages so automated robots always have the drawbacks whereas in case of self operated robot breakdown and exertion can be prohibited. Robots are mainly used for teach and repeat operation[10] system but this paper overcomes it. The key intension of this paper is to utilize the power of robotics in agriculture.

In this system, the user will have the robot in the crop field and the user will activate the robot far from the crop field by seeing the video stream of the field capturing by the robot. When human is used to remove those weeds it will cause damages to the healthy crop when they stepped into the field. Almost many of the plant get affected and give fewer yields[11]. So to avoid this situation MEMS weed cutting robot is designed. The chief intention is to afford consistent and a natural way of controlling the robot using gestures. Because of using gestures even illiterate can operate the robot. The camera fixed on the robotic body is wireless which is capable of sending videos to about 50 meters it can be tuned by the user in the television.

Gesture instructions are given using MEMS which is attached in the wrist band. The gestures used to move the robot in all possible directions in the environment are Forward, Backward, Right, Left and Arm movement. Special movements for arm in enhanced with the gripper. For more convenience button system is introduced to do the task often occurring. The output gesture production depends on the gesture input different output gesture is generated for every possible gesture input. DC motors attached to the robotic wheels is driven using the relay. The control signals will activate the robotic DC gear motor to move the robot. Similarly the DC motor connected with robotic arm will receive the control signal to cut the weeds in the crop field. Using four different gestures the robots can move in the crop field by seeing the crop field in the television the user will instruct the robot. So wherever weeds are found user will control the robot to cut it by giving particular gesture movements.

3. System Overview

This system mainly focuses on cutting unwanted plants in the crop field. Nearly 70% of the yield decreases due to weeds. Man power is much needed to eradicate the weeds, so a proposal of robot in the crop field to cut the weeds is planned in this paper. Command are given by the user is generated at the microcontroller and sent to the robot through RF transmitter and RF receiver within the radio frequency range. The robot performs the action according to the generated command.

3.1 Recognizing Gesture Movements

Gesture movements can be recognized by the RF transmitter and RF receiver using MEMS accelerometer. The transmitter can send the control signals to the receiver for about 400MHz. The gesture commands given to the robot are Forward, Backward, Right Left and Arm movement. For arm movement button system is used. The gesture instructions are given by the user by the hand palm with the wrist band where the MEMS accelerometer is fixed[12]. There will be a lookup table in the microcontroller where the values will be stored for each gesture. Whenever the user gives the gesture the robot will move accordingly.

3.2 Feeding Lookup Table in Microcontroller

Lookup table is where the acceleration values are stored in the microcontroller for which the control signals are generated. The lookup table can be feed by the user to the microcontroller using the embedded c programming concept in MPLAB IDE. Each command should have a separate range of acceleration values to avoid the jamming of control signals.

3.3 Control Signal Generation

This task is performed on the microcontroller only after the lookup table[13] is fed to the microcontroller. Whenever the hand palm with the accelerometer gestures the stored acceleration value, the signal generator in the microcontroller generates the control signal. The RF transmitter encodes the signal and transmits to the RF receiver. RF receiver decodes and performs the necessary actions.

3.4 RF Transmitter and Receiver

Many existing technologies and transmission medium use only Radio Frequency because RF can travel through larger distance than Infra Red. The Radio Frequency (RF) module comprises of an RF transmitter and RF receiver. The RF transmitter/receiver match up operates at a frequency of 433 MHz or 315 MHz ASK RF modules. For long range application RF transmission is used. The RF receiver receives the control signals from RF transmitter and sends it to the microcontroller connected with it. The rate of transmission is about 1Kbps to 10 Kbps. The transmission sector has the encoder with it for encoding the control signals. The encoded signals will transfer to the receiver where the signals will be decoded to carry out the actions. HT12E-HT12D, HT640-HT648 is commonly used encoder/decoder pair ICs.

3.5 DC Gear Motors

As the name suggest DC gear motors takes the direct electric current as source of energy. DC gear motors are attached to all the wheels of the robot. So whenever the gesture signals reached the DC motor it will formulate the wheel to move forward and backward[14]. When high current is applied to the DC motor it may tend to move the robot at very high speed so a load is attached to the motor to slow down the speed. The rotation speed is deliberated in terms of RPM (Revolution per Minute). There are 4 wheels used in this robotic body, two wheels on the front side and another two wheels on the back side of the robot. On the front part of robot the gripper is attached. For gripper control ball caster is attached for arm control.

The Chassis is the robotic body which holds the DC gear motors and the wheels. A wireless camera is also fixed in the robot which sends the wireless video stream tuned and viewed in the television. An AV to USB convertor cable is also used to view the video stream in laptop or interrelated devices. It is more flexible for the user to view the video stream wherever essential. If the chassis is made with water proof material then the robot can be used even in the rainy season with thermal camera or night vision camera attached to the robotic body. The sample DC gear motor is shown in Figure 1.

4. Proposed System

In the planned assignment nine different gestures movement is proposed. In addition a robotic arm with the gripper is used to remove the unwanted weeds. Weeds are the major problem in the crop field which decreases the normal crop yield. For removing the weeds labour cost and time is very high. So to avoid these situations weed cutting robot is designed. For this PIC microcontroller with frequency of 400 MHZ is interfaced for transferring the signals.

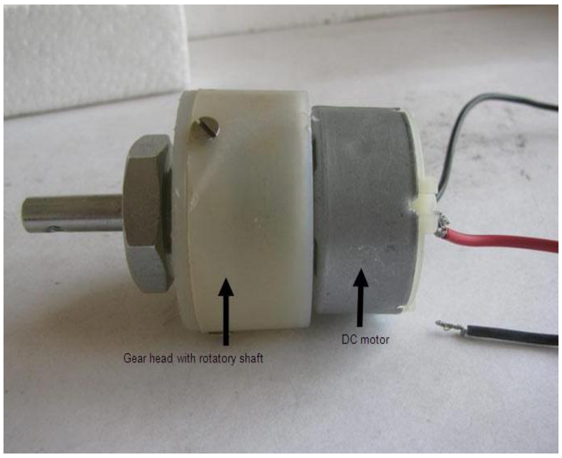

Figure 1. Sample DC motor.

4.1 Robotic Arm

The robotic arm is the fundamental part of the system which is responsible for the cutting and dropping task of this project. The gesture movement will be given to this robotic arm only. The robotic arm is equipped with a Gripper (for cutting the weeds) and an Arm (for raising and lowering the objects)[15]. Both the Arm and Gripper are equipped with motor to control the movement. These movements are synchronised with the hand gestures of the user, operating the Robotic Arm. The accelerometer mounted on hand, which captures the hand gestures[16]. The sample robotic arm is given in Figure 2.

GESTURE 1: To move the robot forward
GESTURE 2: To move the robot backward
GESTURE 3: To move the robot left
GESTURE 4: To move the robot right
GESTURE 5: Camera rotation
GESTURE 6: To Lower the Arm
GESTURE 7: To Raise the Arm
GESTURE 8: To close the Gripper Mouth so that it can cut the object
GESTURE 9: To open the Gripper Mouth so that it can place/drop the object

5. Implementation

The implementation consists of 2 mediums – RF transmitter and RF receiver. Transmitter setup consists of MEMS device which the user holds. The MEMS device gives the gesture to move the robot and receiver setup is the robotic body which has the robotic arm used to remove the weeds in the crop field.

Figure 2. Sample robotic arm for cutting weeds.

5.1 Transmitter

An external power supply of 230V AC is given to the setup, and step down transformer steps down the power as required. A microcontroller is used for controlling the signals to be transmitted. The MEMS accelerometer's acceleration values (3 dimensional axes values) will be displayed in the LCD which is connected with it. Based on that the range of acceleration values are noted down. These acceleration values are stored in the lookup table of the microcontroller with the actions to be performed. Whenever the acceleration values matches with the values in the lookup table, the microcontroller sends the control signals to the RF transmitter then the RF transmitter transmits the control signals to the RF receiver[17]. The block diagram of the transmitter is exposed in Figure 3.

5.2 Receiver

RF receiver receives the control signals from RF transmitter and sends it to the microcontroller connected with it. LCD connected with the microcontroller will display the received signal in which actions to be performed. The microcontroller generates the control signals to the DC motor. Based on the control signals, DC motors makes the robot to run forward and backward. Thus the motion of the robotic body will be achieved. The camera fixed with it can be controlled in the same way and the video stream can be tuned in the television[18]. By seeing the television the user will control the robot and make the robot cut the weeds. The work flow of the receiver is shown in the Figure 4.

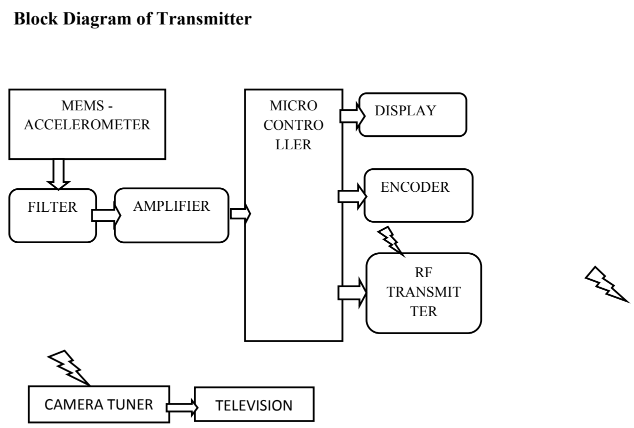

Figure 3. Block diagram of transmitter.

Block Diagram of Receiver

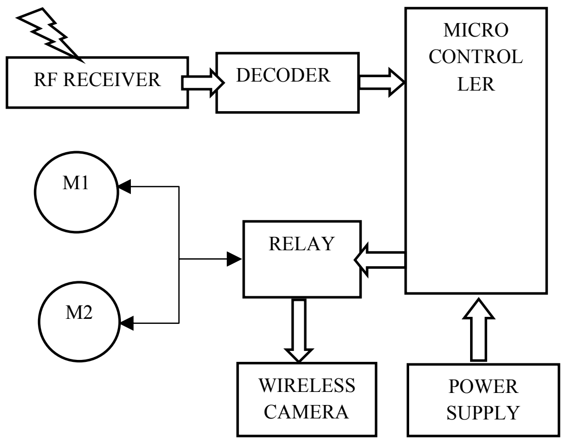

Figure 4. Block diagram of receiver.

6. Result and Conclusion

This manuscript gives the hand gesture recognition system for cutting weeds in the crop field by using MEMS accelerometer. The sample gestures values are taken in the lookup table for controlling the robot. Since hand gesture is used farmer who is the user can easily have power over the device in the absence of acquaintance. The video stream in the television is tuned by using wireless camera tuner attached to the robotic body in the crop field for real time video spectator. The technique of giving input by the direction of hand palm has more efficiency. For control signal generation MPLAB IDE is used in this paper by means of embedded C.

Robots are used in various fields, including agriculture field, but not used effectively and securely. Though it reduces manual work, still to avoid some malfunctions and heavy loss, controlling these robots by the user will be a better job. So this paper will pave the ways for implementing robots in agricultural field to reduce the man power utilization in the same way by controlling them in human hands. Since the control is in our hand many malfunctions can be prevented.

7. Future Scope

The future works can be implemented with the replacement of MEMS with NEMS for more efficiency and accuracy. Harvesting, Ploughing can also be implemented with this robotic body. Other than agricultural field these types of robots can be used in the defence field, medical field etc. MEMS products can be embedded in larger non-MEMS systems like automobiles, printers and biomedical diagnostic equipment.

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