Industrial Burr collecting Robot using Haptic Interface

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***Abstract*- This paper proposes a system to represent the robotic technology in the field of human-machine interaction and wireless communication that helps an operator to collect industrial Burr using Robotic Arm through Tele-guidance. Robotic arm is controlled using haptic interface. Accelerometer and flex sensor forms the Haptic Interface. Task environments are captured from web-camera and sent to the computer. Bluetooth module is used for tele-guidance. DC motors are used for locomotion and Stepper motors are used for stepwise rotation of Robotic Arm. When deciding the end effecter has approached to desired location from where Burr to be grasped or apart Burr grasped has come up to a target location, controller has only to use a haptic device to continue his operation.**

***Index terms* - Human-Machine interaction, Industrial Burr, Haptic interface, Tele-guidance**

I. INTRODUCTION

Conventionally Burr collection process in Industries is carried out by naked hands. Basically Industrial Burrs are rough edges i.e. small metal pieces which are generated as a result of cutting process on Lathe machine, milling machine, etc. This conventional method leads to health issues of workers collecting Burr since at high temperature when Burr is mixed with oil produces poisonous byproducts. This may get mixed with their blood due to injuries caused during burr collection by kin metal pieces.

The Robotics is emerging engineering science which deals with designing, modeling, controlling and utilization of robots. According to the Robot Institute of America, "A robot is a reprogrammable, multifunctional manipulator designed to move materials, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks" [2]. As the research progressed, robots were recognized not only as simple action performer but as a machine that have diverse and variety of purposes and usages. Nowadays we are using Robots in various fields like industrial automation, home automation, military, medical, space etc. and in tasks that are much expensive or hazardous to be performed through humans such as exploring outer space or at the bottom of the sea. Controlling of Robots can be done using remote, autonomous or semi-autonomous methods [2].The Robotic Arm can be controlled using voice commands but they lack in precision [5] also they can be controlled using LabVIEW and ARM controller [6].

The paper focuses on design and implementation of a robotic arm and controls it using a human arm by means of haptic technology. Haptic is the term derived from the Greek word "Haptesthai" which means sense of touch [1]. Haptic is tactile feedback technology which recreates the sense of touch by applying forces, vibrations or motions to the user [3]. Haptic technology is generally used in Video games, computer interfaces, tele-robotics, etc. By using haptic devices the user can not only feed information to the computer but can receive information from the computer in the form of a felt sensation on some part of the body [4]. Haptic can be divided into three areas:

A. Human haptic- the study of human sensing and its control through touch.

B. Machine haptic - the design, construction, and the use of machines to replace or augment human touch.

C. Computer haptic - algorithms and software associated with generating the touch and feel of virtual objects.

The main objective of this work is to carry Human-Machine interaction to next level by implementing haptic technology to control Robot for Burr collection process. The Industrial Burr is collected using Robotic Arm in a dustbin which is mounted on moving Robot. Two stepper motors and a DC motor used for controlling Robotic Arm of

which movements are controlled using haptic interface and sent to Robot via Bluetooth.

This paper is divided in six sections Methodology, Working, Implementation, conclusion, future scope and acknowledgement. The Methodology contains block diagram and general description of various blocks of project hardware. Working section consist of how does the hardware and software combine works to carry out Burr collection process. Implementation section contains software working scheme in form of algorithm and flowchart.

II. METHODOLOGY

In this work we have divided the block diagram in three sections as follows:

A. Robotic Arm controlling section
B. Robotic Arm section
C. Surveillance.

The accelerometer and flex sensors forms haptic interface which gives input via Bluetooth to Robotic Arm section and accordingly respective actions are performed. Surveillance of task environment is done with the help of Webcam and Radio AV receiver.

A. Robotic Arm Controlling Section:-

It controls the Arm section according to the input given through the Flex sensors and accelerometer module. The input received from gestures is converted into the electrical form and then further given to the micro controller. Microcontroller converts these electrical signals into digital form by analog to digital converter. These digital controlling signals are sent wirelessly to the actual Arm section using Bluetooth module. It consists of ARM microcontroller, flex sensor, accelerometer module, Bluetooth module, and power supply.

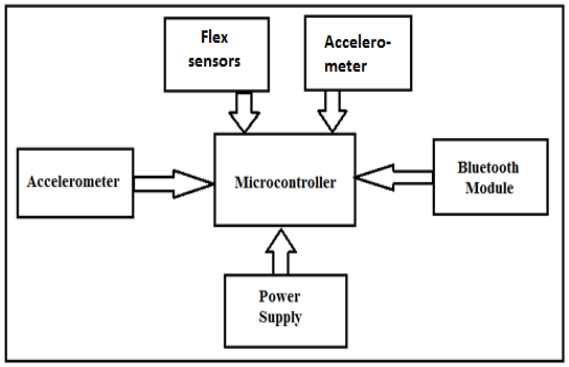


Fig.1 Robotic Arm controlling section

a) ARM Microcontroller

Arm microcontroller is the heart of this system. It is used for monitoring the overall activities. Here we are using LPC2138 as controller. The programming of this ARM controller is done in Embedded C. It is having a 128-bit wide memory interface and a unique accelerator architecture enable 32-bit code execution at maximum clock rate. Due to their tiny size and low power consumption, these microcontrollers are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. It also has dedicated result registers for ADC(s) reduce interrupt overhead. Single 10-bit DAC provides variable analog output. It has Multiple serial interfaces including two UARTs (16C550), two Fast I2C-bus (400 kbit/s), SPI and SSP with buffering and variable data length capabilities. It is having on-chip integrated oscillator operates with external crystal in range of 1 MHz to 30 MHz and with external oscillator up to 50 MHz

b) Flex Sensor:

As the FLEX sensor is flexed or bent, the resistance across the sensor increases. An un-flexed sensor has a nominal resistance of 10,000 ohms (10 K). Sensor is also pressure sensitive, and may be used as a force or pressure sensor. The flex sensor has operating temperature -45F to 125F.

Fig.2 flex sensor

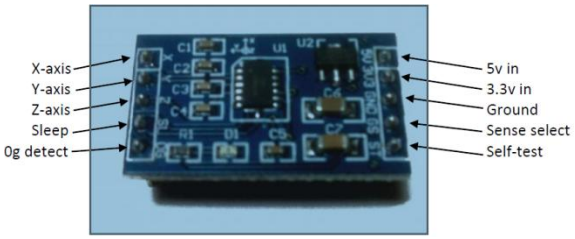


Fig.3 Accelerometer module

c) Accelerometer:

An accelerometer measures proper acceleration, which is the acceleration it experiences

relative to free-fall and is the acceleration felt by people and objects. Put another way, at any point in space time the equivalence principle guarantees the existence of a local inertial frame, and an accelerometer measures the acceleration relative to that frame.

An accelerometer at rest relative to the Earth's surface will indicate approximately 1 g upwards, because any point on the Earth's surface is accelerating upwards relative to the local inertial frame (the frame of a freely falling object near the surface). To obtain the acceleration due to motion with respect to the Earth, this "gravity offset" must be subtracted and corrections made for effects caused by the Earth's rotation relative to the inertial frame.

d) Bluetooth Module:

The Bluetooth module helps for wireless communication in two section and webcam to PC data transfer. Bluetooth module is used in both the section, in Robotic Arm section for transmitting purpose and in actual Robotic Arm section for receiving purpose. The range of the Bluetooth module we are going to use is approximately 10 m. In the provided range we can communicate between both the section of Robotic Arm. Bluetooth wireless technology is a 2.4GHz ISM-band open industry standard for short range Wireless communication, which is capable of voice and data transfer (up to 723 kbps data transfer in ACL link or up to 3 simultaneous voice connections in SCO links).

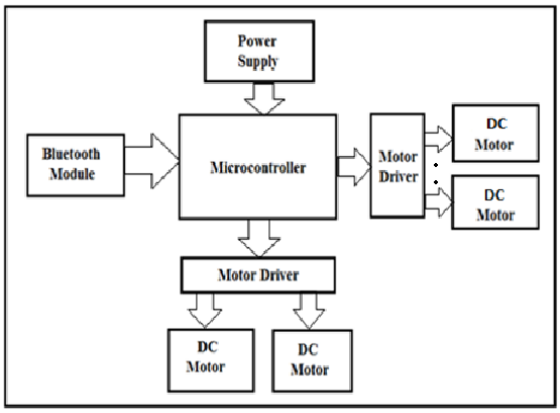


Fig.4 Robotic Arm section.

B. Robotic Arm Section:-

The digital signal received by Bluetooth receiver section is given to the microcontroller. The microcontroller compares received signal with stored values then produces command signal for the respective DC motor to move buggy forward, backward, left, right or stepper motor to move robotic arm up and down. It consists of ARM microcontroller, Bluetooth module, motor driver IC, DC motor, stepper motor, power supply.

a) Power supply:

The power supply converts fluctuating AC voltage received from mains supply into required range of DC voltage. Both the section contains same power supply design. Power supply used for provide 3.3 V supply to microcontrollers in each section, 6-12 V for DC motors also motor driver IC is used for current boosting, 3-6 V for flex sensor, accelerometer module, Bluetooth module.

b) DC Motor:

DC motors are used for the movement of the whole robotic Arm section from one place to other. As we are collecting the Burr so the Robot should be moved accordingly to many places so as to collect the Burr from various places. The power supply provides the voltage required to the motor as per requirement from 6-12 volts. DC motors are rotating in both forward and reverse direction according to current provided.

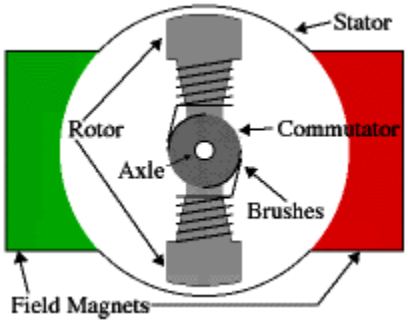


Fig.5 DC motor

We are using another two DC motors for pick and place operation of the burr with the help of programming

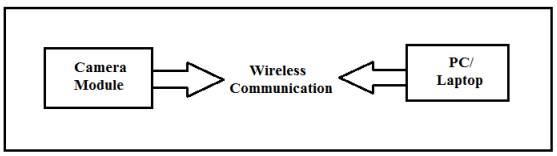


Fig.6 Block diagram of PC interface

C. Surveillance

a) Webcam:

The webcam is used for the surveillance the task environment. It sends the signal to the radio AV receiver. Using the webcam, the operator can see the workplace from the distance and can give command to the robot accordingly.

b) Radio AV receiver

An audio/video receiver is a consumer electronics unit used in processing the audio and video signals. The primary purpose is to receive audio and video signals from source camera, amplify that signals and process them to drive loudspeaker and a display. It has various advantages like light weight and small size, easy installation high quality output etc. It requires 9V DC power for its operation. Operating range of this radio AV receiver is 50 to 100 meters.

III. WORKING

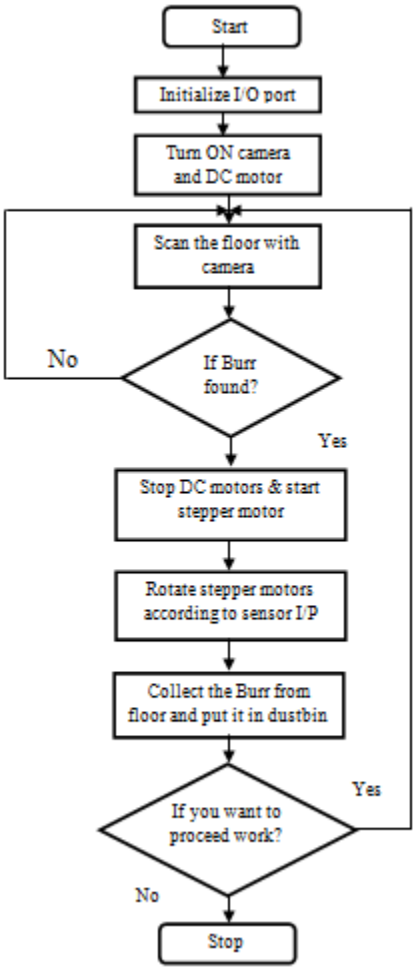
When power working is given to the circuits the welcome message and system status is displayed on LCD. Firstly, with the help of webcam, the surveillance of workspace can be done by the distant operator as camera collects pictures of the workplace and sends it to PC via Bluetooth and from those pictures he can observe the amount and location of burr. Accordingly instruction forward, backward, left, etc. is given by hand movements to the robotic arm section i.e. buggy with the help of accelerometer module for reaching to that location. Here, we are using Bluetooth module for wireless communication between arm controlling section and robotic arm section. Once the robot reaches to the burr, respective hand movements are done to collect burr and these movements are collected by both Accelerometer and flex sensor in form of electric signal. Flex sensors are attached to the glove. The glove is wearable in the human hand and so with the hand gestures the instruction of collecting the burr is given to the robotic arm. Gripper formed with Stepper motors and DC motors are used in the arm for collecting the burr on the robotic arm side and DC motors are used for moving the buggy from one place to another place. The collected burr is then dropped in the dustbin mounted on buggy and the robot is further ready to collect burr which is present on the floor. Liquid Crystal Displays (LCD) are used in both the sections for displaying the commands given.

IV. IMPLEMENTATION

A. ALGORITHM:

1. Start
2. Declare variable
3. Set I/O ports.
4. Scan the surface with the help of camera.
5. If Burr found stop the robot otherwise go to the step 4.
6. Start the stepper motor according to the hand movement.
7. Pick up the burr from floor & put in dustbin.
8. If you want to continue work, if yes go to the step 4.
9. Stop.

B. FLOWCHART:



V. CONCLUSION

Robotics today is a much richer field than even a decade or two ago, with far-ranging applications. Developments in miniaturization, in new sensors, and in increasing processing power have all opened new doors for robots.

The report proposes the system robotic arm based on real-world haptic. Haptic Technology is the only solution which provides high range of interaction that cannot be provided by virtual reality. The touch access technology is important till now. But, haptic technology has totally changed this trend. This technology makes the future world as a sensible one. Haptic Technology enables users to simulate touch and utilize a new input as well as output technology, large potential for applications in critical fields as well as for leisurely pleasures.

These robots have a wide range of industrial and medical applications such as pick and place robots, surgical robots etc. Our robot is capable of managing the wastes of the machines called as Burr which could be harmful to human body to touch or pick. They can be employed in places where precision and accuracy are required. Robots can also be employed where human hand cannot penetrate.

VI. FUTURE SCOPE

The Robotic Arm designed so far is capable of lifting small weights up to 200 gram with the help of DC motors. Further the weight lifting capacity can be increased by using DC motor or stepper motors having high torque capacity. Also communication range can be increased using high range communication networks.

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