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Robot Manipulator with a tactile sensor for object Recognition in Industrial welding process

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ABSTRACT

Robot manipulator is a system with a tactile sensor which is used to perform multiple tasks to recognize the shape, position and orientation. For this type of robot has an ability to pick and place any predefined object from the conveyor system. The sensor used can easily sense the object and perform the effective cooperation between Human and Robot. Tactile sensor has a computer vision to recognize the predefined object to eliminate the manual teaching procedures in Industrial inspection and process of welding. Robotic Arm control is done with dc motor based on sensor values. Object edge scanning is possible with 3D surface based on the angle change. If the values of sensor 1 and 2 are larger than the recognized position edge then the object will not be lifted from the conveyor system. Usually sensor 1 is placed in the conveyor system and sensor 2 in the robot manipulator which lifts the object based on the edge scanning. If the angle of the sensor 1 is small than the edge of the robotic hand then the object is lifted from the conveyor system. The object is recognized and lifted based on edge scanning and position of robotic arm.

Keywords: Robot manipulator, Conveyor, edge scanning, tactile sensor, 3D surface

I. INTRODUCTION

In order to reduce the effort of Human beings robots have been designed to work in various environments such as manufacturing, building and designing for meeting the challenges in day to day world. The branch of engineering deals with mechanical and electrical devices for designing and programming computers using AI. The tactile sensors are used to measure the important parameters of sensors and an object [1]. The torque and force values are measured with respect to an object. One of the common consideration is touch sensing with tactile sensor used to detect and measure the constant force. The touch sensor senses the binary information with single point contact. The spatial distribution of forces are perpendicular for measurement and detection from coordinated group of sensors. It can grasp the object values by interpreting the information from the array of sensitive sites. The forces are able to convey the information of the grip state with position and identify the state of manipulation. The sensing requirements of Robotic system has a gripper to tactile the human sense [2]. The function of actual task is to perform desired characteristics with given specifications suitable for Industrial applications.

II. PROPOSED ALGORITHM

2.1. Problem Definition

Robots are designed with various sensors for computer vision and object recognition. To recognize the object shape, position and orientation tactile sensors are employed much. The features sensed by the human

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eyes even may sometimes lead to inaccurate results. So we need to propose the system that would exactly sense the mentioned parameters of the object.

2.2. Block Diagram

The block diagram shown defines the architecture of Robotic tactile sensor system

The suggested design represented in block diagram mainly consists of:

- Interfacing module
- Robot design modules
- Object sensing module

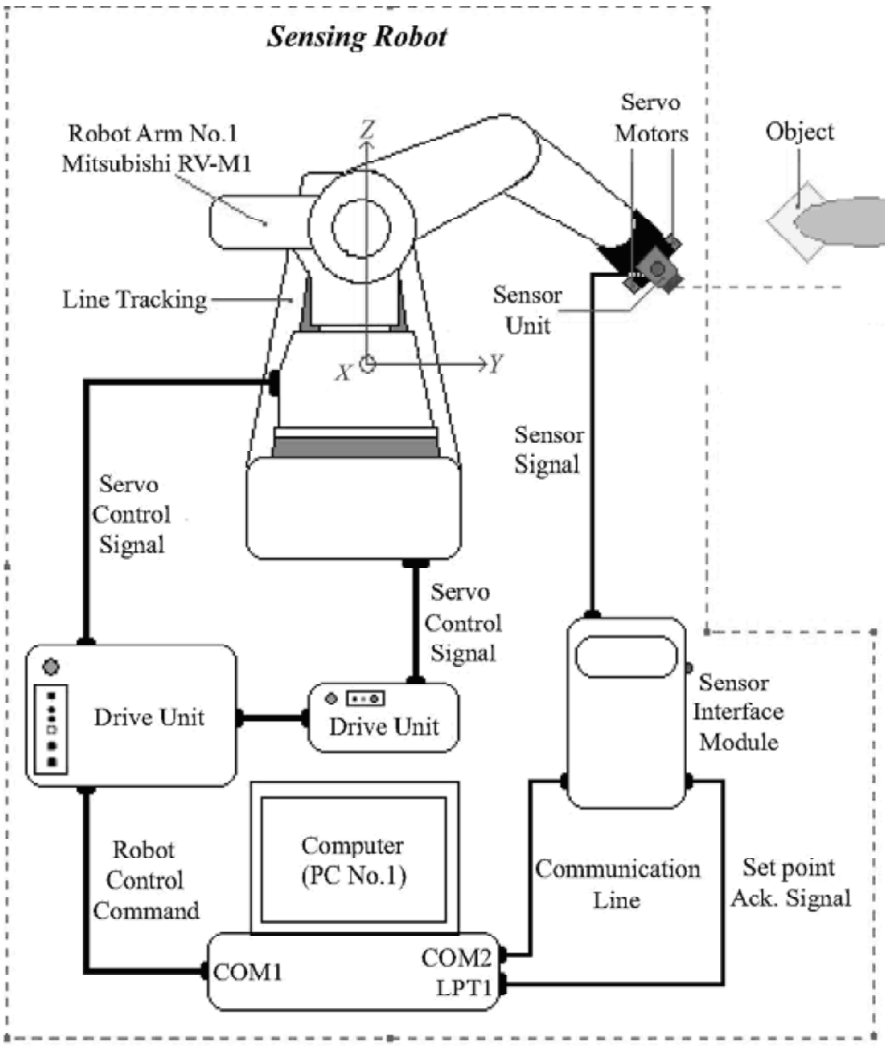

Figure 1: Architecture of Robotic Tactile Sensor System

2.3. Modules Description

2.3.1. Interfacing module

This module will include the code development for Serial communication between PC and controller section and also between interfacing Controller and Robotic Section. Here the Robot movements (Front/ Reverse/Left/Right) are controlled as per the ASCII values sent from the PC.

2.3.2. Robot Design Module

Robot design is done with wheeling mechanism and ARM. DC motors will be fixed in the wheels for its movement. Totally it has three wheels two moving and front wheel will be supportive type.

2.3.3. Object Sensing Module

Tactile sensor will be used for sensing the objects placed in the conveyor and as the stored size and shape of the object in the controller it will check. If it varies in size or shape job will be displaced from the conveyor

2.4. Hardware Requirements

The Hardware requirements needed to work with Robotic tactile sensor system are Microcontroller (16F877A), Robot, RS232,Sensing unit, Conveyor, PC, DC Motors which are explained as follows

2.4.1. Sensors in Robot Welding

- Tactile sensors
- Optical sensors
- Inductive sensors
- Through-the-arc sensors

2.4.2. Tactile Sensors

The Sensor devices are used to detect and measure any object in confined region by interaction. Tactile sensor is a sensitive device which makes contact either by touch, pressure or force. It is a sensor which can contact the object based on the environment and measured values in binary. It is much used in computer Hardware, security systems, Industrial and welding process applications which involves object recognition.

Tactile sensing is used with spatial distribution perpendicular with forces of an object for detection and measurement. It can easily detect the object with predefined criteria of sensor values in a coordinated group with single contact at any size. The sensor's specifications interprets the information based on the number of variables of sensitivity of touch. These characteristics can be considered as stable and repeatable with low loss.

2.4.3. PIC 16F877A Microcontroller

PIC 16F877A microcontroller is manufactured by Microchip Corporation which has the following features.

Table 1
Major Features of pic micro controller

	Program Memory							*MSSP*				
Device	*Bytes*	*# Single Word Instructions*	*Data SRAM (Bytes)*	*EEPROM (Bytes)*	*1/O*	*10-bit A/D (ch)*	*CCP (PWM)*	*SPI*	*Master I^2C*	*USART*	*Timers 8/16-bit*	*Compara-tors*
PIC 16F877A	14.3K	8192	368	256	33	8	2	Yes	Yes	Yes	2/1	2

The microcontroller is used as an interface with sensors for interpreting the analog value in to digital. It has a transceiver to transmit the data with a SPI protocol for processing the data. It is also required to

operate the relays with I/O pins. The programming is done for proper conversion of sensor values with data measured in analog quantity. It uses 35 single word instructions with fast execution at 200nS for 40 pin package architecture and is compatible with other series.

Additional features of PIC microcontroller are it is able perform self-programming, USART, 10-bit A-D converter, Inter-Integrated Circuit (I^2C) bus,3-wire SPI protocol used for various applications such as control, security, Industrial etc.

2.4.4. DC Motor

L293D driver circuit us used to run motors with integrated high voltage and current of four channel with DTL logic levels to drive loads of two channels of 2 motors at the same time which can handle up to 600mA current.

2.4.5. RS232

DTE and DCE is a single ended connectivity with control signals with a traditional standard of RS-232. Serial port is a physical interface to transfer information one bit at a time used in serial ports of computer.

It is an standard for asynchronous serial communication for transmitting the information serialy one bit at a time. The message starts and ends with a receiver detected at predefined time slots of communication.

2.4.6. MAX 232

This interface acts as an IC for converting the signals in to TTL compatible format for digital logic circuits. It act as a receiver to convert RTS, CTS signals with necessary drivers at adaptable voltage levels of RS 232 signal. It has one voltage of +5V with different voltage levels from -10 V to +10 V internally.

2.5. Architecture of Tactile Sensor System

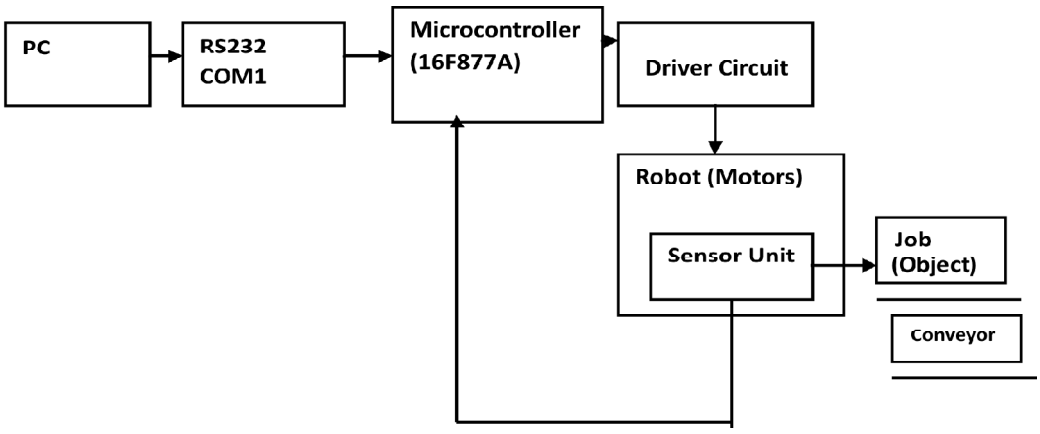

Figure 2: Tactile sensor system in detail

The major elements of this Block consists of Robot section, Conveyor, Driver section, Microcontroller section and PC Section. PC section is to monitor the sensing unit and drive the Robot to particular place and make arm movements. Tactile sensor will be placed in the Robot arm and object to be welded will be placed in the conveyor. Job placed will check for it size and orientation by the sensor before welding. If the parameters are not matched with the sensor position automatically job will be dropped from the conveyor. Driver circuit is driving the motors placed in the robot. Controller provides interfacing of robot and PC through RS232 serial communication.

2.5. Software Requirements

The program development of the robotic tactile sensor system needed various software tools as mentioned below.

- MICROCHIP MPLAB IDE
- HI-TECH C COMPILERS
- EXPRESSPCB

2.5.1. MICROCHIP MPLAB IDE

MPLAB Integrated Development Environment (IDE) is a tool set for an embedded application and it is able to run 32-bit application of MS windows operating system with free software components and debugging application.

It supports embedded paradigm of debugging tool with effective simulator of low cost circuit debugger to increase flexibility and power for eliminating the learning curve

2.5.2. HI-TECH C COMPILERS

It is developed with a compilation technology of 8, 16, 32-bit of pic microcontroller enabled with omniscient code generation of product stability with a whole program of state of art code generation of signal controller architectures.

2.5.3. EXPRESSPCB

The manufacturing service of on board is define in two parts for designing and drawing schematics of circuit boards. This software is of low cost and high quality with fast source and boards of PCB includes SCH with schematics of drawing fixtures.

The layout is complete which determines the cost of the boards at exact difference to define the PCB with complete details.

III. EXPERIMENT AND RESULTS

Figure 3 indicates the snapshots of the work with PIC microcontroller board (PIC16F877A) board with driver circuit, max 232 and power supply with wires. Through RS232 port serial communication is done

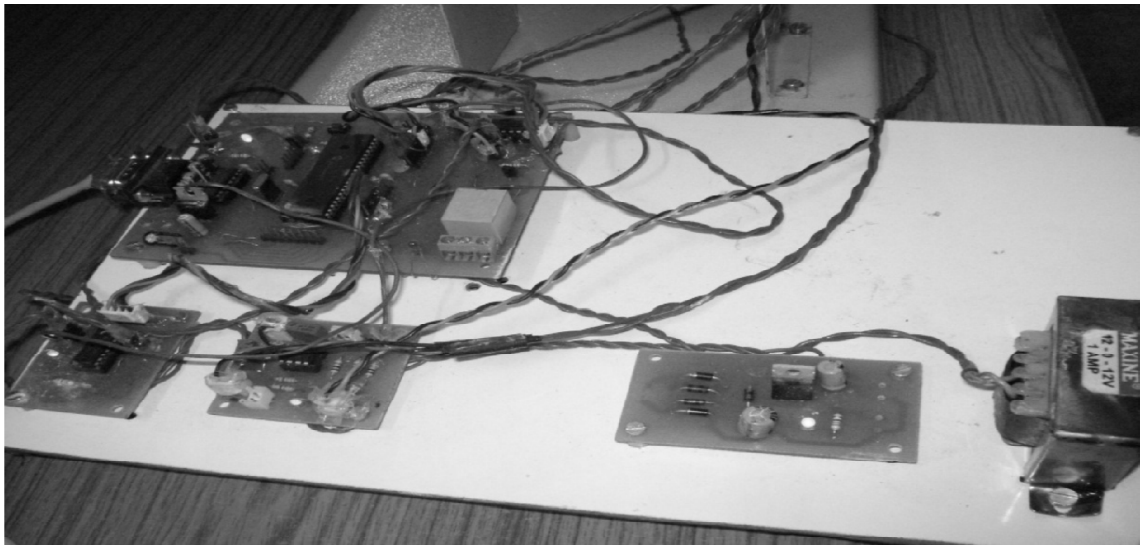

Figure 3: The important elements of the design are PIC controller board with Max 232C, driving circuit and power supply

and commands given to robot through computer. Using the driver circuit dc motors runs the robot and performs various tasks. Controller and other circuits all are fixed to a single board and wires are connected to the robotic arm to run it.

3.1.2. Robotic Tactile Sensor System

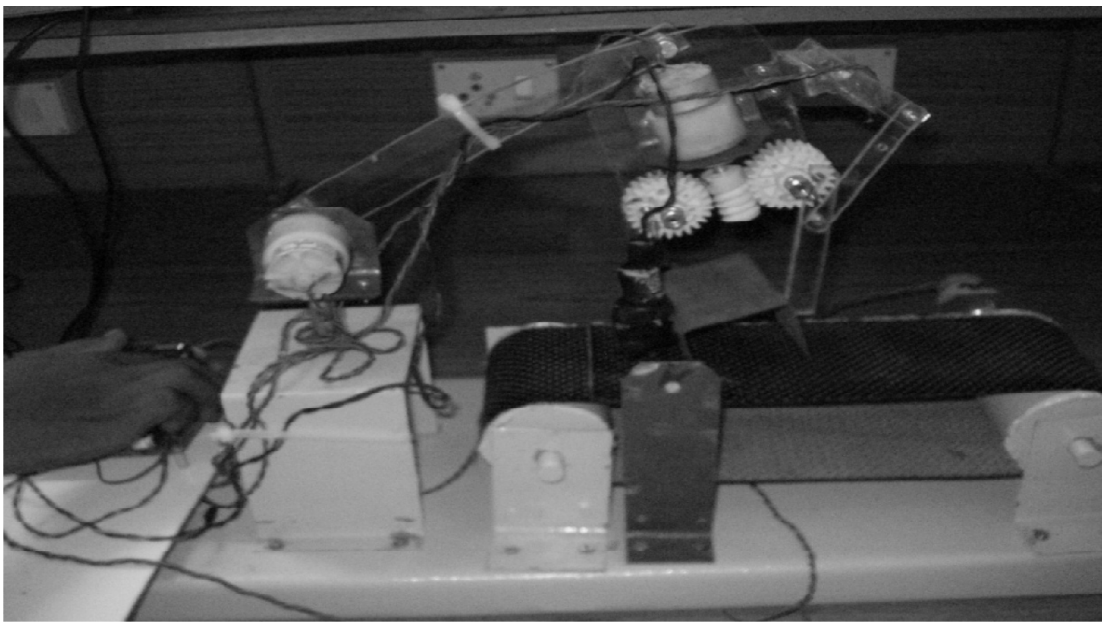

Figure 4: Represent the setup of Robotic Tactile sensor system with arm

The above setup shows the Robotic Tactile Sensor System with an arm like structure to handle an object. Using DC motors this robotic arm will move from left to right and right to left. Through the pc movements of the arm are controlled. In this setup arm, conveyor and fingers are the main architectural elements. Using driver circuitry DC motors are moved by these all robotic actions takes place. Here the object is placed on the conveyor belt. For finger movements two wheels are fixed and a dc motor also used.

3.1.3. Conveyor System

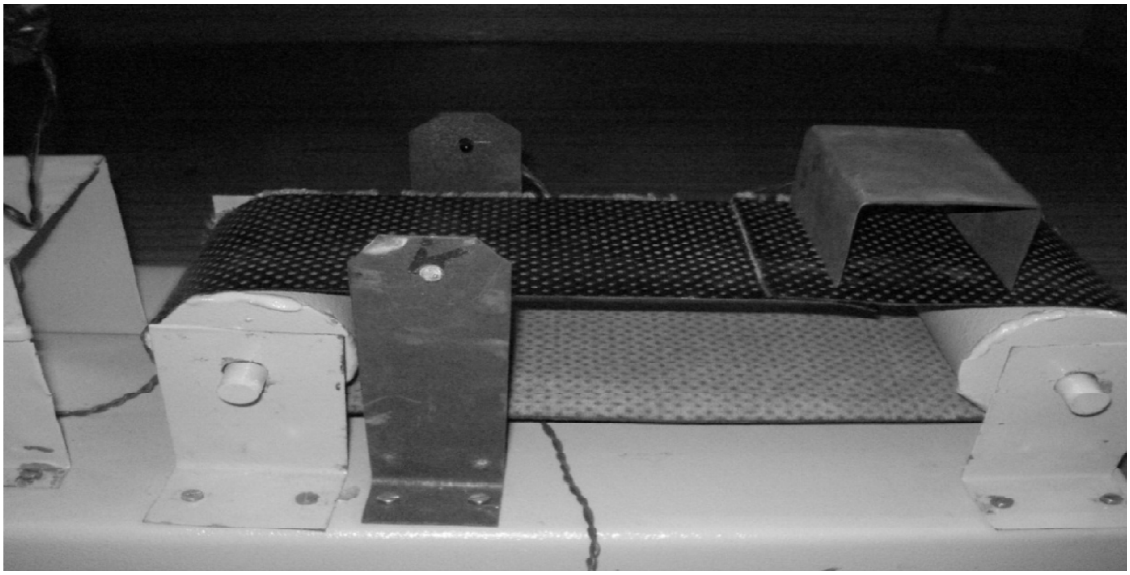

Figure 5: describes the Conveyor belt with an Object on it which is moving towards the arm of the set up

The working setup represents the conveyor of the robot section. By the DC motor conveyer transports the object towards the arm of the robot. IR sensors are attached to the setup for finding the object. Using two rollers and belt this conveyor setup developed. When the conveyor movement is initiated then an object is placed on the belt and it reaches the robotic arm.

3.1.4. Robotic Action

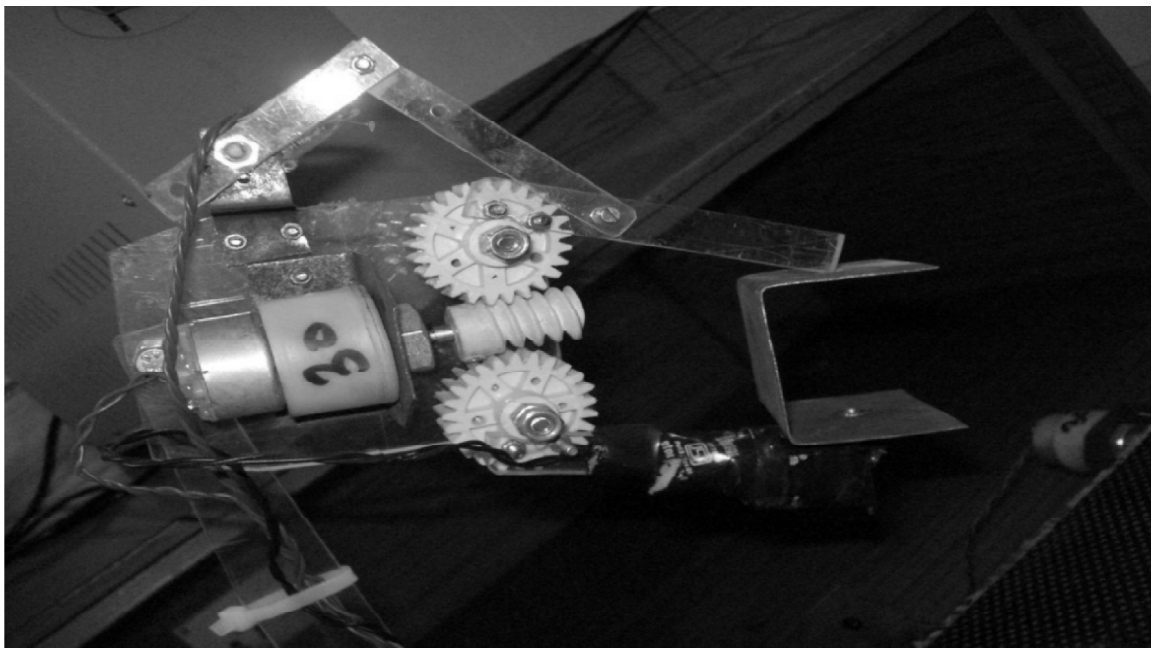

Figure 6: Snapshot represent how the robotic finger is holding an object

The figure 6 describes the carrying part in arm of the robot. A dc motor and two wheels are used to hold the object. When it carries the object then the mechanical tactile switch faces some force .These displacements are given to the secondary devices which converts the values in to digital value after this required object is detected.

3.1.5. Movements of Robotic Arm

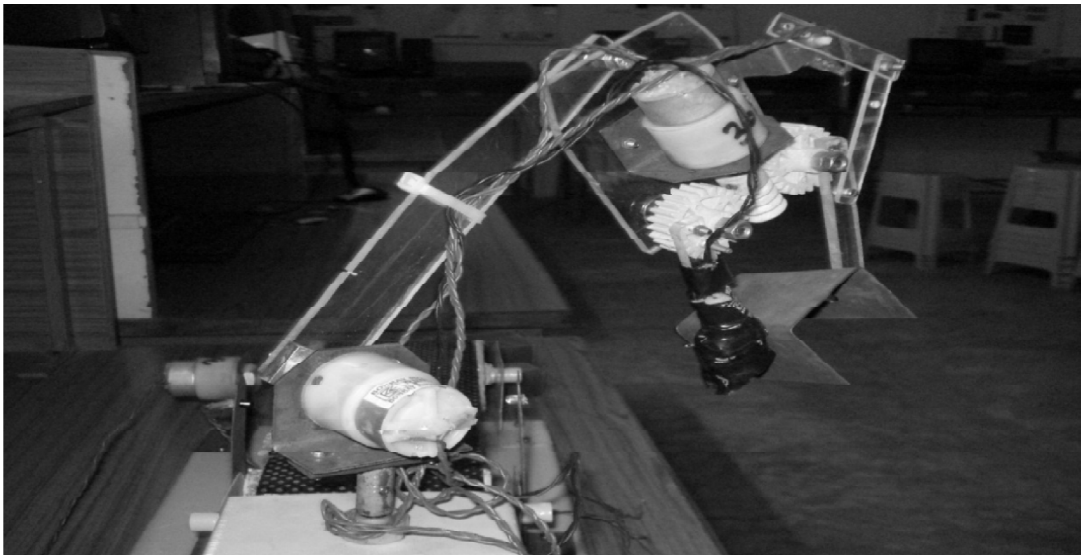

Figure 7: Robotic arm picking an object and moving away from the conveyor

The Figure 7 picture defines the working of a dc motor with Robotic hand moving towards the conveyor and reaches the object and verifies for its shape. This picture shows the operation of the robot. When object is not required then carries the object away from the conveyor otherwise the object is placed on the conveyor itself.

3.1.6. Robot Actions against Nonmatching Object

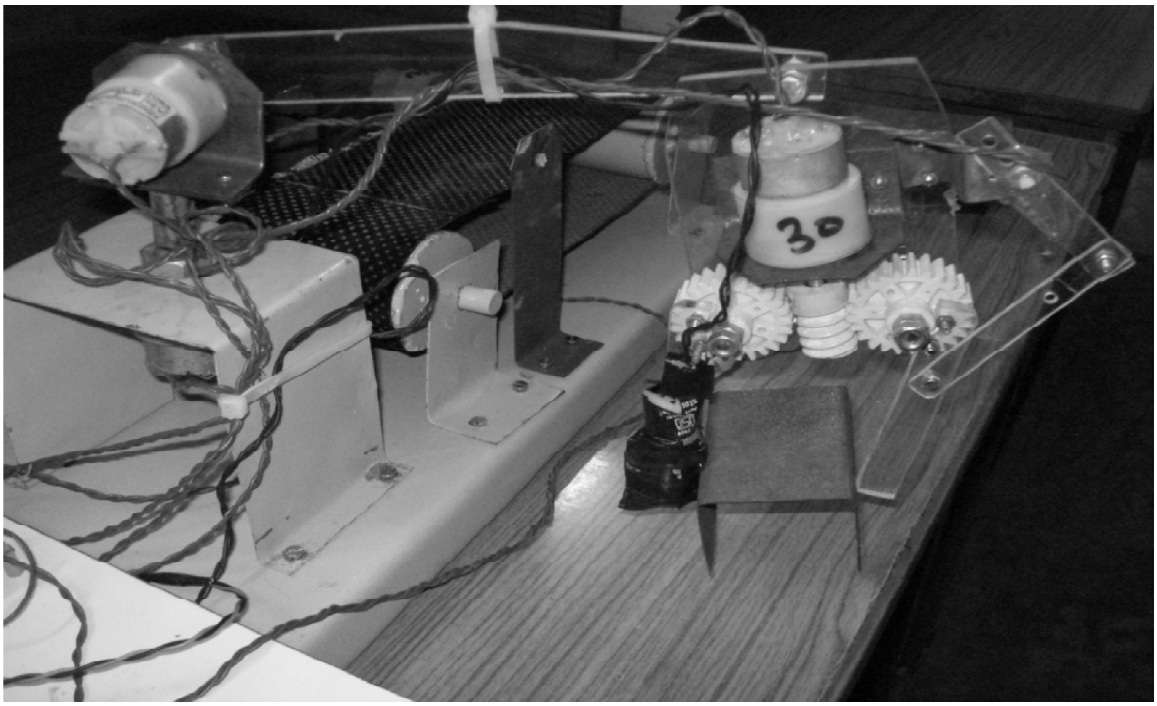

Figure 8: Represents the Robotic arm is placing the object away from the conveyor if it is a non-matching object

The above action describes that the object placed on the conveyor is the required one or not. First an object is placed on the conveyor this moves towards the robot arm .then arm moves towards object and then it handles the object. By this operation mechanical switch feels some force .This force value calculated and verified for the shape if it not matching then it places the object away from the conveyor and again goes for another object. If it finds the required shape then it starts further operations.

IV. CONCLUSION

As expected, the results of the project came to be satisfactory and the important observations are summarized as follows. The robotic tactile sensor system finds the shapes of predefined objects. It verifies the shape of the object which is placed on the conveyor .If the object shape is matched then it will drop it on the conveyor itself otherwise it drops the object away from the conveyor. The tactile sensor is attached to the finger like structure through pc we can monitor the sensor system and robotic arm.

4.1. Future work

On close observation, the Robotic tactile sensor system can be further enhanced in many ways. They can be listed as follows.

1. By increasing number of sensor values we can give more accurate results.
2. No need for predefined information about the objects.
3. The sensor’s characteristics must be stable and repeatable with low hysteresis.

4. It allows mechanical overload for industrial applications.
5. The forces and relative motions between the grasped object and the fingers need to be controlled.

4.2. Applications and Advantages

With little or no modification, the robotic tactile system can be used for the following applications and also its advantages are mentioned.

- To handle object tactile sensors are best sensors.
- Tactile Sensor Imaging Solutions in Medical Devices.
  - Breast cancer detection
  - Gastrointestinal Imaging
  - Knee Joint Replacement
  - Laparoscopic Palpation
- For 3D object edge tracing.
- Robotic arm used in industrial applications like welding purpose, material handling and other applications.
- These sensors give accurate values than human interface in industries.
- Tactile Sensors for Ergonomic Solutions

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