ROBOTIC SENSOR: CONTACT AND NON-CONTACT SENSOR

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ABSTRACT

Robots are widely used in any industries and play a major role in manufacturing. Sensors are most important component of robots to determine actual values of parameters of interest. This paper deals with the Sensing and Control system to allow the robot to move around its environment, using Ultrasound Sensors to detect obstacles. Sensors used in robots provide intelligence to the robot and improve their performance.

Keywords: Robot, Robotic Sensor, Contact Sensor, Non-Contact Sensor

I. INTRODUCTION

In industries, robots are widely used and a sensor makes the working of a robot very effective. Sensors are able to obtain data from the interaction between robotic hands and their environment. It is very difficult for a robot, without sensor to sense the existence of objects and its actual parameter of interest to perform the various tasks such as for pick and place an object. A human is able to find a specified object by sensing it and this human sensing is done by their brain and past experiences. To operate a robot effectively it is necessary to provide them sensor and vision system to sense a object and about its parameter to perform the job. Robot sensing is a very tedious job because it required teaching the robot. Robotic sensors are used in robotic system for a variety of tasks such as to detect the work piece, its existence and obstacles present in the environment.

Greater use of sensors and more intelligence should lead to a reduction of this uncertainty and because the machines can work 24 hours a day, should also lead to higher Productivity [1]. A sensor is a type of transducer. The definition of sensor according to the Instrument Society of America is "A device which provides a usable output in response to a specified measure and". Here the output is an 'electrical quantity' and measure and is a 'physical quantity, property Or condition which is measured' [2]. Robotic sensor may be contacting (tactile) or non-contacting type. Contact sensor detect the change in position, acceleration, force, torque etc. at the end effecter, whereas non-contacting sensor detect presence, distance, features of work piece etc.

II. MOBILE ROBOTIC SENSOR

Robotics has come a long way, especially for mobile robots. In the past, mobile robots were controlled by heavy, large, and expensive computer systems that could not be carried and had to be linked via cable or wireless devices. Today, however, we can build small mobile robots with numerous actuators and sensors that are controlled by inexpensive, small, and light embedded computer systems that are carried on-board the robot

[3]. Mobile robots are designed to move from one place to another. Wheels, tracks, or legs allow the robot to traverse a terrain. Mobile robots may also feature an arm like appendage that allows them to manipulate objects. Of the two stationary or mobile the mobile robot is probably the more popular project for hobbyists to build [4].

III. CONTACT OR TACTILE SENSORS

Contact sensor uses transducer for the sensing operation. Some mostly used sensors are potentiometer, strain gauge etc. Contact or touch sensors are one of the most common sensors in robotics. These are generally used to detect a change in position, velocity, acceleration, force, or torque at the manipulator joints and the end-effecter. There are two main types, bumper and tactile. Bumper type detect whether they are touching anything, the information is either Yes or No. They cannot give information about how hard is the contact or what they are touching. Tactile sensor are more complex and provide information on how hard the sensor is touched, or what is the direction and rate of relative movement. [5]

Tactile sensors that measure the touch pressure rely on strain gauges or pressure sensitive resistances. Variations of the pressure sensitive resistor principle include carbon fibers, conductive rubber, piezoelectric crystals, and piezodiodes [6, 7]. These resistances can operate in two different modes: The material itself may conduct better when placed under pressure, or the pressure may increase some area of electrical contact with the material, allowing increased current flow. Pressure sensitive resistors are usually connected in series with fixed resistances across a DC voltage supply to form a voltage divider. The fixed resistor limits the current through the circuit should the variable resistance become very small. The voltage across the pressure variable resistor is the output of the sensor and is proportional to the pressure on the resistor. The relationship is usually non-linear, except for the piezodiode [6,7], which has a linear output over a range of pressures. An analog to digital converter is necessary to interface these sensors with a computer. Different contact sensing as [8] are:

(1). Touch and force sensing.

(2). Proximity or displacement sensing.

(3). Slip sensing.

3.1 Three Axis Tactile Sensor

Three-axis tactile sensors as et al [9] the robotic hand was composed of two robotic fingers equipped with three axis tactile sensors. Using the robotic hand, it was found that tri-axial tactile data generated the trajectory of the robotic fingers, even if a simple initial trajectory was provided for the control program. In the verification test, the robotic hand screwed a bottle cap to close it. The tactile sensor is composed of a CCD camera, an acrylic dome, a light source, and a computer as shown in Fig. 1. The light emitted from the light source is directed into the acrylic dome. Contact phenomena are observed as image data, which are acquired by the CCD camera and transmitted to the computer to calculate the three-axis force distribution. The sensing element presented in this paper is comprised of a columnar feeler and eight conical feelers. The sensing elements, which are made of silicone rubber, are designed to maintain contact with the conical feelers and the acrylic dome and to make the columnar feelers touch an object. [10].

When the three components of the force vector, Fx , Fy , and Fz , are applied to the tip of the columnar feeler, contact between the acrylic dome and the conical feelers is measured as a distribution of gray-scale values, which are transmitted to the computer. Fx , Fy , and Fz values are calculated using integrated gray-scale value G and the horizontal displacement of the centric of gray-scale distribution. We are currently designing a multi-

fingered robotic hand for general-purpose use in robotics. The robotic hand includes links, fingertips equipped with the three-axis tactile sensor, and micro actuators (YR-KA01-A000, Yasukawa). Each micro actuator, which consists of an AC servo-motor, a harmonic drive, and an incremental encoder, is particularly developed for application to a multi-fingered hand. Since the tactile sensors must be fitted to a multi-fingered hand, we are developing a fingertip that includes a hemispherical three-axis tactile sensor [9, 11]

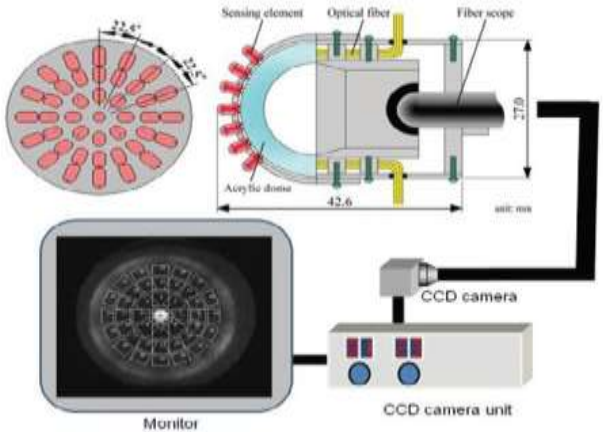

Fig. 1 Three-Axis Tactile Sensor System [10]

Fig. 2 Two-hand-arm robot equipped with optical three axis tactile sensor [10].

IV. NON-CONTACTING SENSOR

Non-contacting sensors are also a very important type of sensor, which detect parametric information about the environment of the object. It is used to detect the existence, distance and features of the object.

There are mainly six types of non-contacting sensor are as [8]:

(1). Visual and optical sensor.

(2). Magnetic and inductive sensor.

(3). Capacitive sensor.

(4). Resistive sensor.

(5). Ultrasonic and sonar sensor.

(6). Air pressure sensor.

Visual and optical sensors operate by transforming light into an electrical signal. The photo detectors can be as simple as a single photo diode or as complex as a television camera. With stereo cameras, robotic vision systems are analogous to the human sense of sight. [8].

Magnetic sensor is a type of non-contacting sensor which converts the magnetic energy into electrical signal. By this electrical signal it is able to determine the velocity, proximity of any metallic object.

Capacitive sensor is similar to magnetic sensor. The most common capacitive probes are flat disks or flat metal sheets. Probes are electrically isolated from their housings by guard electrodes insuring that the electric field produced is perpendicular to the sensor. Systems can make measurements in 100 microseconds with resolutions of 1/10 of a micron, and probe diameters range from thousandths of an inch to several feet [12].

Resistive sensing determines the distance between a robot arc welder and the welding seam. This sensing is done by means of varying resistance of the welding are. Figure 3 shows the basic technique for through the arc position sensing.

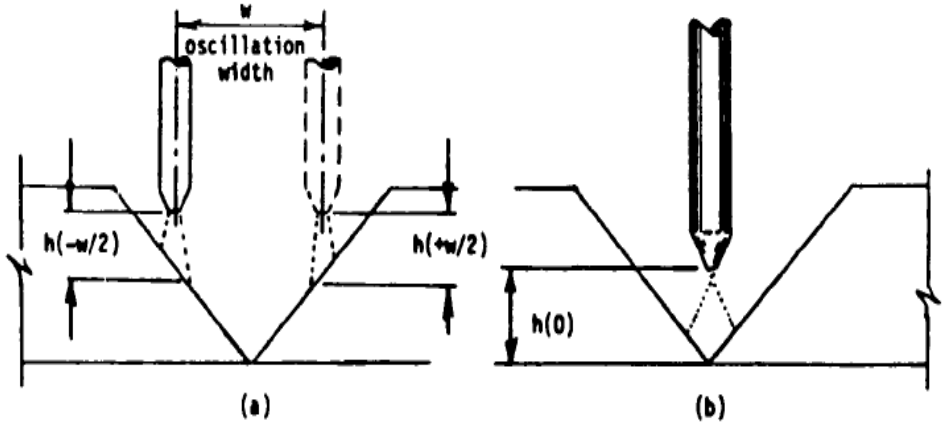

Fig.3 Welding Technique For Through he Arc Sensing [13].

Ultrasonic and sonar sensors are detected position, velocity, orientation etc. using high frequency acoustic waves.

V. CONCLUSION

It is concluded that, robotic sensor is the most important device for a robot to perform various tasks. Sensor makes the working of a robot very effective, which is able to obtain information from the interaction between robotic hand and their environment. Sensors used in robots provide intelligence to the robot and improve their performance. To operate a robot effectively it is necessary to provide them sensor and vision system to sense a object and about its parameter to perform the job. Robotic sensor may be contacting (tactile) or non-contacting type. Contact sensor detect the change in position, acceleration, force, torque etc. at the end effecter, whereas non-contacting sensor detect presence, distance, features of work piece etc. contact sensing may be of various types such as, touch and force sensing, proximity or displacement sensing, slip sensing. Non-contacting sensors are also of various types mainly six such as, visual and optical sensor, magnetic and inductive sensor, capacitive sensor, resistive sensor, ultrasonic and sonar sensor, air pressure sensor. A sensor can be choosing according to the requirement and the working environment of the robot.

REFERENCE

[1]. Ernest L. Hall1 and Nathan Mundhenk, “Intelligent Robot Trends and Predictions for the New Millennium”.

[2]. D Patranabis, “Sensors and Transducers”, Wheeler Publishing, New Delhi, 1997.

[3] Thomas Braunl, "Embedded Robotics Mobile Robot Design and Application with Embedded System", Springer 2006.

[4]. Gorden Mc Comb & Myke Predko, "Robot Builder's Bonanza", Mc-Graw Hill, 2006.

[5]. R.k. mittal and I J Nagrathan, "Robotics and Control" page n. 344- 350.

[6]. U.S. Patent 3,323,358, June 5,1967. Anthony V. Fraioly, inventor.

[7]. U.S. Patent 3,509,583, May 5.1970, Anthony V. Fraioly, inventor

[8]. Robotic Sensing Devices David J. Hall CMU-RI-TR-84-3 Department of Electrical Engineering. The Robotics Institute Carnegie-Mellon University Pittsburgh, Pennsylvania 15213 March 1984

[9]. Ohka, M., Morisawa, N. and Yussof, H. B., "Trajectory Generation of Robotic Fingers Based on Tri-axial Tactile Data for Cap Screwing Task", 2009 IEEE International Conference on Robotics and Automation, Kobe, Japan, May 12-17, 2009, pp. 883-888

[10]. Geometrical Data Extraction Using Interaction Between Objects and Robotic Fingers Equipped with Three-axis Tactile Sensors Sukarnur Che Abdullaha, Masahiro Ohkab, Yusuke Doshob, Takuya Ikaib and Hanafiah Yussofa

[11]. Ohka, M., Morisawa, N., Suzuki, H., Takada, J., Kobayashi, H., Yussof, H., "A Robotic Finger Equipped with an Optical Three-axis Tactile Sensor," Proc. of IEEE Inter. Conf. on Robotic and Automation, 2008, pp. 3425-3430.

[12]. Section 5 - Transducers, Machine Design, vol. 54, no. 11, May 13,1982

[13]. Cook. George E., A. Michael Wells, Jr. and Hussam Eldean E. H. Eassa, Microcomputer Control of an Adaptive Positioning System For Robot Arc Welding, IECI Proceedings of Applicarioris of Mini and Microcomputers, November1981.