CONTROL OF WHEELED MOBILE ROBOT USING CENTROID ALGORITHM

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Abstract: In today's developing technology, industries are playing important role for the betterment of life and society. But in industries many functions are running under hazardous conditions, so demand of human free interaction arises, which can be fulfilled by robotics. In Chemical, Oil & Gas, Petrochemicals and many manufacturing industries today we need human safety on head, and it can be done by robots. This paper implies such type of mobile robot which can be used in complex industries. The work is based on Image processing and Centroid Algorithm. The physical quantities like (temperature, pressure, humidity, stress, PH) and leakage of gases and liquids, fire, spark and many human safety related things which can be encountered by this mobile robot. By using this robot, the main achievement is human safety and simultaneously cost effective, precision and all far away data can be easily available through IoT (Cloud) [1]. Also, it works without any disincentive at particular of desired time in day or night, where particular place requires physical quantities measurement. In this project the main components are Controller (Raspberry Pi), Four DC Motor for each wheel, Pi Camera for image detection and processing, motor driver logic and physical quantities sensor [2].

Keywords **- Centroid Algorithm, Robot, Pi Camera, Raspberry Pi, Image Processing.**

I. INTRODUCTION

Application

There are ample robots design for different applications. But generally, they are working using different sensors. In this project mobile robot timely based actuated in different physical quantities measurement like pressure, temperature, humidity, PH, Gas and hazardous chemical leakage, fire and spark detection. Also, it plays increasingly major role in defense sector for explosive detection. It follows path for supervision of pipe and mine detection. It also works under unstructured environment.

Raspberry Pi

Raspberry Pi is one of Lone-board computer without peripherals like mice, keyboards and cases. It is a general-purpose controller widely used in education, Home Automation, Industrial Automation and mainly used in Robotics Application. In market two types of Raspberry Pi Model are available namely model- A and model-B and upgraded to A+ and B+. ARM Cortex-A53 processor is itself in-build with CPU and GPU and operating system. Linux is most favorable operating system supported in Raspberry Pi.

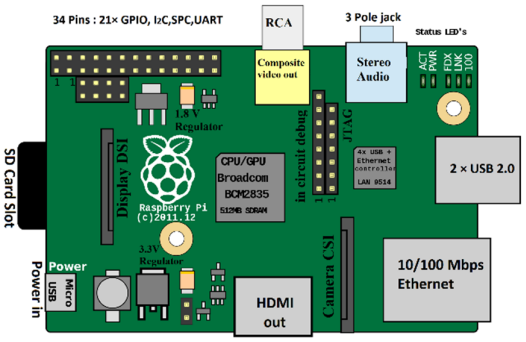

Figure 1 Raspberry Pi Architecture

The speed range of processor is from 700MHz to 1.4GHz and same as memory range from 256MB to 1GB RAM. The board has 4 USB terminal points for HDMI, Video and Audio Output and lower output is supported with GPIO pin sustained with I^2C bus protocol.

Presently many projects have developed using Raspberry Pi because it is open source hardware and compatible with user. Ethernet has additional and internal support to connect USB port. Also, system on chip is directly connected with USB port, which can be understood by below diagram.

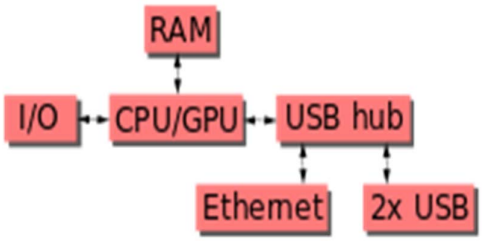

Figure 2 Raspberry Pi Bus Structure

Pi Camera

Pi camera V2 is introduced by Raspberry Pi Corporation. V2 is very high-quality image sensor of 8 Megapixel with fixed focal length. Camera module is connected with CSI port of Raspberry Pi. Check that it is not conductive with any other interface. Lift the collar of Pi zero and insert it carefully. It's shown in below image clearly [4].

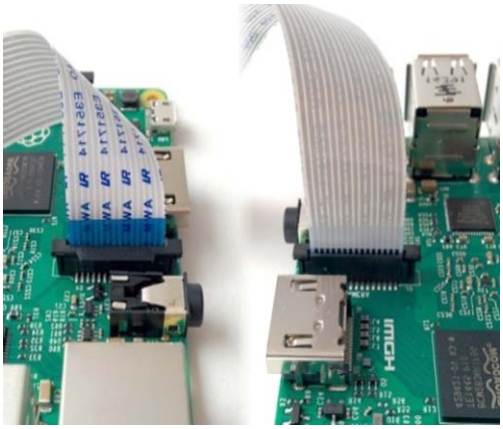

Figure 3 Pi Camera Interface

The L293B is quad push-pull drivers capable of delivering output currents to 1A per channel. Every channel is controlled by a TTL-compatible logic input and every try of drivers (a full bridge) is provided with associate inhibit input that turns off all four transistors. A separate input is provided for the logic so it's going to be got away a lower voltage to cut back dissipation. As per change in voltage it will change the logic of DC Motor start and stop conditions.

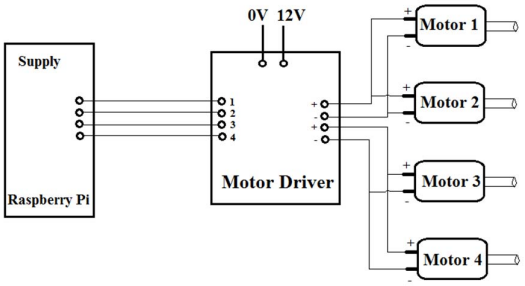

Figure 4 *Motor Driver Logic (L293B)*

Centroid Algorithm

Centroid Algorithm calculates several white and black contours in a binary image and that image converted in grey scale image. If there is black contour, coordinates of $X_c$and Y_c of the contour centre being calculated by using below formula.

$$X_c = \frac{1}{M}\sum_{i=1}^{n} x_i\, m_i$$

Where M is sum, m_i is a pixel intense value, x_i or $y_i$are pixel location for image, n is total number of pixels.

II. PROBLEM DEFINITION

Time is extremely important aspects of industries. So, robot is very important device to save both time and human efforts. In today's era of technology, innovation plays an ultimate goal for human safety. This mobile robot rectifies the human error. Also, it prevents all safety related issues and follows black-line and detects hazardous situation and timely and within constrained time hurdles can be overcome. The bellow figure is one best example of path following carpet of Robot in industry.

Figure 5 Black-line Path

III. METHODOLOGY

To attain this project centroid algorithm is implemented so that the robot can follow the desired path. This robot is mainly designed for hazardous industry purpose. To get the data as well as pictures at certain time so, by doing the time settings in robot, it can automatically go and take the data at that present time. This is accomplished using image processing, at first video is converted in to frames with format 'BGR' Image. The program is written in language called Python i.e. high-level language. Here, robot is design to follow black line, which is denoted by Image= (0, 0, 0), (75, 75, 75). In GPIO Board different pins are set for individual motors that are attached to four wheels. From open computer vision platform, erode command is used for noise cancellation. The contour of black line is detected using 'find contours' command [5]. Through this the angle of black line is detected i.e. when the robot tilts right the angle is towards negative and when the robot tilts left then the angle is positive. After finding the contours the centroid of the black line is measured. Therefore, by taking centroid as a reference point, the angle is referred as positive or negative.

The detection of path using camera captures is shown in image. The bounded rectangle captures the blackline in the numbers in red color shows the angle between camera and blackline. When angle is changed accordingly, output to motors also changes.

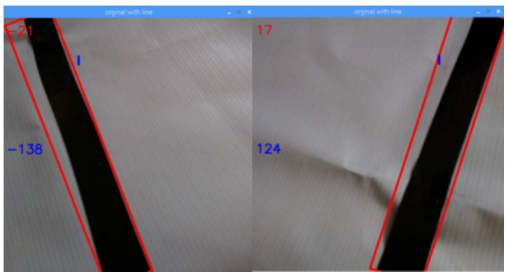

Figure 6 Straight and Curve path detection

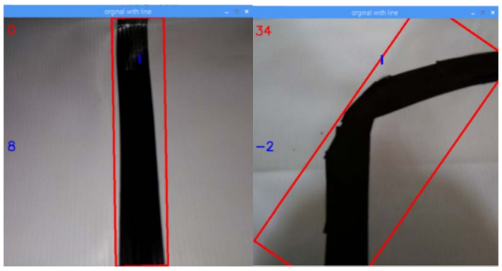

Figure 7 Right and Left Move

Using conditional statements i.e. when **-10 <=ang>=20** then all outputs are switched high at the same time all four motors start running forward. When **40<=ang>=60,** two outputs are switched low and two outputs remain high. Because of that robot starts turning left and this continue for negative angle to take right turn [17].

Model Architecture

The model of mobile robot is as shown in figure which is equipped with temperature, pressure, humidity, PH, noise sensors and camera [6].

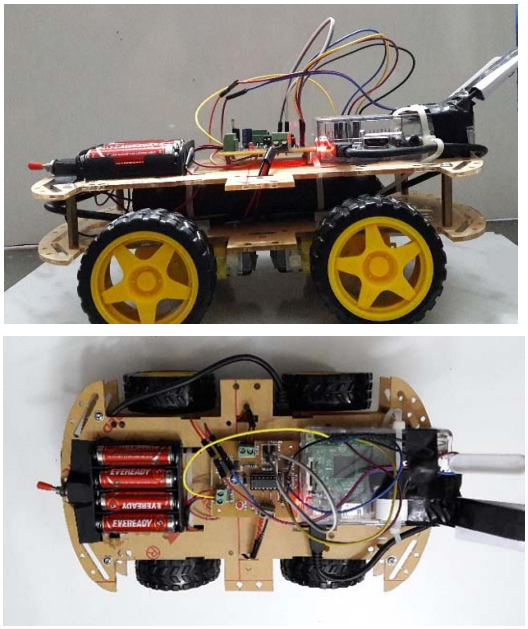

Figure 8 Model of Mobile Robot

IV. INFERENCE

This project has high advantages in industry level as it is cost effective, saves time, reduces manpower can perform task, dirty and as many times required. Using ultra sonic sensors technique it is able to detect the obstacles, in its path. It can prevent occurring of industrial accidents by notifying an alarm. As in hazardous industry error can't be neglected therefore it gives us a great form, where errors are rectified before occurring.

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