Obstacle Detection and Path Crossover using Fire Bird V Robot

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Abstract— In today’s world robotics is a fast growing and interesting field. Robot has sufficient intelligence to cover the maximum area of provided space. The main objective of this paper is to develop a robot that will move according to the code assigned and navigate according to the conditions i.e., navigating from any obstacle on its way to avoid collisions. The guidance system consists of infrared sensors for obstacle detection, range determination and avoidance. IR proximity sensors are used to detect the obstacles in robots path. The infrared sensor reading is taken and processed to avoid the obstacles. Obstacle avoidance robot has a vast field of application. They can be used as service robots, for the purpose of household work and so many other indoor applications. Nowadays, even in ordinary environment, people also require that robots can detect and avoid obstacles. The desired goal of this system is to avoid obstacles along its path and to determine the distance.

Key words: Obstacle Detection, Fire Bird V Robot

I. INTRODUCTION
Robotics is the branch of technology that deals with the design, construction, operation and application of robots. Robots are now widely used in many industries due to high level of performance and reliability. The word “robot” was first used to denote fictional humanoid in a 1921 play R.U.R. by the Czech writer, karel capek. Electronics evolved into the driving force of development with the advent of the first electronic autonomous robots created by William Grey Walter in Bristol, England in 1948. Isaac Asimov a renowned science fiction writer came up with the word “robots”. The idea of putting machines to work can be traced as far back as Aristotle (384-322BC) who put forth the notion of pulling machines to work for humans. Designing autonomous robot requires the integration of many sensors and actuators according to their task. Obstacle avoidance is primary requirement for any autonomous robot. The robot acquires information from its surrounding through sensors mounted on the robot. Various types of sensors can be used for obstacle avoiding. Methods of obstacle avoiding are distinct according to the use of sensor. The common used sensing devices for obstacle avoiding are infrared sensor, ultrasonic sensor and charge coupled device (CCD). Among them infrared sensor is most suitable for this obstacle avoiding robot because of its low cost and ranging capability. The fire bird V robot has 8 IR proximity sensors. It has an infrared sensor which are used to sense the obstacles coming in between the path of robot. Infrared sensors are extensively used for measuring distances. The disadvantage with the obstacle avoidance based on triangulation is the need of the robot to stop in front of an obstacle in order to allow for a more accurate measurement. All robots feature some kind of collision avoidance, that detect an obstacle and stop the robot short of it in order to avoid a collision. The obstacle avoidance algorithm needs to steer the robot around the obstacle and resume motion toward the original target.

In this paper, robot doesn't have to stop in front of an obstacle during its navigation. Hence the robots may overcome some of the problems during navigation and it can navigate smoothly during its operation avoiding the collisions.

II. ROBOT TASK
The task of our robot is obstacle detection and avoidance. The robot has to be made in such a way that it will move forward until it detects an obstacle. On detecting an obstacle, it will turn left or right depending on the free space available in front of it. On detecting any obstacles through the IR sensors, it moves towards left or right depending on the amount of IR rays detected by IR sensors (left and right) respectively.

A. Design of the Robot
Fire bird V will help you get acquainted with the world of robotics and embedded systems. As a universal robotic research platform, fire bird V provides an excellent environment for experimentation, algorithm development and testing. It’s modular architecture allows you to control it using multiple processors such as 8051, AVR, PIC and ARM7 etc. Modular sensor pods can be mounted on the platform as dictated by intended applications. Precision position encoder makes it possible to have accurate position control. It is powered by high performance rechargeable NiMH battery. Auxiliary power supply provides regulated 12V, 1Amp supply. When robot is powered by battery, it can use maximum of 2Amp current while auxiliary supply will provide only 1Amp current. Fire bird V robot can sense its current consumption using hall effect current sensor ACS712/ACS714. Sensor’s current sensing element is located between battery’s positive terminal and robot’s electronics.

B. Sensors used in this Project:
- Three white line sensors,
- Five sharp IR range sensors,
- Eight analog IR proximity sensors,
- Two position encoders,
- Current sensing,
- Battery voltage sensing,
- Five ultrasonic range sensors.

III. WORKING MODULE
Here as the name indicates IR proximity sensor are being used for sensing the obstacles on the surface. They are used for sensing the location of the system there by detecting could be done. Robot can be fitted with five IR range sensors. For accurate distance measurement robot uses sharp IR range sensors. Sharp IR sensors consists of IR LED and linear CCD array. IR LED with the help of the leads transmits a narrow IR beam. When light hits the obstacle
and reflects back to the linear CCD array, depending on the distance from the obstacle, angle of the reflected light varies. This angle is measured using the CCD array to estimate distance from the obstacle. It gives same response to difficult colored objects as measured distance is function of the angle of reflection and not on the reflected light intensity. Software are just like a brain of the whole embedded system as this consists of the programming languages used which make hardware work.

IV. SENSORS FOR OBSTACLE AVOIDANCE

A. Infrared Sensors:

In this paper, three infrared sensors are utilized for distance measurements. The IR sensor consists of a LED emitting the infrared light and a photodiode. This sensor enables to detect objects without any influence on the color of reflective objects, reflectivity, the lights surrounding. It generates an analog voltage that is a function of range. The output voltage can be measured by an analog-to-digital (ADC) input line. Infrared proximity sensors are used to detect proximity of any obstacles in the short range. IR proximity sensors have about 10cm sensing range. These sensors sense the presence of the obstacles in the blind spot region of the sharp IR sensors. Firebird V robot has 8 IR proximity sensors. In the absence of the obstacle, there is no reflected light hence no leakage current will flow through the photodiode and output voltage of the photodiode will be around 3.3V. As obstacle comes closer, more light gets reflected and falls on the photodiode and leakage current starts which causes voltage across the diode to fall.

B. White Line Sensors:

Line sensors are used for sensing white line on dark surface. It can even detect nodes and move on the maze of the white or black lines. It consists of high intensity red LED for illumination and highly directional photo transistor for line sensing. Phototransistor consists of a photo transistor and convex lens. Because of precise alignment between lense and photo transistor it has very narrow viewing angle of 5 degrees. Due to the directional nature of the photo diode, it does not get affected with ambient light unless it is very bright. When the robot is on a white line, more lights get reflected resulting in considerable increase in the leakage current which causes voltage across the sensor to fall between 2 to 0.1V. When the robot is not on a white line, amount of light reflected is less, hence less leakage current flow through the photo transistor. In this case, the line sensor gives an output in the range of 2V to 3.3V.

C. Buzzer:

In this project, buzzer is used to make sound when the robot is approaching the obstacle. When the robot is a bit far from the obstacle then it makes a less pitch sound, as it approaches the obstacle further, the sound of the buzzer increases drastically.

V. OPERATION OF OBSTACLE DETECTION AND AVOIDING SYSTEM

This IR range sensor produces voltage signal when the photo diode conducts due to reflection of IR rays. The emitter emits a pulse of IR light. This result travels out in the field of view and either hits an object or just keeps on going. In the case of no object, the light is never reflected and the reading shows no object. If the light is reflect off an object, it turns to the detector and create a triangle between the point of reflection, the emitter and the detector. The angles in this triangle vary based on the distance to the object. The triangle described above. It is an analog infrared proximity sensor. It can be used to detect obstacles. This sensor has a LED that emits infrared light. Infrared light has the interesting property that it bounces on obstacles. On the front of the sensor, beside the LED that emits infrareds, there is a photodiode that is sensible to infrared light. It will vary the output voltage based on the amount of infrared light that bounces back to the sensor. The more infrared light it sees, the closer is the object and the higher output voltage generated by the photodiode. The sensor will provide an analog output voltage that is proportional to the distance of the object it senses. Its analog output will then be fed into analog-to-digital converter of the microcontroller. This value can be used to determine whether or not there are obstacles close to the sensor and how far these obstacles are.

![Fig. 1: Block Diagram](image1)

![Fig. 2: Flow Chart](image2)
VI. SENSING STATEMENTS
Initially robot is programmed with the black line following and the movement the robot is pre-controlled with the programs. The is intent to traverse from its starting point and complete it movement with the end point. And the robot movement is altered when it counters with the obstacle in its path of movement. The robot is programmed in such a way that, whenever a robot encounters an obstacle, it takes reverse motion to reach its prior node and from that node it chooses to move left or right direction. According to the flowchart, pre-node is the starting point. From this point, the robot begins to move forward. On moving forward, if an obstacle is detected by IR sensor of the robot, it changes its direction of the movement by tuning either right or left. Supposing that, it moves forward after turning right due to the detection of obstacle and detects an obstacle again on the path of reaching endpoint, it turns left again and takes another path for reaching end point. If there is an absence of obstacles in the path of the robot, it moves straight from the starting point and to reaching the end point.

VII. IMPORTANT OF OBSTACLE AVOIDANCE
In scientific exploration and emergency rescue, there may be places that are dangerous for humans or even impossible for humans to reach directly, then we should use robots to help us. In those challenging environment, the robots need to gather information about their surroundings to avoid obstacles. For outer space exploring robots, this is even more important because there can be a delay of seconds or minutes between the control station on earth and the robot. Nowadays, even in ordinary environments, people also require that robots can detect and avoid obstacles. For example, an industrial robot in a factory is expected to avoid workers so that it won’t hurt them. In conclusion, obstacle avoidance is widely researched and applied in the world, and it is probable that most robots in the future should have obstacle avoidance function.

A. Program Coding:
```c
#define F_CPU 14745600
#include <avr/io.h>
#include <avr/interrupt.h>
#include <util/delay.h>
#include <math.h>
#include "lcd.h"

void port_init();
void timer5_init();
void velocity(unsigned char, unsigned char);
void motors_delay();
unsigned char ADC_Conversion(unsigned char);
unsigned char ADC_Value;
unsigned char flag = 0;
unsigned char Left_white_line = 0;
unsigned char Center_white_line = 0;
unsigned char Right_white_line = 0;
unsigned char adc_reading;
char str;
void MOSFET_switch_config (void) {
    DDRH = DDRH | 0x0C;
    PORTH = PORTH & 0xF3;
    DDRG = DDRG | 0x04;
    PORTG = PORTG & 0xFB;
}
void lcd_port_config (void) {
    DDRC = DDRC | 0xF7;
    PORTC = PORTC & 0x80;
}
void adc_pin_config (void) {
    DDRF = 0x00;
    PORTF = 0x00;
    DDRK = 0x00;
    PORTK = 0x00;
}
void motion_pin_config (void) {
    DDRA = DDRA | 0xF0;
    PORTA = PORTA & 0xF0;
    DDRL = DDRL | 0x18;
    PORTL = PORTL | 0x18;
}
void left_encoder_pin_config (void) {
    DDRE = DDRE & 0xEF;
    PORTE = PORTE | 0x10;
}
void right_encoder_pin_config (void) {
    DDRE = DDRE & 0xDF;
    PORTE = PORTE | 0x20;
}
void turn_on_sharp15 (void) //turn on Sharp IR range sensors 1,5
{
    PORTH = PORTH & 0xFB;
}
void turn_off_sharp15 (void) //turn off Sharp IR range sensors 1,5
{
    PORTH = PORTH | 0x04;
}
void port_init()
{
    lcd_port_config();
    adc_pin_config();
    motion_pin_config();
    left_encoder_pin_config();
    right_encoder_pin_config();
    DDRC = DDRC | 0x08;
    PORTC = PORTC & 0xF7;
    MOSFET_switch_config();
}
int main()
{
    init_devices();
    lcd_set_4bit();
    lcd_init();
    int count=0;
    while(1)
    {
        Left_white_line=ADC_Conversion(3);
        Center_white_line = ADC_Conversion(2);
        // Code for obstacle detection and path crossover...
    }
}
```

Right_white_line = ADC_Conversion(1);
flag=0;
print_sensor(1,1,3);
print_sensor(1,5,2);
print_sensor(1,9,1);
if((Center_white_line>0x40 && Right_white_line>0x40))
{
    stop();
    _delay_ms(500);
turn_on_sharp15();
    sharp = ADC_Conversion(9);
    value = Sharp_GP2D12_estimation(sharp);
    velocity(100,100);
    if (value >= 230 && value < 800)
    {
        id_node = value;
    }
    else if (value < 230)
    {
        id_node = value;
        buzzer_on();
        _delay_ms(1000);
    buzzer_off();
    }
    turn_off_sharp15();
    right_degrees(200);
    stop();
    _delay_ms(500);
    back_mm(100);
    stop();
    _delay_ms(500);
    turn_on_sharp15();
    sharp = ADC_Conversion(9);
    value = Sharp_GP2D12_estimation(sharp);
    if (value >= 230 && value < 800)
    {
        id_node = value;
    }
    else if (value < 230)
    {
        id_node = value;
        buzzer_on();
        _delay_ms(1000);
        buzzer_off();
    }
}
}

B. Advantages
- Whenever robot senses any obstacle automatically diverts its position left or right and follows the path without human guidance.
- It is a low cost circuit.
- The programming of the microcontroller is easy.
- Vehicle search alternate path in case of accident in front side.
- Security and remote monitoring of vehicles.
- The track detection is easy and low cost of implementation.

C. Applications:
Obstacle avoiding technique is very useful in real life, this technique can also use as a vision belt of blind people by changing the IR sensor by a kinetic sensor, which is on type of microwave sensor whose sensing range is very high and the output of this sensor vary in according to the object position changes. This technique makes a blind people able to walk anywhere. On top of obstacle avoiding robot temperature/pressure sensors can be added to monitor the atmospheric conditions around. This is useful in places where the environment is not suitable for humans.

VIII. Conclusion
The future prospect of the project includes improving the accuracy of the system. We will use more efficient techniques to reduce the computational complexity and to detect the obstacles. We developed the robot with a very good intelligence which is easily capable to sense the obstacle and by processing the signal coming from the sensor it is perfectly avoiding the obstacle coming in between the path. In future, the sensing range can be increased by increasing the sensor quality with the help of the IR signal spread all over the provide area. Here, the obstacle avoidance algorithms stability, its speed makes it popular for real time collision detection and practical to implement. By doing this project we came across many challenges, fixed them and now we are confident enough to work in any component in embedded field.

REFERENCES