ECE 511: MICROPROCESSORS

A project report on

SNIFFING DOG

Under the guidance of Prof. Jens Peter Kaps

By,

Preethi Santhanam (G00767634)

Ranjit Mandavalli (G00819673)

Shaswath Raghavan (G00776950)

Swathi Guruduth (G00841388)

Vignesh Ravishankar (G00771987)

ABSTRACT:

'Sniffing dog' is a smart toy that is capable of working on both independent and synchronized control of the geared motors, servo motor and the IR sensors. The controller is built around a 16 bit Microcontroller to provide fast and reliable control operations. In addition, geared motors are used for the locomotion of the robot, while the servo motors are used like a hinge support to make a 180 degree horizontal scan. The IR sensors are used for proximity sensing and edge detection with very high capabilities to accurately detect objects at a specified distance. The controller uses two ports to control the integral peripherals of the robot, that is, it can be used to horizontally scan with the aid of a servo motor while simultaneously perform edge detection while in motion.

The aim of our project was to control and monitor the motion of a robot that navigates and tracks objects using an IR sensor. The purpose of this project is to demonstrate how simple algorithms can produce useful behavior in a robot. The dog flinches away when approached by an object and is drawn towards the object until certain distance when the object moves away. The prototype contains proximity sensors that constitute the tracker and follows the moving object. Depending on the distance between the object and the robot, it makes a decision to move forward or backward. The dog moves in right or left direction according to the movement of object. The prototype also has an edge-detecting IR sensor that prevents it from falling off an edge.

INDEX

A.MOTIVATION:

In current lifestyle, all applications are preferred to be automatic so as to save a lot of time and man power. A 'Robot' is one such device that automates our work. They are applicable in various fields such as automobile, laboratories, space, material handling, mining, micro surgery to household applications as well.

The motivation to our project was to design a robot that is cost effective and be applicable in daily life. The theme was to build a toy so we named our robot as 'Sniffing Dog'. The concept behind the prototype is similar to working of an automated vacuum cleaner that can be made to run on ground or over any platform as well.

B.BLOCK DIAGRAM:

The block diagram in the Figure 1, consists of two L293D drivers, one of which is used to drive two geared motors and the other one to drive the servo motor. The drivers are directly interfaced to the MSP430 microcontroller. The analog infra-red range finding sensor is mounted on the servo motor. A pair of IR sensors, each of which is placed at the front and rear of the prototype for edge detection.

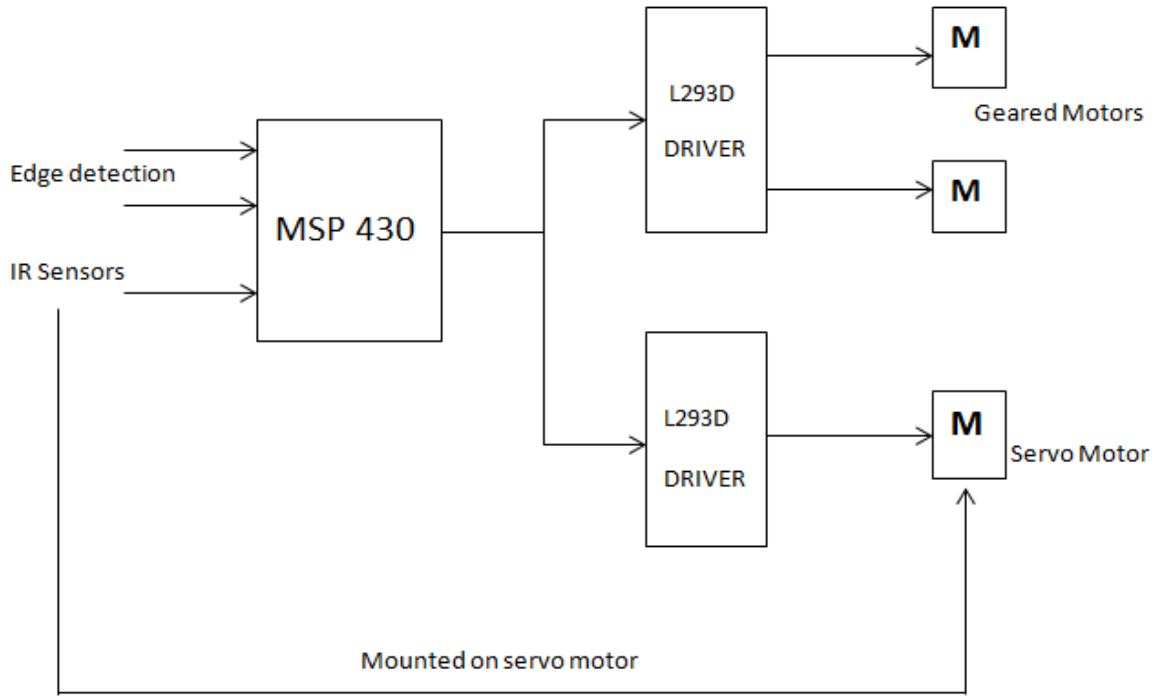

Figure 1: Block Diagram

C.HARDWARE DESCRIPTION:

1. MSP430G2553 MICROCONTROLLER

MSP430G2553 series is an ultra-low-power mixed signal microcontrollers with built-in 16-bit timers, up to 24 I/O capacitive-touch enabled pins, a versatile analog comparator, and built-in communication capability using the universal serial communication interface. In addition, it also has a 10-bit analog-to-digital (A/D) converter. It is the heart of the circuit, holds the logic to run each of the peripherals. Typical applications include low-cost sensor systems that capture analog signals, convert them to digital values, and then process the data for display or for transmission to a host system.

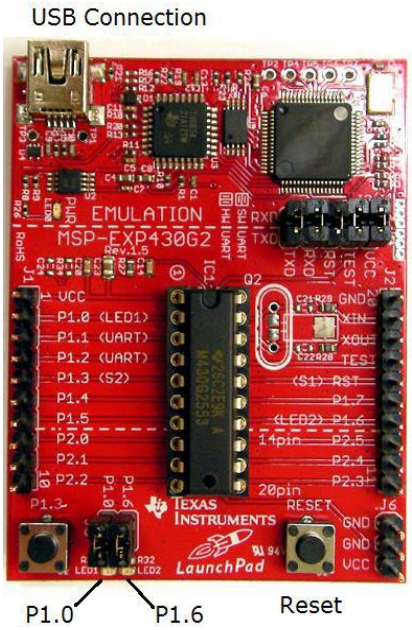

Figure 2: MSP430 microcontroller

Figure 3: Geared Motors

Figure 4: Servo Motor

2. GEARED MOTOR AND SERVO MOTOR

The GM9 motor, when driven by a 3V power supply runs at 40RPM generating a torque of 44.4oz (It draws 400mA at stall and 50mA during free run).It has a 7mm double-flat output shaft (there is no output on the other side), a built-in clutch and built-in mounting screw holes. These units have an overall size of 70.2mm (2.76") x 30.4mm (1.20")x 22.6mm (0.89") .Geared motors consist of two gear wheels that run in a housing with minimal play. One gear wheel is rigidly interconnected with the drift shaft, the other generates the torque. Two gear flats are directed with compressed air into the turn direction and one gear flat against the turn direction.

The S03N Standard Servo has two ball bearings on the output shaft. These ball bearings decrease internal friction and allow for slightly increased torque. Speed (sec/60deg): 0.23, Torque (Kg-cm/Oz-in): 2.40/35, Size (mm): 39.5x20x39.6, Weight (g/oz): 41/1.44 are the specification of the servo motor being used. It is a type of motor used in applications that require precise positioning. The servo drive receives a command signal from a control system, amplifies the signal, and transmits electric current to a servo motor in order to produce motion proportional to the command signal. Typically the command signal represents a desired velocity, but can also represent a desired torque or position.

3. L293D

L293D is a dual H-bridge motor driver integrated circuit. Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse directions. The motor operations of two motors is controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.

Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and is in the high-impedance state.

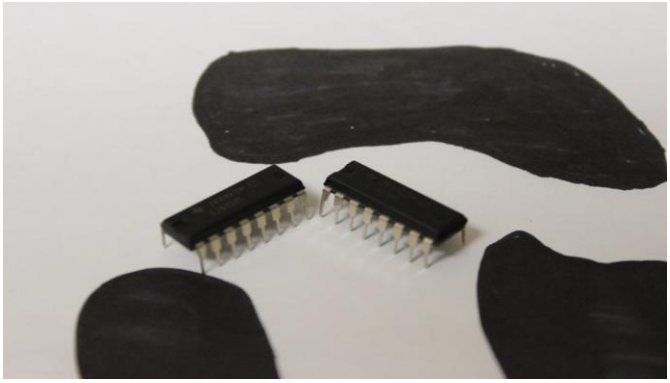

Figure 5: L293D driver

4. IR SENSOR AND ANALOG INFRA-RED RANGE FINDING SYSTEM

IR sensor –The model is 276-0142. This is just used for edge detection system.

IR Range Finding System - 10cm to 80cm takes a continuous distance reading and reports the distance as an analog voltage with a distance range of 10cm (~4") to 80cm (~30"). The interface is 3-wire with power, ground and output. Features include less influence on the color of reflective objects, reflectively, line-up of distance output/distance judgment type, detecting distance ranges from 10cm to 80cm, external control circuit is unnecessary and has low cost. The Output Voltage ranges from 2V to 0.2V

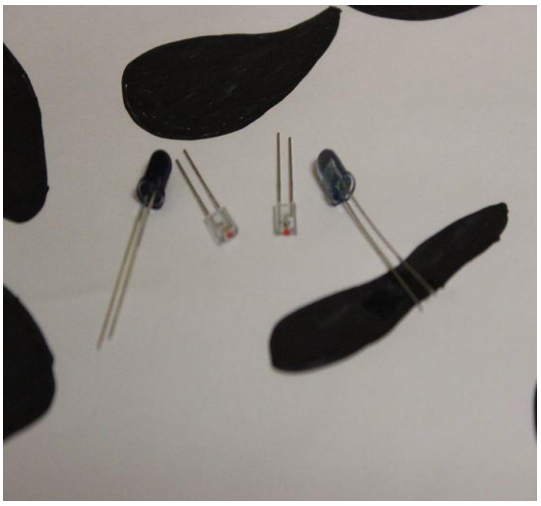

Figure 6: IR sensor for edge detection

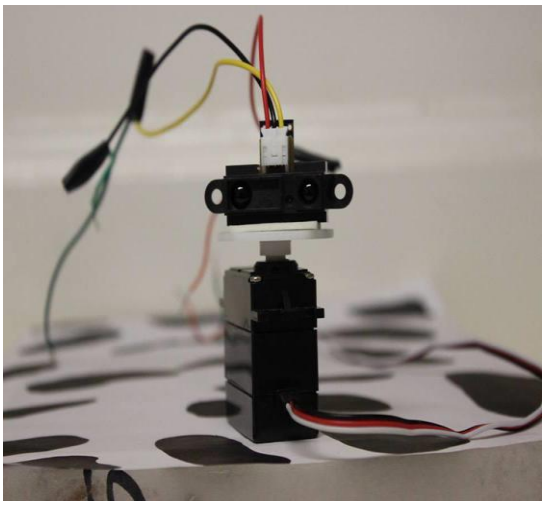

Figure 7: Analog IR range finding system

D. SOFTWARE INTERFACING:

The software interfacing is segregated into two parts:
1) Motors(geared motors and servo motor)
2) IR sensor

Brief procedure:
Once the motor is turned on, the servo motor starts a horizontal scanning of the area around the vehicle. The IR sensor which is mounted on the servo motor checks for the object within its proximity. If an obstacle is sensed, the servo stops scanning and an angular motion is actuated by the geared motors which positions the vehicle in line with the object.
After this process, the servo repeats the horizontal scan and IR sensor starts sensing again. If the object is in the same position, a forward motion is actuated by the geared motors and the vehicle starts moving towards the object. Once the IR sensor senses the object to be very close, a reverse motion is actuated by the geared motors and the vehicle moves back.

The software interfacing of motor has two parts:
1) Interfacing of geared motors to the MSP430 on P2.0, P2.1, P2.3, P2.4 through L293D
Forward
Stop
Back
2) Interfacing of the servo motor to the MSP430 on P2.2 through L293D
Timer configuration for PWM
Servo Scan

A separate software module is been written for each section mentioned above:

Code for Geared motors:

```
forward() // This code actuates a forward motion in the Geared motors
{
        P2OUT = 0x09;
        for (i = 0; i < 3; i++){
        for (j = 0; j < 50000; j++)
        {  sensor();
        }
```

```
        }
        }
stop()// This code makes the vehicle to stop. It calls another function for aligning the vehicle with the object.
{
        P2OUT = 0x00;
        for (i = 0; i < 3; i++)
           {
                for (j = 0; j < 50000; j++);
            }
        DCMotor_turnAccordingToServoMotorAndMoveForward();
        }


back() // This module actuates a backward motion in the geared motors and  calls a function sensor() which
checks the IR sensor output to monitor the object continuously
{
        P2OUT = 0x12;
        for (i = 0; i < 2; i++)
           {
                for (j = 0; j < 10000; j++)
                {
                        sensor();
             }
           }
        P2OUT = 0x00;
        for (p = 0; p < 50000; p++);
       }
```

Code for servo motor:
Timer configuration to generate PWM:

```
WDTCTL = WDTPW + WDTHOLD;
TA1CCTL1 = OUTMOD_7;
TA1CTL = TASSEL_2 + MC_1;
TA1CCR0 = PWM_Period - 1;
TA1CCR1 = PWM_Duty;
P2DIR |= BIT2;
P2SEL |= BIT2;
```

Servo scanning:

```
TA1CCR1 = servo_lut[x] \\ This makes the servo to rotate to an angle x° where
x={30,60,90,120,150}
```

E. RESULT AND CONCLUSIONS:

The Sniffing Dog was completed as per the proposal. The project was planned to be executed in three phases starting with identifying and procuring the required components as per design to carrying out standalone testing of the individual components to the eventual interfacing of all the components with software. The opportunity to learn was immense as we came across several challenges along the path, before we finally crossed the line. Few highlights of these are the realization of the importance of using the correct port numbers. We realized that overall complexity of the code could be reduced by making suitable port choices. With an uphill task of interfacing 3 peripherals on one MSP430, we understood how wisely the timers could or could not be used. The proximity sensing was challenging with need for accurate calibration to extract optimum performance through which we realized several workarounds to tackle issues pertaining to these .The dog moved forward and scanned simultaneously in search of the object. Once it detected the object, our sniffing dog stopped and successfully aligned with the object and eventually completed the sniffing action like an actual dog. The edge detection was successfully put into place to ensure that the dog always stayed on top of the table. The prototype working is as shown in the link below:
http://www.youtube.com/watch?v=WOGrI81tnts&feature=youtu.be

F. REFERENCES:

- http://courses.cs.washington.edu/courses/cse466/11au/calendar/04-Interrupts-posted.pdf
- http://www.ti.com/product/msp430g2553
- http://mitchtech.net/msp430-launchpad-pwm/
- http://e2e.ti.com/group/microcontrollerprojects/m/msp430microcontrollerprojects/494158.aspx
- http://batchloaf.wordpress.com/2012/09/28/basic-example-program-for-msp430g2231
- http://myweb.wit.edu/johnsont/Classes/462/ADC%20for%202%20sensors.html
- http://www.uniobuda.hu/journal/Kuljic_Simon_Szakall_17.pdf

G. APPENDIX:

1. List of team members and their tasks

- Gear motor standalone testing and interfacing - Shashwath and Ranjit.
- Servo motor standalone testing and interfacing - Vignesh and Preethi.
- IR sensor standalone and interfacing - Swathi.

2. Parts list

TI MSP430G2553 microcontroller	---- 1
Geared Motors	---- 2
Servo Motor	---- 1
Sharp Analog IR Range Finding System (AERS)	---- 1
IR Sensors	---- 2
L293D drivers	---- 2
270 Ω Resistors	---- 2
10KΩ Resistors	---- 4
Battery holder	---- 1
AA batteries	---- 4

3. SCHEMATIC DIAGRAM