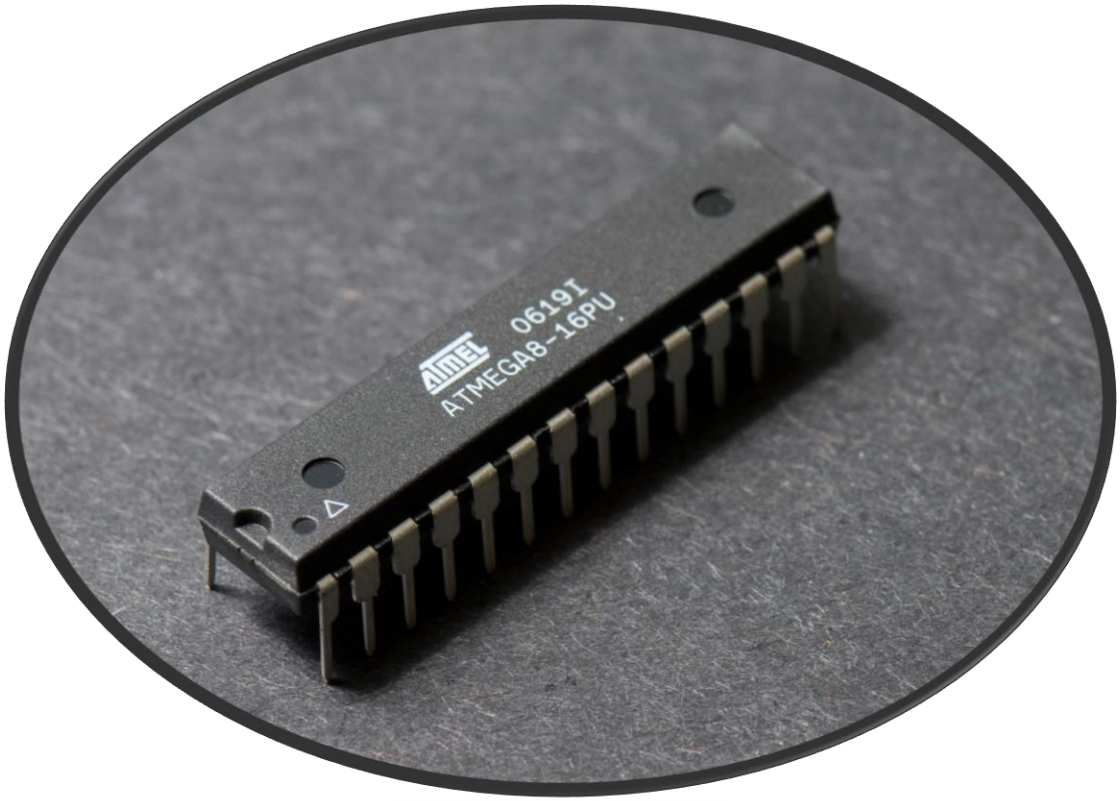

Bluetooth Smart Car

USING ATMEGA8 MICROCONTROLLER

Prerak | Embedded System using AVR & Arduino | July 31, 2014

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Tevatron Technologies

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Tevatron Technologies (A registered private limited company under Ministry of Corporate Affairs, Govt. of India) is a **Design and Product Company focused** on **VLSI Design, FPGA Based Design** & **Embedded Systems** and nurturing the ecosystem for the same.

Tevatron Technologies **Semiconductor** expertise spans FPGA based Design, VHDL / Verilog RTL Development & Verification, CMOS Layout & PCB Design. Their **Embedded Software** expertise ranges from Firmware & Device Drivers Development, RTOS Porting to Embedded Reference Board Development on microcontroller, ARM processor and DSP processor based platform.

Emphasising on innovative design services, Tevatron is actively positioned to service the needs of high end technology industry. The company is also focused on bridging the existing gap between industry and academia by giving proper, customized and industry oriented skill building solution for colleges & students.

Tevatron business is broadly classified into the following:

Tevatron VLSI Design & Embedded Systems Group: The VLSI Design & Embedded Division at Tevatron is focused on servicing the needs of Electronics Chip Design and Embedded Systems industry. The focus is on VLSI Design, Embedded System and PCB Design based services.

Tevatron Education Solutions Group: The Education Solutions Division at Tevatron is involved in providing quality, industry & placement oriented skill building/enhancement solutions to educational institutes and students.

Introduction

An embedded system is a computer designed for a specific purpose and operation. It has a limited hardware set and generally involves real time operations. They are based on Microcontrollers, ie. CPUs with flash memory and peripheral interfaces.

Since it is used for designing a specific product, thus the design engineers can reduce the number of components and further reduce the cost of development. The design can be highly customized and additional components can be installed.

Embedded systems varies from a small digital watch to large stationary traffic lights, from a simple digital temperature display to a complex modem, from a rear parking sensor display to aircraft control panel.

Bluetooth Smart Car is an embedded system designed using the Atmel's Atmega8 AVR Microcontroller. It is smart because it is wirelessly controlled using Bluetooth Technology. The data received via Bluetooth is processed by the microcontroller for driving the car. The communication is digital and data transfer is of 1 byte that is 8 bits

Atmega8

Atmega8

The AVR is a modified Harvard architecture 8-bit RISC single chip microcontroller which was developed by Atmel in 1996. The AVR was one of the first microcontroller families to use on-chip flash memory for program storage, as opposed to one-time programmable ROM, EPROM, or EEPROM used by other microcontrollers at t-he time.

Salient Features

- Data Memory: 1024bytes
- EEPROM: 512bytes
- Clock Frequency: 8MHz
- IO PORTS: 3 PORTS(B, C, and D) 23pins
- USART: Tx, Rx
- ADC: 10bit resolution.
- Timers/Counters: Two 8bit, One 16bit

Features

Atmega8 is an 8bit Atmel AVR Microcontroller. The microcontroller has the following features

Memory: It has 8 Kb of Flash program memory (10,000 Write/Erase cycles durability), 512 Bytes of EEPROM (100,000 Write/Erase Cycles). 1Kbyte Internal SRAM

I/O Ports: 23 I/ line can be obtained from three ports; namely Port B, Port C and Port D.

Interrupts: Two External Interrupt source, located at port D. 19 different interrupt vectors supporting 19 events generated by internal peripherals.

Timer/Counter: Three Internal Timers are available, two 8 bit, one 16 bit, offering various operating modes and supporting internal or external clocking.

SPI (Serial Peripheral interface): ATmega8 holds three communication devices integrated. One of them is Serial Peripheral Interface. Four pins are assigned to Atmega8 to implement this scheme of communication.

USART: One of the most powerful communication solutions is USART and ATmega8 supports both synchronous and asynchronous data transfer schemes. It has three pins assigned for that. In many projects, this module is extensively used for PC-Micro controller communication.

TWI (Two Wire Interface): Another communication device that is present in ATmega8 is Two Wire Interface. It allows designers to set up a commutation between two devices using just two wires along with a common ground connection, As the TWI output is made by means of open collector outputs, thus external pull up resistors are required to make the circuit.

Analog Comparator: A comparator module is integrated in the IC that provides comparison facility between two voltages connected to the two inputs of the Analog comparator via External pins attached to the micro controller.

Analog to Digital Converter: Inbuilt analog to digital converter can convert an analog input signal into digital data of 10bit resolution. For most of the low end application, this much resolution is enough.

MEMORY

Flash, EEPROM, and SRAM are all integrated onto a single chip, removing the need for external memory in most applications. The low-power Atmel 8-bit AVR RISC-based microcontroller combines 8KB of programmable flash memory, 1KB of SRAM, and 512 K EEPROM.

I/O PORTS

Atmega8 has 23 I/O lines from three ports; namely Port B, Port C, and Port D

Port B: 8 I/O lines

Port C: 7 I/O lines

Port D: 8 I/O lines

USART

USART – universal Synchronous Asynchronous Receiver Transmitter is used for serial communication using two wires. USART is the most common protocol used for serial data transfer. The data frame contains start bits, data bits and stop bits. The protocol involves two buffers receiver and transmitter. The 8 bit data is stored bit by bit into the buffer and then transferred to the data register.

UART involves 5 registers

- UDR – UART DATA REGISTER
- UCSRA
- UCSRB
- UCSRC, all are USART CONTROL STATUS REGISTER
- UBRR – USART BAUD RATE REGISTER

INTERRUPTS

A single microcontroller can serve several devices. One such method is use of Interrupts. Whenever any devices needs the microcontroller's service, the device notifies it by sending an interrupt signal. Upon receiving an interrupt the microcontroller stops whatever it is doing and serves the device. The program associated with the interrupt is called Interrupt Service Routine or Interrupt Handler

Project Overview

Bluetooth Smart Car is a car that is controlled by the data signals send via a Bluetooth enabled device. It is smart because it is operated wirelessly. This embedded system uses Atmega8 microcontroller for controlling the movement of car and processing of various data signals. The signals received by Bluetooth will be of 8 bits which can be interpreted as a character. Internal interrupts can be used for detecting the received bits which are later processed.

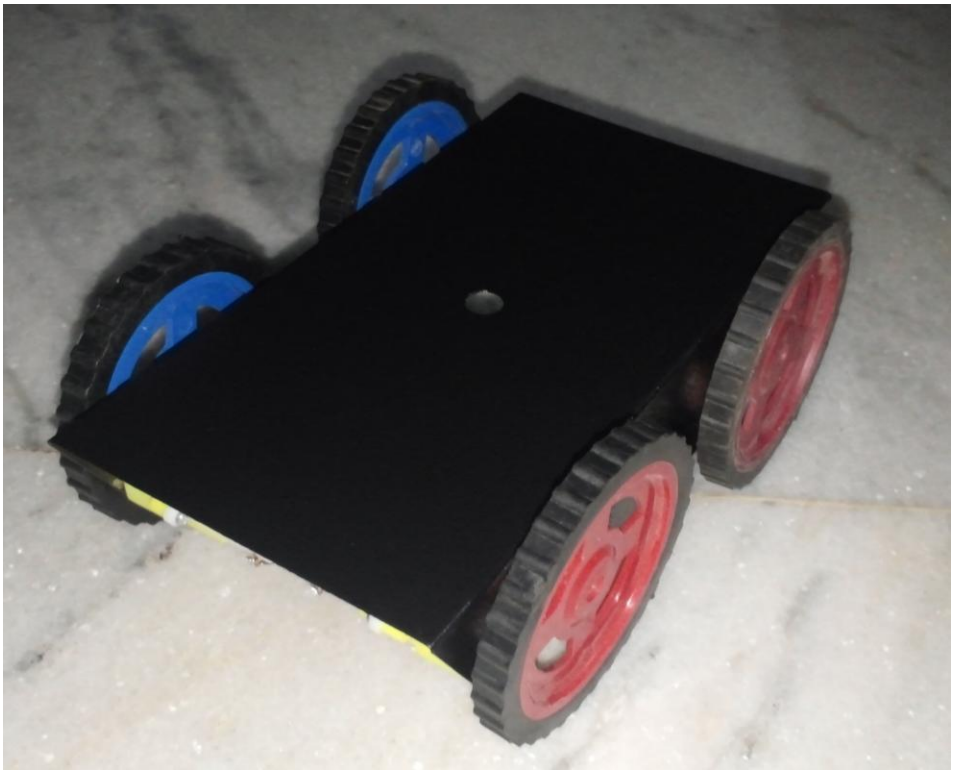
Problem Analyses

This embedded system involves controlling of car based on signals received from a Bluetooth enabled device (mobile phone). The microcontroller must drive the motors according to the signals received. These requirements give rise to the following problems

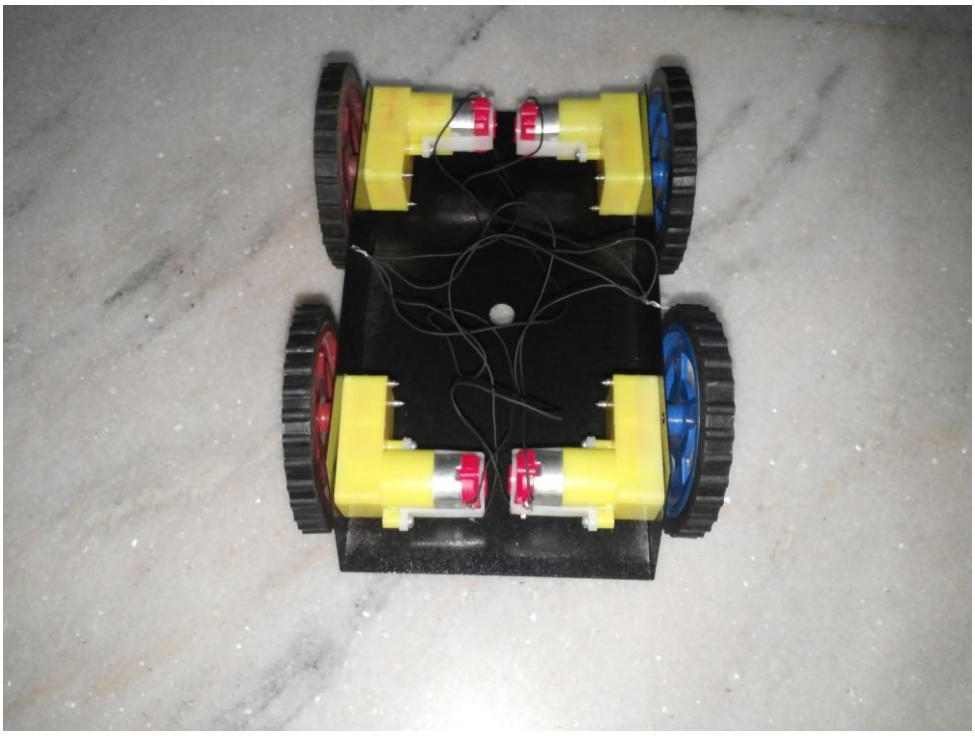
- A device to receive the Bluetooth signals.
- A method of transmitting these signals from the device to the microcontroller.
- Driving high voltage motors through a low voltage microcontroller.
- Designing the chassis of the car.

Design Complexity

- The car chassis need to have a room for 4 DC motors to drive the 4 wheels of the car. Therefore a rectangular chassis is chosen to get a larger wheel base.
- Motors attached to the same side of the chassis are driven through the same logic levels (they are shorted). Thus we have 2 pairs of motors each pair controlling motion of their respective side.
- For forward motion both the motor pairs are given same logic levels.
- For reverse motion both the motor pairs are given same but opposite logic levels.
- For motion in right direction the motor pair of left side are driven while the motor pair of right side are at logic 0.
- For motion in left direction the motor pair of right side are driven while the motor pair of left side are at logic 0.



Top View of Car Chassis



Motors attached to Chassis

Bluetooth Signal Processing

- Bluetooth wireless technology is becoming a popular standard in the communication arena, and it is one of the fastest growing fields in the wireless technologies. It has the bandwidth to meet most of today's demands for mobile communications. Bluetooth technology handles the wireless part of the communication channel; it transmits and receives data wirelessly between these devices. The most popular host controller interface today is either a USART or a USB.
- Here we will be using the USART interfacing for receiving the data send by the Bluetooth enabled mobile device.

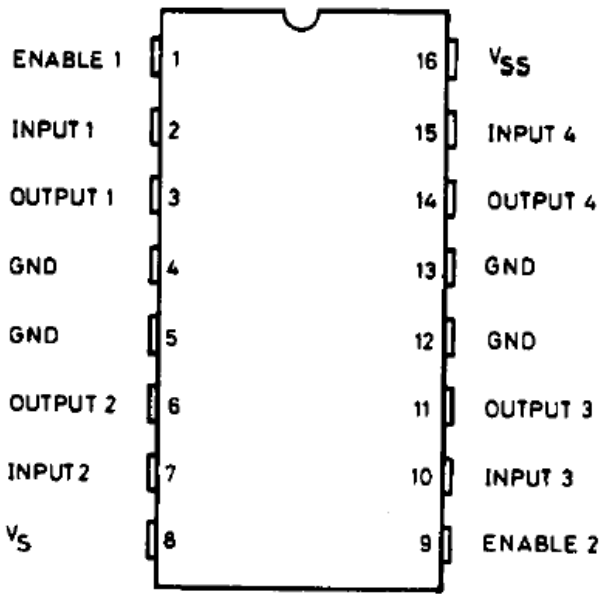
HC-05

UART

- USART is an abbreviation for Universal Asynchronous Receiver Transmitter.
- For interfacing our Atmega8 microcontroller working at a frequency of 8MHz, we set a baud rate of 9600 for receiving 8bit data from the Bluetooth module.
- The transmitter of the Bluetooth Module is connected to the Rx pin of microcontroller for receiving the 8bit data. The data is received asynchronously.
- Atmega8 has a built in USART interfacing, therefore the moment the receive buffer is full we read the USART data register (UDR) bits. The data received is now processed so that the corresponding motors can drive the car.

Driving Motors – L293D

- The major problem while driving the motors is the need for a 9V supply. Since the microcontroller works on logic high (5V) or logic low (0V), thus proving 9V supply from the microcontroller isn't possible.
- L293D is a motor driver IC which converts 5V to a given reference voltage. We will provide the reference voltage of 9V to the L293D IC for driving our motors.
- The IC can take 4 input voltages (2 pairs of inputs) and provide 4 output voltages (2 pair of outputs), thus we can easily drive 2 motors using a single IC.
- The output pins from the microcontroller acts as L293D's Input pins.



L293D Pin Diagram

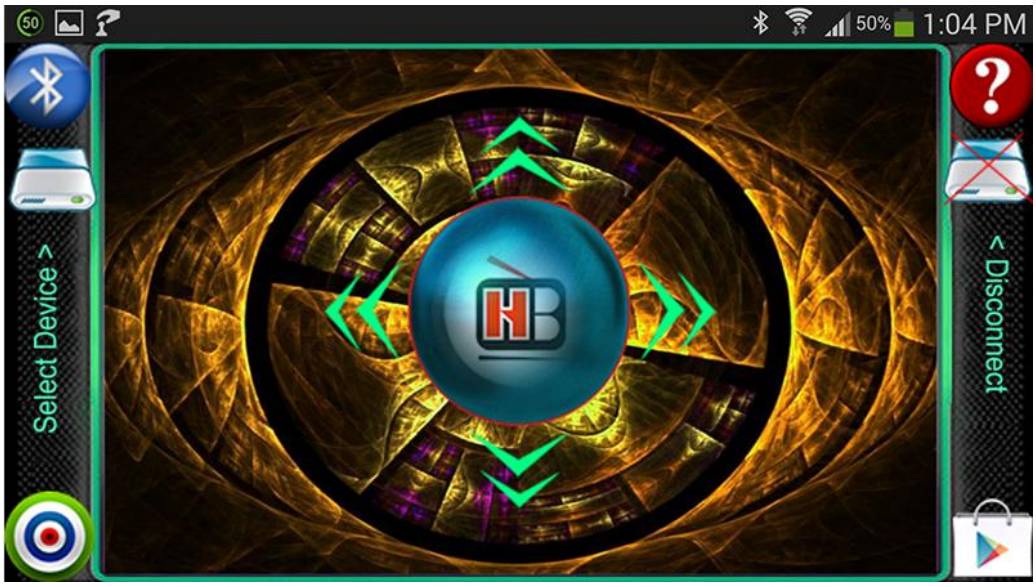
IC L293D

Bluetooth Robot Car Controller

Bluetooth Robot Car Controller is an ANDROID mobile application. It gives 8 bit data corresponding to the direction in which the mobile device is tilted. The accelerometer of the mobile device is used for analyses of tilt direction

The app is programmed to send the following 8 bit data

- 'A' : Forward Tilt
- 'B' : Backward Tilt
- 'C' : Left Tilt
- 'D' : Right Tilt
- 'E' : Not Tilted



Source Code

```
#include <avr/io.h>
#include <avr\interrupt.h>
void init_usart(char a);
ISR(USART_RXC_vect);
int main(void)
{
        DDRB=0xff;
        init_usart(51);
        sei();
        while(1);

}

void init_usart(char a)
{
        UBRRL = a;
        UBRRH = 0x00;
        UCSRC =(1<<UCSZ1)|(1<<UCSZ0)|(1<<URSEL);
        UCSRB =(1<<RXEN)|(1<<RXCIE);
}
```

```
ISR(USART_RXC_vect)
{
        char dir;
        dir=UDR;
        switch(dir)
        {
                case 'A' : PORTB=0b00000101;
                        break;
                case 'B' : PORTB=0b00001010;
                        break;
                case 'C' : PORTB=0b00000100;
                        break;
                case 'D' : PORTB=0b00000001;
                        break;
                case 'E' : PORTB = 0b00000000;
                        break;

        }

}
```

References

- http://www.atmel.com/devices/atmega8.aspx
- http://www.tevatrontech.com/
- https://www.google.co.in/

Apart from the above mentioned websites, following books were also referred

- The AVR microcontroller and embedded systems – Muhammad Ali Mazidi
- Programming and customizing the AVR microcontroller – Dhananjay V. Gadre