Introduction

Building an embedded system is a broad subject, which involves systems requirements analysis, hardware design, and software design tasks. In this assignment it is required that you develop a simple embedded system using a SBC (Single Board Computer) and an FPGA (Field Programmable Gate Array), as shown in Figure 1. The purpose of this project is to implement a controller to be able to control the velocity of a DC motor.
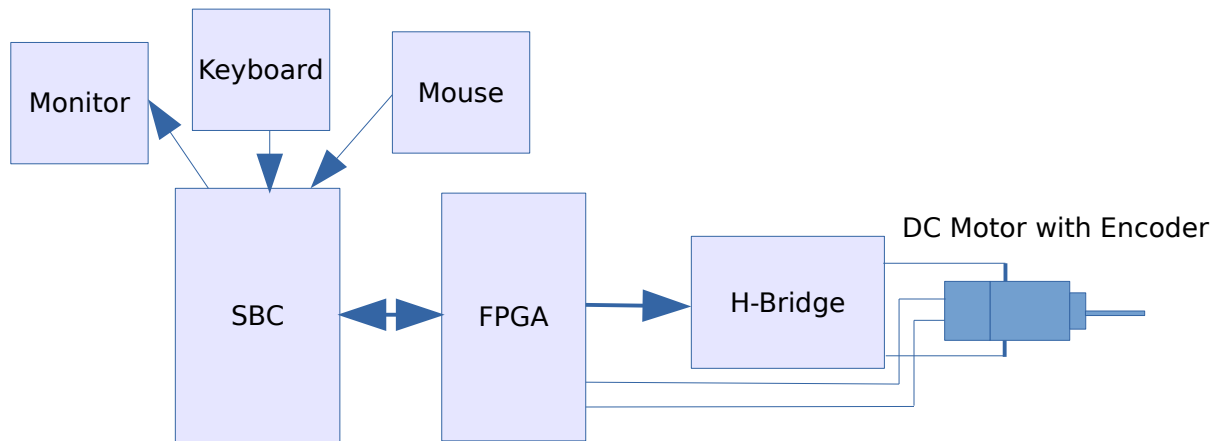

Figure 1. Block diagram of the motor velocity control system.

The objective of the SBC is to interface with user and allow the setting/changing of the velocity of the motor through the use of a minimum number of peripherals like a monitor, keyboard, and a mouse. A Raspberry Pi2 (RPi2) will serve as the SBC in this project. An FPGA (Altera DE0 or DE Nano) will be used to generate a PWM signal to drive the motor. According to online documentation RPi2 is not able to generate high frequency signals (a 5 Khz PWM signal is needed to drive the motor), so the FPGA will be used for this purpose.

Hardware requirements

The SBC we will be using in this project is the Raspberry Pi 2. This board is a credit-card size computer that plugs into a monitor, mouse, and a keyboard. It is a capable computer which can be used in electronics projects, and for many other projects that a desktop PC does. The SBC has 512 MB RAM, 4 USBs, 40 GPIOs, and Ethernet port. It runs at 900 MHz quad-core ARM Cortex-A7 CPU and has a 1GB RAM, shown in Figure 2.
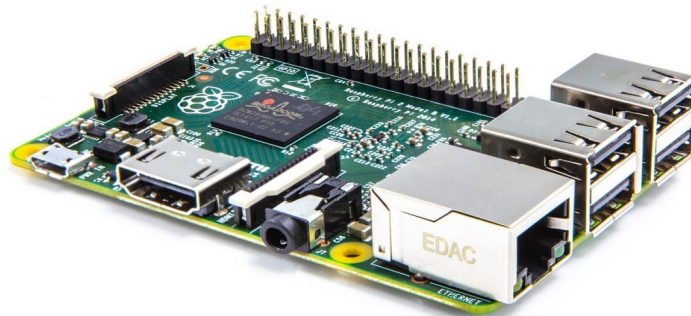

Figure 2. A Raspberry Pi 2 B.

The FPGA required in this projects is the Altera DE0 (or DE0 Nano), shown in Figure 3. The DE0 is designed in a compact size with all the essential tools to gain knowledge in areas of digital logic, computer organization and FPGAs. It is equipped with Altera Cyclone III 3C16 FPGA device, which offers 15,408 Logic Elements (LEs), and 346 user I/O pins. The DE0 combines the Altera low-power, and high performance Cyclone III FPGA to control the various features of the DE0 Board. The DE0 Development Board includes software, reference designs, and accessories required for embedded projects.
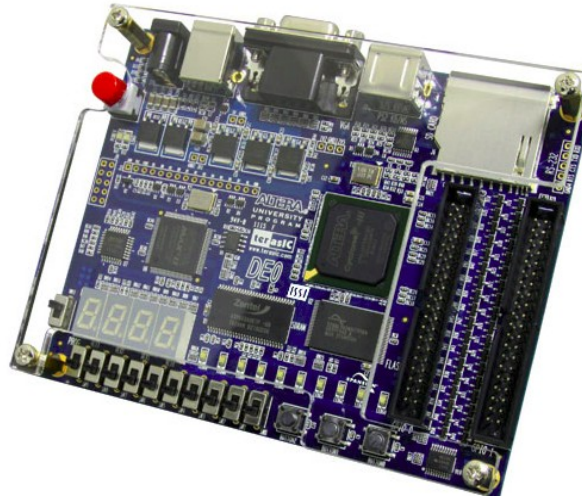

Figure 3. The Altera DE0

Deliverables

Each design team should deliver the following items by September 16:

- A working prototype that would allow a user to set a velocity on the motor, through the SBC.
- A 1-5 page electronic report containing the following topics:
      a) Front matter: title, names of the team participants, date.
      b) Body matter: introduction, description of the system, summary.
      d) Back matter: references.
      Note: The report should contain the wiring of the system, and the listings of all the code that is required for the SBC and the FPGA boards in an appendix.