PROJECT - WASHING MACHINE
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1 Aim

1. To understand the control system requirements of a washing machine
2. To implement a microcontroller for washing machine
   (a) propose a hardware configuration of AVR Atmega8 MCU with interrupts
   (b) write the assembly code
   (c) identify the ways of emulation of real-world input / output to the MCU
3. come up with a strategy to demonstrate its working in the lab

2 Problem Definition

Inputs			
Load Condition of the Washing Machine (Through Switches)	Soft	A.0	
	Medium	A.1	
	Heavy	A.2	
Task to perform? (Through Switches)	Washing & Drying	A.4	
	Washing Only	A.5	
	Drying Only	A.6	
Outputs (Displayed using LED's)			
Soft	Green LED will glow throughout the operation	B.0	
Medium	Blue LED will glow throughout the operation	B.1	
Heavy	White LED will glow throughout the operation	B.2	
Washing (Soft load)	Two LED's will glow for 2 seconds each for 3 times with a gap of 2 seconds (Indicating 3 times washing and rinsing is happening)	B.4,B.5	
Washing (Medium load)	Two LED's will glow for 2 seconds each for 5 times with a gap of 2 seconds (Indicating 5 times washing and rinsing is happening)	B.4,B.5	
Washing (Heavy load)	Two LED's will glow for 2 seconds each for 7 times with a gap of 2 seconds (Indicating 7 times washing and rinsing is happening)	B.4, B.5	
Drying (Soft load)	Two Red LED's will glow for 4 seconds (after final washing and rinsing if washing is there, else only drying)	B.6	

Drying (Medium load)	Two Red LED's will glow for 8 seconds (after final washing and rinsing if washing is there, else only drying)	B.7	
Drying (Heavy load)	Two Red LED's will glow for 12 seconds (after final washing and rinsing if washing is there, else only drying)	B.8	

Program Flow

1. The inputs are the load condition of the washing machine (soft, medium, heavy) and the task to perform (washing & drying, washing only, drying only), which is given by the user. The user enters the inputs through the switches which comes to the assigned ports (Please note port numbers can be changed after checking the datasheet).

2. As mentioned in the above table, for the required inputs perform the required tasks and display the outputs using LED's.

3. There is an extra input through a switch (corresponding to the **pause button** in the washing machine) which goes to the **interrupt pin** of the microcontroller.

4. If the user presses the pause button, an **interrupt** will come and he can change any of the above inputs, i.e. he can change the load condition or the task to perform.

5. Then according to the above changed rule, the washing machine has to perform the activity and display the output.

Notes:

The above delays in the program has to be performed using timers in the microcontroller.

3 Conventional Implementations of Washing Machine

3.1 Introduction

The washing machine washes the cloths dumped along with some soap. The washing is done in a sequence of many stages: water filling, agitronic soaking, washing, draining the dirty water, spinning and finally buzzed sounding resulting in dry, washed cloths.

3.2 Engineering Problem

3.2.1 Basic operation sequence of a washing machine :-

The basic operation sequence is like this

1. Water filling (variable, as pressure switch stops the inlet valve, once a level is reached)
2. Agitronic soak (15mins)
3. First wash (15mins)
4. First drain (4mins)
5. Second wash or call it as first rinse (10mins)
6. Second drain (4mins)
7. Spin (5mins)
8. Buzzer chim (15sec)

3.2.2 Design Specifications

This include both hardware and software specifications.

1. The system considered here is a fully automatic one. (The commercial washing machines can operate in any of the modes, automatic mode, semi-automatic mode and manual mode. Modes are selectable by a keypad).
2. Under fully automatic mode user intervention requirement should be zero. Once the system is started in this mode it should perform its work independently and after the completion of work it should notify the user about the completion of work. This mode instantaneously should sense cloth quality and requirement of water, detergent, load, wash cycle time and perform operation accordingly. In our implementation, the time is as given above.
3. If (loading) door is accidentally opened in between any of the operations mentioned above, then the system should stop working in 1 secs.
4. The system should provide all basic features of a washing machine like washing, rinsing, spinning, drying etc, as given above.
5. In the event of power failure, the washing machine should automatically start its cycle from the point of interruption when power is resumed.

3.2.3 Implementation Specifics

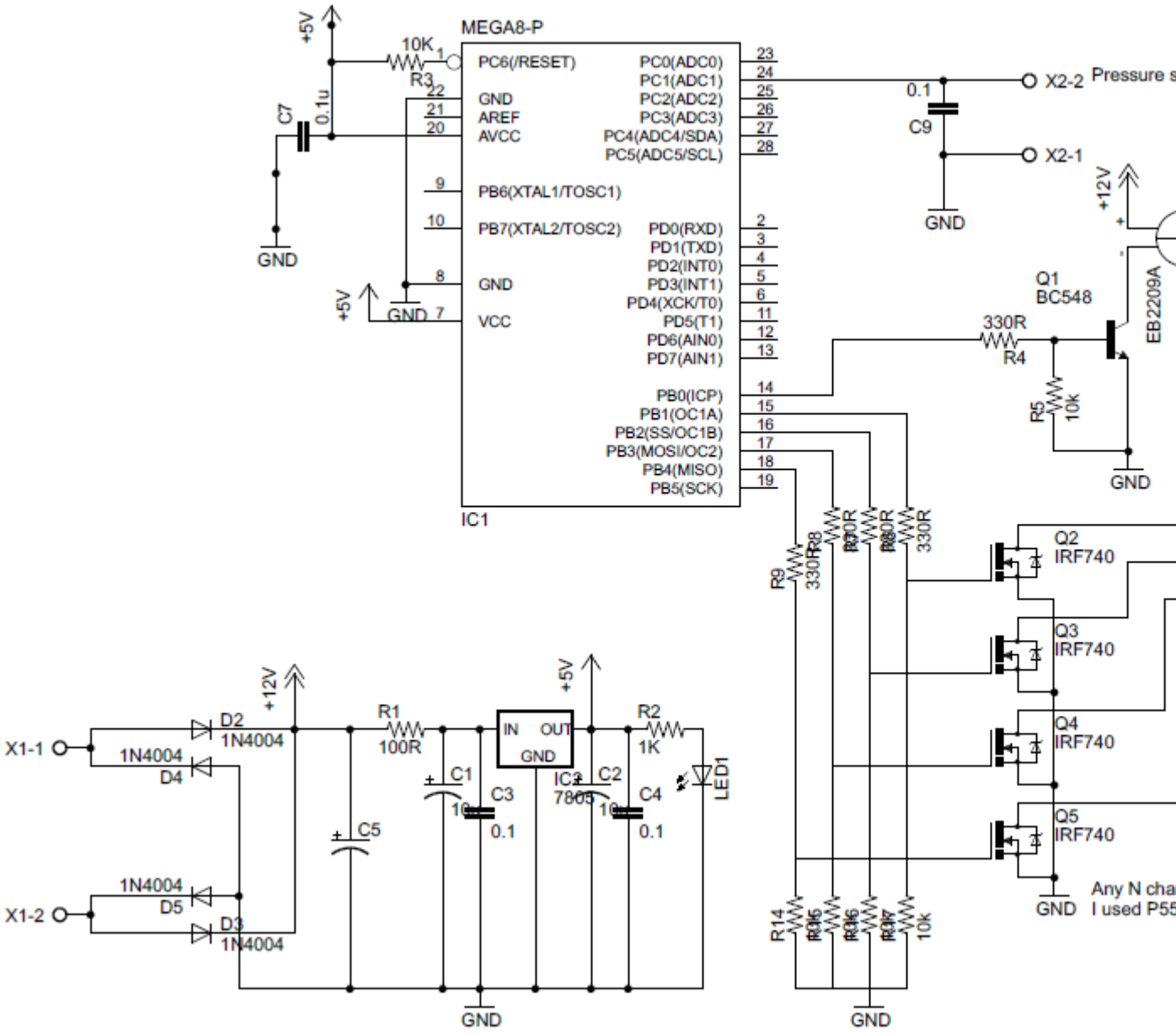
1. There is just 4 relays to be controlled in a regular sequence (See the next Section hardware configuration).
   (a) Drum reverse relay (DRR)
   (b) Drum forward relay (DFR)
   (c) Drain solenoid relay (DSR)
   (d) Water inlet solenoid valve relay (WISVR)
2. DRR and DFR allow the main drum driving motor to run in the reverse and forward direction. DSR allows the water drain motor to pump out the water in the drum. WISVR opens the inlet valve for water to fill in the main drum.
3. There are two sensors in the system considered
   (a) Pressure switch which allows to know the water level in the drum
   (b) Loading door switch: This is actually a main switch which is closed by the door. When it is open, the power to the motor is cuts OFF and the alarm sounds.
4. Inputs
   (a) Sensor inputs
5. Outputs
   (a) The four relays have to be switched on the right time
   (b) The timer output to switch the above relays at the right time

Next, we give a part of the solution & the main programming part has to be done by the students. Here, we choose to give the hardware part.

4 Solution Tips

4.1 Hardware setup

We herewith give the ATmega8 break out board with 1 inputs and 4 outputs (Ref 1). Here is the schematic diagram of controller.



4.1.1 Atmel's Atmega8 Assembly Program

Implementation by assembly programming tips:

1. Use the timers extensively to implement each sequence (job) of the washing machine eg: water filling, agitronic soak, washing (rotating), draining etc, with the timing suggested above.
2. Use TIMSK, TCCR, TNCT registers corresponding to timers.
3. Properly configure the AVR pins which of them are input and which of them are outputs.
4. Use interrupt to stop the machine, when the door is opened and sound an alarm to get immediate attention.
5. Once it is over, 10 times beep sound to tell that job is done.

5 Demonstration in Lab

We need to necessarily emulate the real-world washing machine system in the lab, for demonstration purposes.

5.1 Input Emulation

Hence, all inputs are emulated through the push button switches. Here we have only close the door after loading with cloths and press start button. Automatic mode would carries the washing process till end. [But the water filling end has to be emulated by pressing a key apart from an interrupt due to accidental door opening].

5.2 Output Emulation

Outputs are (a) stage of washing process (b) final beep sound to indicate the end of washing process (c) alarm due to interrupt.

To emulate (a) 3 LEDs are used to indicate which stage the wash process is in (though the last part is also indicated through buzzer chime - which HAS to be implemented). The alarm due to accidental door opening has to be implemented by a different frequency altogether with high amplitude.

6 References

1. Mohammad Ali Mazidi
2. William Stallings