MICROPROCESSORS AND INTERFACING

DESIGN PROJECT

PROJECT NAME:

AUTOMATIC WASHING MACHINE

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In the partial fulfilment of the requirements of

CSE/ECE/EEE/ENI F241: MICROPROCESSORS AND INTERFACING

Contents

Problem Statement

Automatic Washing Machine

Description: An Automatic washing machine with Dryer.

The Washing Machine can handle three different types of load: Light, Medium and Heavy.
The Washing Machine has three different cycles: Rinse, Wash and Dry.
Depending on the load the number of times a cycle is done and the duration of the cycle varies.

Light Load: Rinse- 2 mins, Wash- 3 mins, Rinse – 2 mins, Dry Cycle –2 mins
Medium Load: Rinse- 3 mins, Wash- 5 mins and Rinse – 3 mins Dry Cycle –4 mins
Heavy load: Rinse- 3 mins, Wash- 5 mins and Rinse – 3 mins, Wash- 5 mins and Rinse – 3 mins, Dry Cycle – 4 mins

•The Washing Machine is a single tub machine.
•The door of the washtub should remain closed if the agitator is active.
If the door is not closed the system should not start and should indicate that the door is open by Sounding the alarm.
•Before each cycle the water level is sensed. At the beginning of the cycle the water level should be at the maximum possible level, the water should be completely drained during the dry cycle.
The cycle should begin only when the water level is correct.
•There are relays that control the opening and closing of relays to let in water via the inlet pipe and drain the water via the outlet pipe.
•At the beginning of the wash cycle the user should have added the detergent.
•At the end of the complete wash process the Buzzer is sounded.
•User can turn off system by pressing STOP Button
•Different sounds are used for different events.
The number of times the load button is pressed determines load: 1press- light; 2 presses – medium and 3 presses –heavy.
To begin the washing process START is pressed.
Pressing STOP can stop the process.

User Requirements & Technical Specifications

Design an automatic washer and dryer that can manage three different types of workloads.

The following are the technical specifications:

There are three kinds of loads: light, medium, and heavy

1. **Light mode:** Rinse - 2 mins, Wash - 3 mins,
   Rinse - 2 mins, Dry - 2 mins

2. **Medium mode:** Rinse - 3 mins, Wash - 5 mins,
   Rinse - 3 mins, Dry - 4 mins

3. **Heavy mode:** Rinse - 3 mins, Wash - 5 mins,
   Rinse - 3 mins, Wash - 5 mins,
   Rinse - 3 mins, Dry - 4 mins

The cycle buzzer sounds at the end of the entire washing process

There are four buttons for the user to control the washing machine: Load, Start, Resume, and Stop

1. **Load:** The number of presses of this button determines the load. One press - Light, two press - medium, three press – heavy

2. **Start:** The washing process begins when the start is pressed. It has to be pressed after the load is decided

3. **Stop:** This can stop the process

4. **Resume:** This button can resume the process after it has been stopped or in case of any other issue.

During the entire wash cycle, the door is securely closed.

Assumptions and Justifications

Assumptions:

1. Before starting the Wash Cycle, the user adds the detergent.
2. The machine will only halt during the water input or water output process if there are inappropriate water levels, and it will restart after the user has resolved the problem.
3. Assume that when the agitator is running, the door is locked. Before starting the agitator, the software verifies if the door is locked.
4. Agitator and revolving tub are modelled by three-phase induction motors.
5. The user will have to hold the door in place before the Rinse cycle begins.
6. In case of any issue, the user will need to intervene and fix the issue.
7. To make the circuit look understandable we have used individual gates ("or","not" and "and") whereas in practical situations we must use 7432(OR Chips),7408 (AND Chips), 7404 (NOT Chips).
8. All Vcc pins are 5V DC Sources.

Justifications:

1. The only problem that can arise is one that is connected to the water supply (filling and emptying of water from the machine). If the water filling/emptying operation takes longer than expected (Here 10 minutes), the machine will sound an alert.
2. User is expected to fill the detergent relay before the wash cycle.
3. Any resolvable issue will be attributed to the supply of water/jamming of the water i/p or o/p pathways. They must be manually repaired because they are not part of the control circuit.

Components used with justifications wherever required:

- 8086

- 8284(Clock generator)
- Water Level Sensor (FS-IR02) with convert board - 2 nos (Manual Attached)
    - The sensor sends data to the converter board, which produces a high output when the sensor is submerged in water and a low output when it is not.
    - Sensor o/p range (i/p to convert board) - 0-5V (<0.1V for low o/p and >4.6V for high o/p)
    - Voltage o/p of convert board (5V if high, else 0)
    - 4-pin connector to the convert board (GND,GND,VCC,o/p - of sensor)
    - There are two sensors, one on top and one at the bottom of the spinning tub. When the top sensor's o/p rises high, it means the water tank is full. When the bottom sensor is low, it means the water tank has been emptied
- Water-In, Water-Out, Lock and Detergent Relays - Used to display the status of Water-In, Water-Out, Lock and Detergent Valves.
- Magnetic Contact Reed Switch - For Door Sensor(Reed Switch Datasheet and product manual attached)
    - One end connected to Vcc and other to the 8255.
    - A magnet attached to the lid and the reed switch near the door's contact on the body.
    - When the door is closed, the magnet makes contact with the reed switch, which closes and sends a high i/p to 8255.
- Piezoelectric Buzzer(KPI 1410) (with RKi-4076 hardware) (Buzzer Datasheet and Hardware manual attached)
    - Depending on the frequency of the i/p square wave, it produces a continuous sound of various frequencies. As a result, it may be used to sound different buzzers/alarms for different purposes.
    - RKI-4076 hardware inputs: VCC,I/O,GND
      Buzzer operating voltage - 3-16 VDC
      Max Rated Current - 7mA at 12VDC
      Resonant Frequency - 4.0 (+/-) 0.5 KHz
    - RKI-4706 Operating Voltage - 3-5V
- Door Lock
    - Circuit drawn in the chart
    - Operating Voltage - 3-5V
    - When the door sensor gives a high input to port PB3 of 8255, through another port (PA0) the microprocessor locks the door.

● Agitator/Revolving Tub Motors and Motor Drivers(Motor and motor driver data sheets attached):
    - Motors : Crouzet 801405 BLDCs
    - Max Speed : 10000 rpm
    - Peak torque : 500m N-m
    - Motor Drivers : Allegro A4915 Motor Drivers
    - Enable us to switch the motors on/off with a digital control signal

● 8255 – Interface 8253, agitator, revolving tub, water level sensor, buzzer, user interface buttons, the door and water in and water out relays[8].

● 8253 – 2 nos. To generate the Clock for the agitator and revolving tub. Also to generate input square wave with 50% duty cycle for buzzer hardware(RKI-4076)

● 2716 – 2 nos. The Smallest ROM chip available is 2K and as we need to have even and odd banks and ROM is required at the reset address which is at FFFF0H and 00000H - where there is the IVT

● 6116 – 2 nos. The smallest RAM chip available is 2 K and we need odd and even banks. We need RAM for stack and temporary storage of data

● 74LS138 – 2 decoders, to generate chip select signals for 8255 and 8253s

● 74LS373 – 3 latches, used for demultiplexing the address lines.

● 74LS245 – 2 latches, used for demultiplexing the data lines.

● Required gates – or, not, and

● Buttons – 4 nos. Used as the user interface in the form of start, stop, resume and load.

MEMORY MAPPING

ROM Chip Used : 2716

RAM Chip Used : 6116

ROM1:4KB = 2KB(even)+2KB(odd)

- ROM1 (Even Bank): 00000H,00002H, ,00FFCH,00FFEH
- ROM1 (Odd Bank): 00001H,00003H, ,00FFDH,00FFFH

ROM2:4KB = 2KB(even)+2KB(odd)

- ROM2 (Even Bank): FF000H,FF002H, ,FFFFCH,FFFFEH
- ROM2 (Odd Bank): FF001H,FF003H, ,FFFFDH,FFFFFH

RAM1:4KB = 2KB(even)+2KB(odd)

- RAM1 (Even Bank): 20000H,20002H, ,20FFCH,20FFEH

	A19	A18	A17	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
ROM1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	**1**
ROM2	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	**0**
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**1**
RAM1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	0	0	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	**1**

I/O MAPPING

8255 – 00 – 06H

8253(1) – 10 – 16H

8253(2) – 20 – 26H

Port - A (Input)	Port - B (Output)	Port C (Lower - I/P,Upper - O/P)
PA0 - Lock	PB0 - Water in valve	PC0 - Load
PA1 - Water In	PB1 - Water Out Valve	PC1 - Start
PA2 - Water Out	PB2 - Resume	PC2 - NC
PA3 - Alarm	PB3 - NC	PC3 - NC
PA4 - Alarm	PB4 - 8253(1) Out-2	PC4 - 8253(1) G1
PA5 - Detergent	PB5 - 8253(2) Out-0	PC5 - 8253(1) G2
PA6 - Issue	PB6 - 8253(2) Out-1	PC6 - 8253(2) G3
PA7 - NC	PB7 - NC	PC7 - Stop Enable

Variations in Proteus Implementation with Justification

1. Stop interrupt using 8259 does not function in proteus therefore the stop signal is utilised as NMI.
2. ROM in only 00000h — since proteus enables you to alter the reset address.
3. 2732 is substituted as 2716, as it is not found in Proteus. As a result, instead of 00000h to 00FFFh for IVT, we had to use 8KB of ROM in Proteus from 00000h to 01FFFh.
4. Memory is implemented using a gate-based circuit — this is the same as LS 138.
5. 8259 is not present (justified in point no.1)
6. Two push buttons have been used to replicate the water level sensors in proteus. (hitting the water full button signals that the top water level sensor is immersed. Similarly, pressing the water

empty button indicates that the lower water-level sensor is not submerged in water i.e the water has drained out) (holdable) since the water level sensors that have been used aren’t available in proteus.\

7. Because the door latch cannot be simulated in proteus, the i/p to lock (PA0) in the proteus design goes to an LED and relay (electrical) circuit to display when it's high or low. A green LED illuminates when the lock is turned on, and a red LED illuminates when the door is unlocked in the proteus simulation. The i/p to lock (PA0) is used as a control signal by a solid-state relay to open and close the lock in this configuration (bimetallic interlock).
8. Because an agitator and a rotating tub (with motor drivers) are not accessible in Proteus, a basic motor is employed instead.
9. Because magnetic contact reed switches (used in the design) aren't accessible in proteus, the door sensor i/p to 8255 is mimicked using manual push buttons.
10. Because a buzzer enable signal cannot be utilised to sound the buzzer, an LED is used in Proteus design to symbolise the buzzer ringing.
11. As 8284 is not accessible in Proteus, the reset in 8086 is attached to a switch.
12. The water-in, water-out, and detergent valve signals in the design are sent to the respective water-in, water-out, and detergent valve relays. In proteus, however, these impulses were mimicked using LEDs and relays (electrical). A green LED illuminates while a valve is open, and a red LED illuminates when the valve is closed.
13. In Proteus, the LS138 is not used for memory decoding because there is just one ROM and RAM, both of which are decoded using OR gates.