Bilkent University

GE401

Innovative Product Design & Development I

Product Specification and Preliminary Design Report

Smart Faucet

Team 5

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1. Product Overview

Smart faucet is aimed to cover the need for % 100 hygienic faucet controls. Both switch on, off and water temperature can be controlled by smart faucet with completely touch-less controls. In this process, there would be used some equipments like sensors, microcontrollers, motors etc.

Smart faucet will turn on automatically as you put your hands in front of it and stop the water flow when you get your hands away from the sensor. For this we will buy an electric sensor faucet where we can work on to finalize our product. The functions of the faucet also include manual temperature adjusting, clever timers to avoid water consumption and water flooding. **[1]**

2. Preliminary Design

Product Tree:

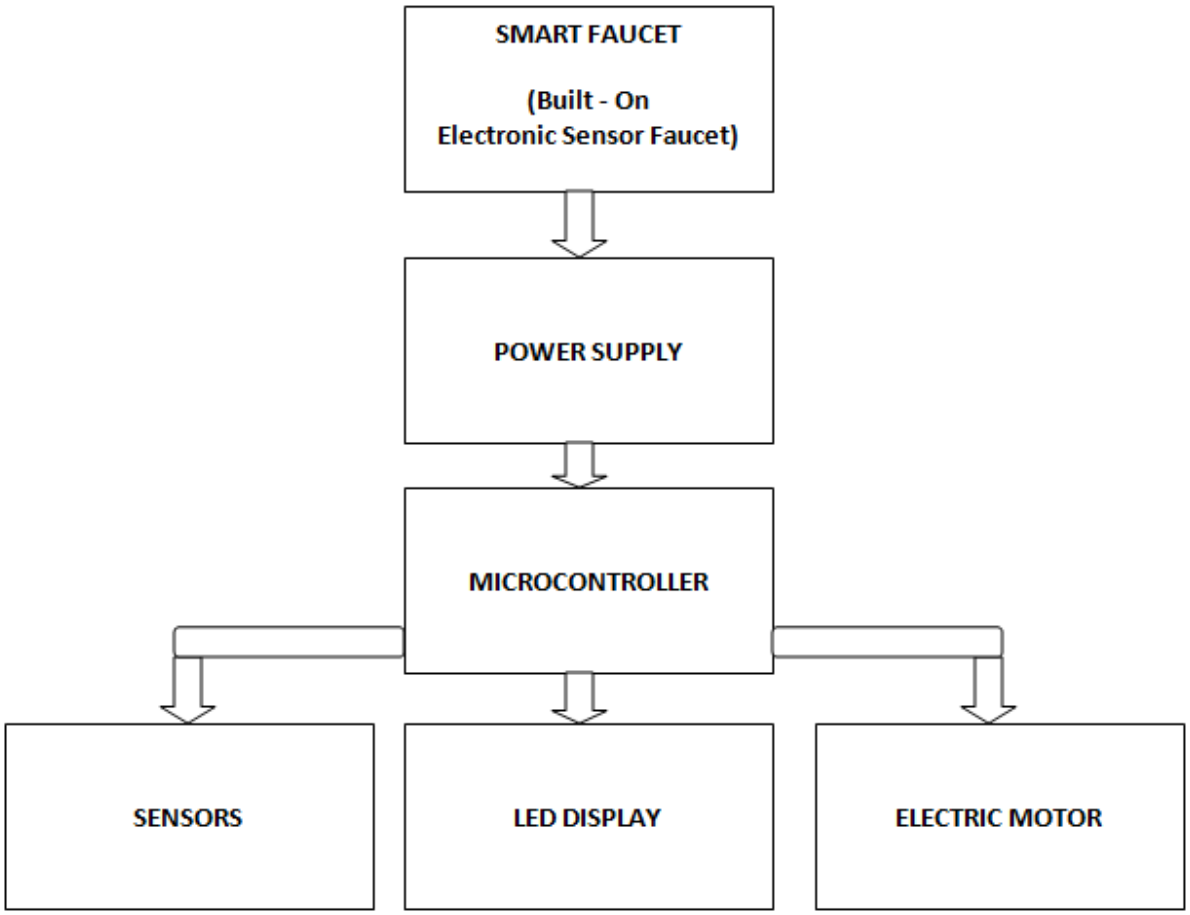

Figure 1: Product Tree with Main Blocks

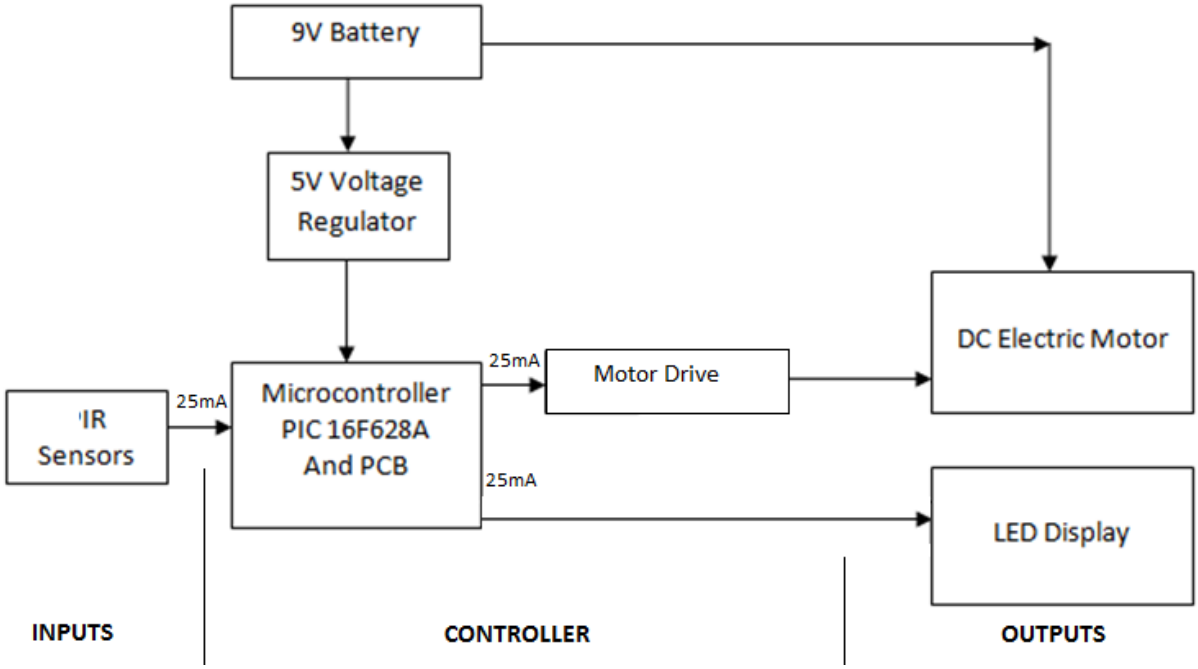

Figure 2: Block Diagram with Signals and Input / Output Directions

The block diagram shows the main blocks of the product which are the microcontroller, sensors, electric motor, and the LED display. The block diagram also shows the inputs outputs and the internal circuitry to every detail. The microcontroller requires 25mA inputs and outputs as shown in the diagram. We require an additional motor drive to be able to control the DC Electric Motor. Design details will be explained later on.

Interface of the Product: **[3]**

The sensors will be placed on the side of the faucet for easy accessibility. With a single hand movement, the water temperature will be increased or decreased. The main body enclosure will be placed at the back of the faucet where the connections from the sensors and the electric motor will be made. The electric motor will be built on the water temperature valve as shown in the figure above.

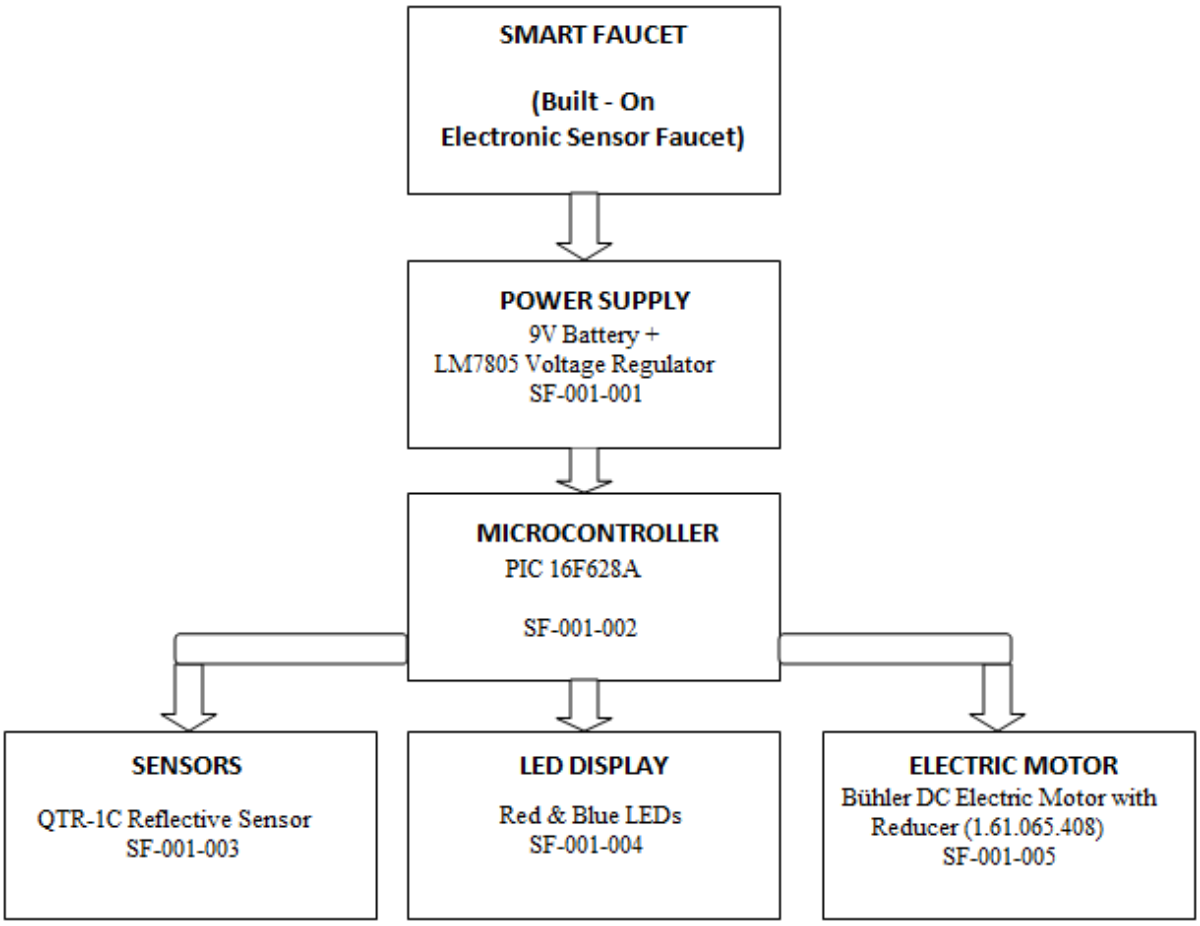

Figure 3: Product Tree with Component Details and Stock Numbers

3. Technical Specifications & Design Details

1. LED Display

We will get regular red and blue LEDs, resistors, and other necessary components from Konya Street, Ulus. They will be placed in a plastic enclosure with these dimensions:

Height: 3cm Width:3cm Length:25cm

Figure 4: Our LED display will look like this **[8]**

2. Controller Body

We will get a plastic enclosure with a battery socket from Altınkaya Elektronik Cihaz Kutuları. Height: 5cmWidth: 6cm Length: 10cm **[4]**

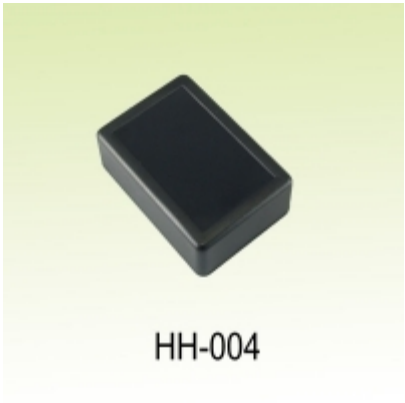

Figure 5: Enclosure for the body **[4]**

3. Infrared Sensors

QTR-1C sensors will be placed on one side of the faucet. There will be 3 sensors placed with 4.5 cm in between them. These will be used to detect the direction and the speed of hand gestures so that the water can be heated or cooled at the required sensitivity. The outputs will be given similar to figures below, when the hand is right across the sensor there will be a peak value which will allow us to place the sensors side by side and not care for the operating angle. The output is also digital, which will be directly connected to the pins of the microcontrollers.

Specifications

- Dimensions: 0.3" x 0.5" x 0.1" (without header pins installed)
- Operating voltage: 5.0 V
- Supply current: 25 mA
- Output format: digital I/O compatible
- Optimal sensing distance: 0.125" (3 mm)
- Maximum recommended sensing distance: 0.375" (9.5 mm)
- Weight without header pins: 0.008 oz (0.23 g)

Figure 6: Infrared Sensors' place on faucet **[2]**

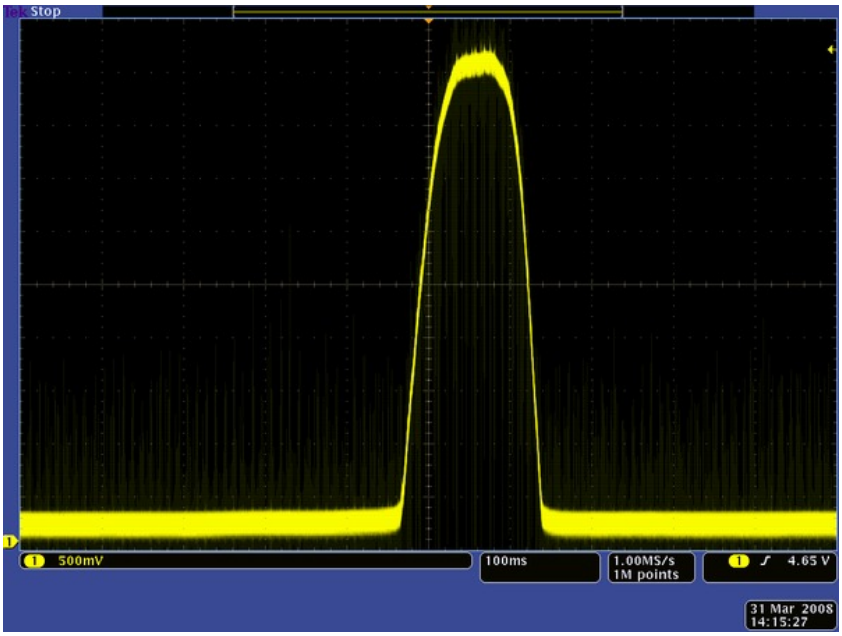

Figure 7: Example output of QTR-1C Reflective Sensor **[2]**

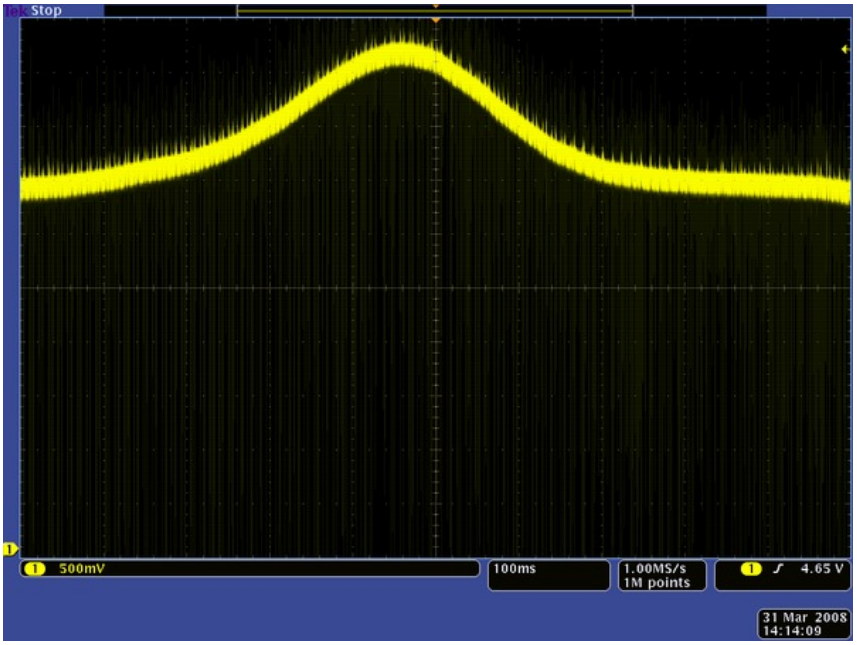

Figure 8: Example output of QTR-1C Reflective Sensor **[2]**

4. Electric Motor

We require 10N*0.03m= 0.3Nm=300mNm of maximum torque. We will use a lower power consuming and small sized electric motor with a reducer. An option for us is Bühler DC Electric Motor with Reducer (1.61.065.408), which can generate a 300-420 mNm of torque, which is enough for us. It is working with 6 volts as we require, below 9 volts.

Figure 9: Bühler Electric motor **[7]**

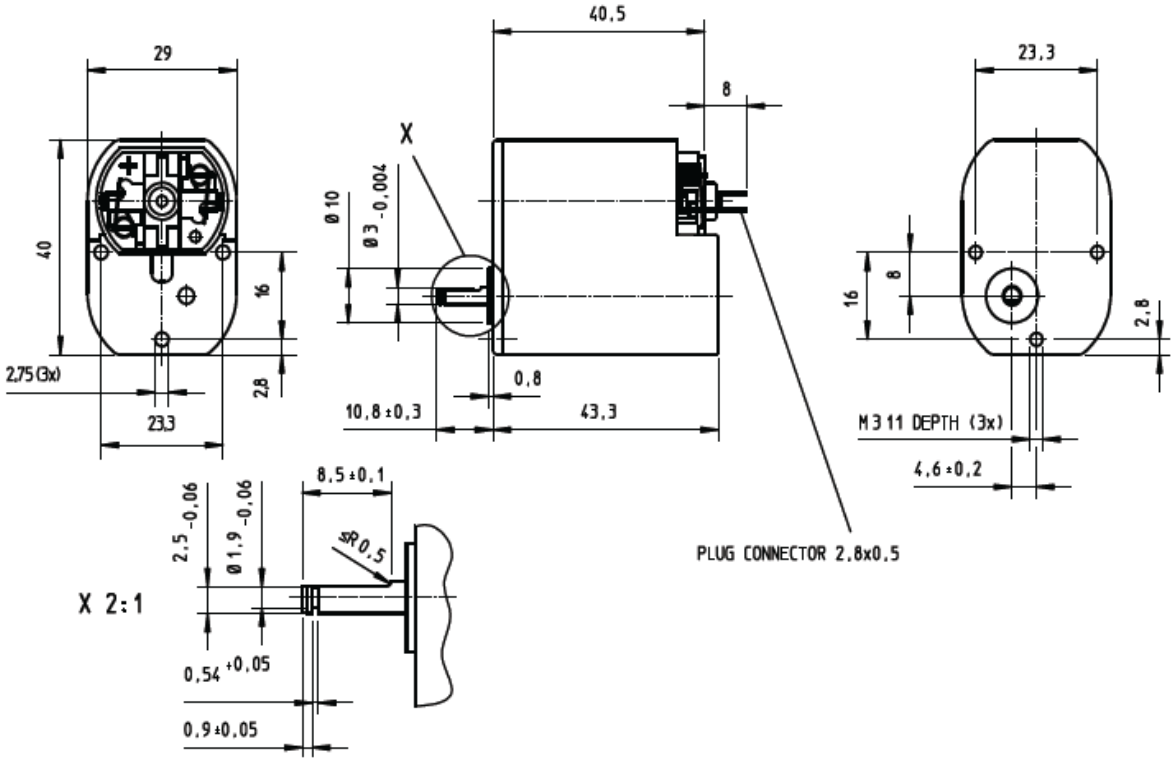

Figure 10: The dimensions of the electric motor **[7]**

5. PIC Parameters (16F628A):

The input from the sensor is 25mA which is optimal for the microcontroller, and the outputs will be in this range. However, electric motor will require more voltage input in order to process. We will need a motor drive in order to control the electric motor. You can see the details in the preliminary design block diagrams.

Program Memory Type	Flash
Program Memory (KB)	3.5
CPU Speed (MIPS)	5
RAM Bytes	224
Data EEPROM (bytes)	128
Digital Communication Peripherals	1-A/E/USART,
Capture/Compare/PWM Peripherals	1 CCP
Timers	2 x 8-bit, 1 x 16-bit
Comparators	2
Temperature Range (C)	-40 to 125
Operating Voltage Range (V)	2 to 5.5
Pin Count	18 **[5]**

6. Voltage Regulator

Parameter	Symbol	Conditions		MC7805/LM7805 Min.	Typ.	Max.	Unit
Output Voltage	V_O	T_J =+25 °C		4.8	5.0	5.2	V
		5.0mA ≤ Io ≤ 1.0A, P_O ≤ 15W V_I = 7V to 20V		4.75	5.0	5.25	
Line Regulation (Note1)	Regline	T_J=+25 °C	V_O = 7V to 25V	-	4.0	100	mV
			V_I = 8V to 12V	-	1.6	50	
Load Regulation (Note1)	Regload	T_J=+25 °C	I_O = 5.0mA to1.5A	-	9	100	mV
			I_O =250mA to 750mA	-	4	50	
Quiescent Current	I_Q	T_J =+25 °C		-	5.0	8.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1.0A		-	0.03	0.5	mA
		V_I= 7V to 25V		-	0.3	1.3	
Output Voltage Drift	$\Delta V_O/\Delta T$	I_O= 5mA		-	-0.8	-	mV/ °C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A=+25 °C		-	42	-	μV/Vo
Ripple Rejection	RR	f = 120Hz V_O = 8V to 18V		62	73	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J =+25 °C		-	2	-	V
Output Resistance	r_O	f = 1KHz		-	15	-	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A =+25 °C		-	230	-	mA
Peak Current	I_{PK}	T_J =+25 °C		-	2.2	-	A

Figure 11: Electrical Characteristics of Voltage Regulator **[6]**

Standards

We are not using any protocols or standards that are widely used, our product will have **ISO9001:2008** standards for quality managing of both the product and the company.

References

1) http://en.wikipedia.org/wiki/Automatic_faucet

2) **QTR-1C Reflective Sensor**
http://www.pololu.com/catalog/product/958/pictures

3) http://www.tekzen.com.tr/newsite/prd-657815001-rainy_fotoselli_batarya.aspx

4) http://altinkaya.com.tr/El_Tipi_Kutular/HH-004.html

5) **PIC 16F628A:** http://ww1.microchip.com/downloads/en/DeviceDoc/40044G.pdf
8-bit CMOS Microcontroller

6) **LM 7805:** http://www.datasheetcatalog.org/datasheet/fairchild/LM7805.pdf
5V Voltage Regulator

7) **Bühler DC Electric Motor with Reducer (1.61.065.408)**:
http://www.mugul.com/buhler/DC-gear-motor-1_61_065_en.pdf

8) **LEDs**
http://i.ytimg.com/vi/LqnXRdc4KFs/0.jpg