Homework 4: Design Constraint Analysis and Component Selection Rationale

Due: Thursday, February 12, at Classtime

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Introduction

The design project proposed is a smart fish aquarium. The fish aquarium's main feature is for the aquarium to be self-sufficient with minimal human maintenance , hence requires for a very well planned software program to take care of the fishes' needs. The device should be relatively secure and protected from electrical hazards, especially since electricity and water are in close proximity. The device also features an online capability which allows for the aquarium owner to monitor his/her aquarium from wherever he/she is. This constrains our aquarium to be within certain geographical locations; close to an Ethernet port.

Analysis – the real world!

Computation Requirements

On computational power, there is little need for the microcontroller to be able to do high level computations to maintain aquarium conditions. There is however a slight demand for computational ability, in terms of data transferring, from the microcontroller for the usage of the optional web-cam attachment and the aquarium's ability to be accessed from the internet.

Higher amounts of memory are required to maintain the database of aquarium conditions. Memory is also needed for image storing and processing when a digital still image is taken from the web-cam and sent through the Ethernet port.

Interface Requirements

The design of a smart fish aquarium entails several peripherals to take care of the needs of the fishes in the aquarium. This introduces an increased need for I/O pins to serve all the peripherals and communicate with them.

The following is a list of peripherals minimally required:

1. **Temperature Sensor**

   A simple digital probe used in detecting water temperature.

2. **pH Sensor**

   A simple probe used in detecting pH levels in the water; to measure ammonium levels in the aquarium.

3. **Water level Sensor**

   A photo-diode used to sense water levels via a floating ball placed in a vertical plastic tubing.

4. **Lighting Control**

   A relay to control power feed to lighting systems in the aquarium.

5. **Water pump/Filter**

   A relay to control power feed to a commercial water pump/filter.

6. **Water Heater**

   A relay to control power feed to a commercial 25W aquarium water heater.

7. **Autofeeder**

   A rotary chamber containing fish feed which is rotated at a regular interval.

All the peripherals are communicated through I/O pins from the microcontroller and do not require additional ports to interfaced with our design.

The optional web-cam is designed to interface with the design via a serial port and uses an RS-232 converter to communicate with the microcontroller.

A LCD display screen with keypad input is connected to the design to allow for human input at the aquarium itself. This gives the consumer control over the settings of the aquarium locally.

An internal real-time clock (RTC) is also useful but not essential to the success of the project. A RTC serves in assisting the software program in timings; to feed the aquarium's occupants at regular intervals and allow for the aquarium to simulate day and night.

Power Supply Requirements

Power for the device comes from a regular 120V wall socket. Regular wall transformers will be able to supply the required 3.15-3.45V DC to power the microcontroller. As most peripherals included in the design are low voltage devices, this should not prove to be a significant problem. The only concern would be the 25W water heater which would require significantly more power than everything else. This can be taken care of by a voltage regulator.

Packaging Requirements

The overall design should be compact enough to attach to a small aquarium; minimum size of at least 5 gallons. Packaging should also allow for the entire design to be water proof as a safety measure; to prevent water and electricity from coming into contact.

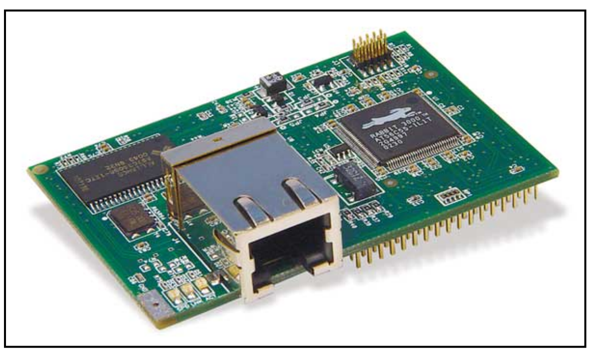
The device should be aesthetically beautiful or be able to blend with the aquarium as aquariums generally used for display purposes and should not have an ugly or contrasting device attached to it.

Cost Constraints

The cost of this device should not be excessively high given the required parts. A reasonable sum would not excess $400 not taking into account labor and design costs. This sum takes into consideration all the major components, the peripherals, all wiring and cables, and packaging. As this design is laid out with a general home usage in mind, costs should be kept as low as possible to be feasibly affordable for a regular earning household.

Components Rationale

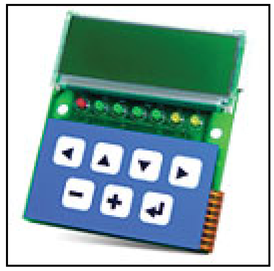
The RCM3200 RabbitCore microcontroller from Rabbit Semiconductors and Atmel’s AVR series ATmega8535L were the two main microcontrollers we considered using for our design. PIC microcontrollers were initially looked at as well, due to its small size and low cost. However due to its extreme lack of useable I/O pins, and our high need for I/O pins, we stopped considering PIC microcontrollers.



Looking further into the RCM3200 RabbitCore microcontroller, we found the large addressing space and high number of I/O pins to our favor. Our main constraints lie in the number of I/O pins we require to handle all our peripherals and the RCM3200 has 52 digital I/O pins; 44 configurable, 4 fixed input, and 4 fixed output. An internal battery backable RTC is extremely useful for our design as well.

Our next major concern was for an Ethernet port and the ability to communicate through the Internet. The RCM3200 is designed to be fully integrated with 10/100Base-T Ethernet connectivity. It has an Ethernet port built in readily integrates with our design.

Another feature of the RCM3200 is its available keypad/LCD display unit. Rabbit Semiconductors markets a keypad/LCD display unit which plugs directly onto the RCM3200 prototyping board, which although we will not be using, will be able to allow us to follow existing schematics to design the aquarium.



The ATmega8535L microcontroller also features a high number of I/O pins, 32 maximum pins available (not necessarily all useable). But the lack of integrated 10/100Base-T Ethernet connectivity makes our design a lot more complex.

Most features on the ATmega8535L are comparable to the RCM3200, but the lack of Ethernet connectivity is a major concern since monitoring the aquarium through the Internet is a major feature in our smart aquarium.

Although Atmel doesn’t market a keypad/LCD display, this is trivial point because 12 button keypads with decoders are readily available and would not be extremely difficult to integrate with any microcontroller. However we liked the keypad/LCD display from Rabbit Semiconductors because of its simplicity; it has few buttons, which are sufficient for our uses and an LCD display which simplifies our design as we would not be required to interface another external LCD display.

List of Major Components

Component	Vendor	Part Number	Quantity	Cost
Microcontroller RCM3200	Rabbit Semiconductor	101-0520	1	$89.00
Keypad/LCD display	Rabbit Semiconductor	101-0601	1	$79.00
			Total Cost:	$168.00

List of References

The following are datasheets and informational web pages we referred to in parts consideration:

RCM3200 RabbitCore	http://www.rabbitsemiconductor.com/products/rcm3200/index.shtml
ATmega8535L	http://www.atmel.com/dyn/products/product_card.asp?part_id=2009
Microchip.com (PIC)	http://www.microchip.com/
Micromint.com (PIC)	http://www.micromint.com/