Weekend Pet Feeder Project Report

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CSE 3442: Embedded Systems 1

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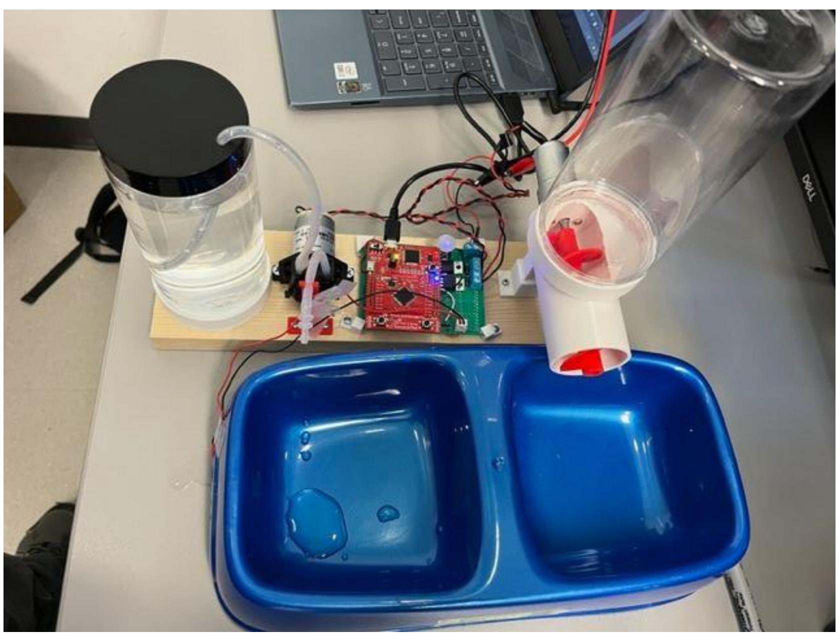
This Report is submitted towards and in support of the partial completion of the requirements for the Professional Practices Course.

Introduction

The project focus is building a weekend pet feeder, an automated system to fetch water and food to pets at the desired time and necessity. The system is built upon a Digital Signal Controller (DSC), TM4C123GH6PMI, by Texas Instruments to implement peripherals enabling multiple features. For example, the project's hardware, such as the motor or sensor, depends on the DSC for working instructions. Another key component of the project is the soldered circuits on a blank printed circuit board (PCB) which include N-Channel MOSFETs, NPN transistors, a motion sensor, a microbuzzer, capacitors, and resistors. The circuits connect to the motor which controls the auger for fetching food and the pump for pumping water to the dish. The speed of the auger is controlled for the preferred amount of food being dispersed. Similarly, desired water could be set and the pump will auto-fill. Moreover, the pump also offers the feature of freshening the water wherever there is a motion captured by the motion sensor. Basically, water is being freshened up on a pet's visit. In a situation of water running out of the container or water not being pumped into the pet dish, a buzzer of every 5 seconds is set which is a hardly missed high pitch frequency indicating refill. Pet log-ins were also saved to keep track of their diet schedule. All in all, the weekend feeder prototype offers all the needs with accuracy and success for a pet's luxury.



Theory of Operation

UART Module:

The PuTTY secure shell (SSH) is used for communicating between the input of the DSC and the user. The DSC emphasizes the usage of UART for properly taking input values. UART stands for Universal Asynchronous Receiver/Transmitter. Because UART is asynchronous data is transmitted without the clock's edges instead similar baud rate (bits per second) is set on both PuTTY and the DSC for synchronization. UART configuration is set according to the 40 MHz DSC frequency cycle which gives a baud rate of 11520. Details of the UART configuration are in the code.

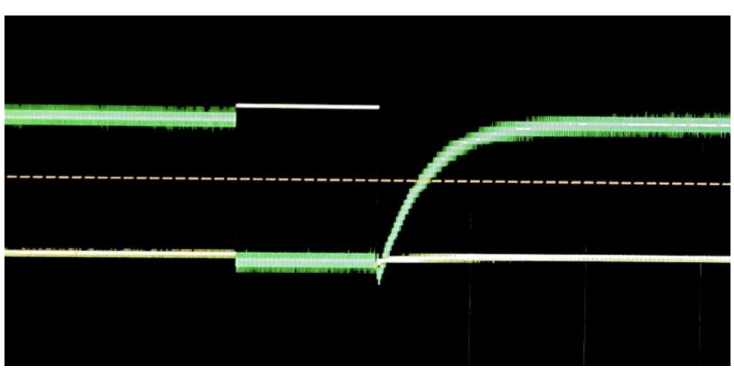
Hibernation Module:

The hibernation module could be taken as a time-keeping peripheral for this project. The module is configured on a 32-bit Real-Time Clock (RTC) for keeping track of time from whatever time is set by the user which is done by a real-time clock load register. Additionally, enabling the RTC match register (RTCM0) and its interrupt mask the feeding feature is configured. Whenever M0 equals the value in the RTC current time register (RTCC) an interrupt is triggered which performs a feeding event by getting all the information from the EEPROM and sets the next event in RTCM0. One of the key aspects of configuring the hibernation module is waiting for "Write Complete" to complete (value '1' in that bit) which gives the right to write to the register. Details of the hibernation configuration are in the code.

Analog Comparator Module:

Background: Water level is measured in this project and to be able to do so copper strips/tapes are put in parallel under the water bowl (the bowl is translucent) which allows copper strips to work as a capacitor. Noting the clock ticks of charging copper strips helps estimate the water level since charging ticks will vary with different amounts of water. Clock ticks are proved to be proportional to charging ticks from this project.

The Analog comparator takes in two inputs of analog signals and can output a digital signal. However, for this project on the equivalent of two voltage inputs, an interrupt will occur where we will get the charging ticks. First, create an interrupt of 10 seconds that grounds pin C7 (C0-) for only a few microseconds. C0- is connected to copper strips which start to charge after grounding is done by turning on one GPO. This will be compared with the internal analog signal of DSC which will be about 2.467 Volts from pin C6 (C0+). When C0- and C0+ are equal comparator interrupt will fire up giving charging ticks. Upon experimentations, tick ranges were calibrated for a certain amount of water level. Details of the analog comparator configuration are in the code.

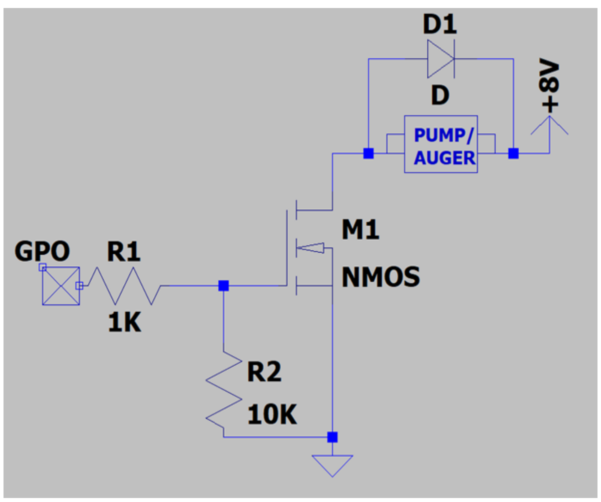


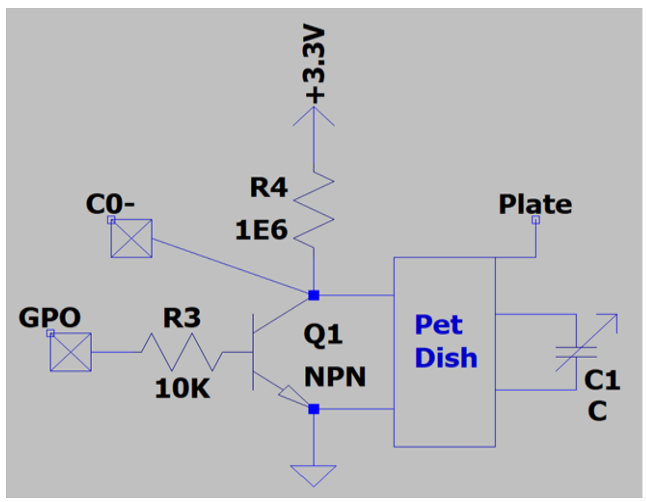
EEPROM Module:

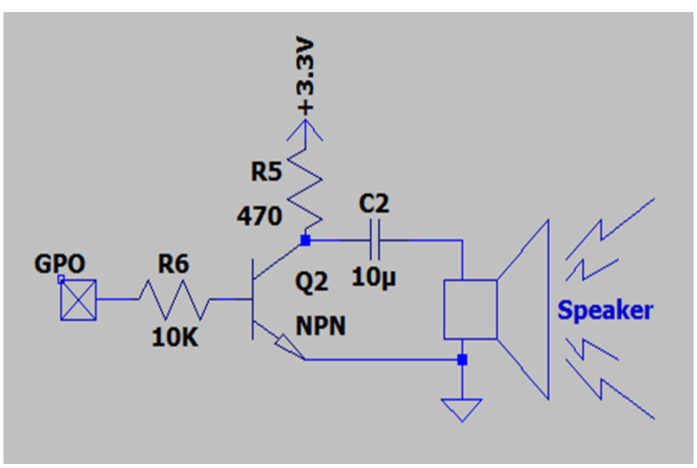
EEPROM is Electrically Erasable Programmable Read-Only Memory which is non-volatile meaning written data is stored even on power cut-off. The DSC provides 10 blocks and 16 32-bit ‘words’ for each block. This memory was used in saving feeding events and ‘log in’/visit of the pet to the feeder which can be useful to see the pet’s schedule. Doing so preserves user data upon device turn-off or power outage. Details on how to initialize EEPROM and store data in EEPROM are in the code.

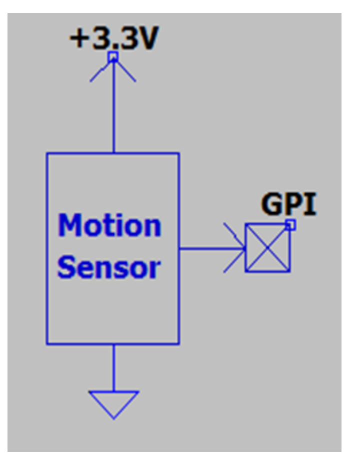
Circuits on PCB:

1. MOSFETs are used as a switch controlled by GPO. Diode D1 prevents Induced EMF (Back EMF) from harming the DSC or the circuit. GPO uses pulse width modulation (PWM) to control the speed of the pump and auger.
2. GPO grounds pin C7 (C0-). C0- takes in the analog signal from C1 (copper strips).
3. GPO returns ‘1’ and ‘0’ back and forth every 183 microseconds creating AC for the speaker. The optimal solution could be pulse width modulation for GPO.
4. Motion sensor simply outputs signal on any capture and GPI reads it.









Observation

The most essential and common observation made was experimenting with clock ticks of water bowl charging capacitance. Clock ticks would easily bounce up or down. To fix such an issue I had to narrow down the gap between strips and put more shoder on the wire to strips connection. Moreover, when I tried to implement an additional feature of monitoring the food container that is it empty or not. I faced a hardware issue with the proper placement of the IR detector. These points could be considered for better design.

Conclusion

In summary, the weekend pet feeder effectively utilizes the TM4C123GH6PMI Digital Signal Controller and its various peripherals and additional hardware components for building an automated system prototype. Important peripherals include UART for establishing a connection with PuTTY secure shell, a Hibernation Module for scheduling feeding events, an Analog Comparator Module for water level measurement, and EEPROM for data storage of log-ins and events. The PCB circuits include a motion sensor, a micro buzzer, a motor, a pump, and a pet dish complete project functionality. However, hardware challenges, such as capacitance charging clock ticks measurement issues, highlight the needed development of the design. Overall, the prototype successfully meets its goals and provides great insight and experimentation into the world of embedded systems.