Sunny Patel
Douglas Williams and Thomas Michaels
S9 - Automated Spice Mixer
ECE 4011 – Section A05

Low Power Microcontrollers for Portable Household Appliances

Introduction

With improvements to electronics like decreasing power consumption and reducing the size of devices, there are more applications for portable household appliances. To understand the data that is being acquired, the center of these portable household appliances is the processor. Typically, the processor that is used for these kind of applications is a microcontroller. Unlike a normal processor, a microcontroller also has other parts like memory and converters. This paper is a review of low power microcontrollers in terms of their commercial application, improvements made in the technology, and implementation of the microcontroller.

Commercial Applications of Low Power Microcontrollers

For portable household appliances to be useful, the most important feature of the microcontroller is low power. However, to minimize the power used by the microcontroller, it should not have the same processing power as a desktop processor. As a result, a low power microcontroller like the STM32L1 microcontroller uses around 23 mW [1]. The main advantage of this microcontroller is that it is ARM based architecture, which is the same kind of processor used in cellphones. This microcontroller also has many different types of communication interfaces like USB, UART, SPI, and I2C [1] and costs $4.47 [2].

Another popular microcontroller used for low power applications is the TI MSP430. Like the STM32L1, it also uses RISC architecture [3], but is not specifically ARM. The advantage of this particular microcontroller is that at its peak performance, it uses only 11.5 mW [4]. However, this comes at a price as it can only run at 16 MHz [4] compared to the 32 MHz that the STM32L1 is capable of running [1]. Another disadvantage is that this microcontroller is more expensive as it costs $11.48 [5].

Technology of Low Power Microcontrollers

Most low power microcontrollers use the RISC (Reduced Instruction Set Computer) architecture in their processor. This type of architecture is preferred over the CISC (Complex Instruction Set Computer) architecture found in desktop processors because it allows tasks to be completed in a simpler manner. RISC architecture tries to implement a simple instruction every clock cycle whereas CISC will try to implement a specific and complicated task but will only require one instruction [6]. As a result, CISC architecture requires more complicated hardware to account for more complicated tasks whereas RISC will use more software based techniques to complete the same task. Both CISC and RISC end up having similar performance in terms of run time but RISC ends up being less complicated from a user perspective. Furthermore, since RISC architecture requires less

Sunny Patel
Douglas Williams and Thomas Michaels
S9 - Automated Spice Mixer
ECE 4011 – Section A05

diverse parts, it will require fewer transistors, which will in turn mean that it can be smaller than a CISC device [7]. The benefit of this is that it allows for a smaller microcontroller to fit into a given area, which is important for portable household appliances.

Another aspect of designing a microcontroller is using the system-on-chip (SOP) interface. This interface allows for many different components to be on a chip. The advantage of this is that all of the necessary components like a processor, memory, converters, and others can all be put onto one die, and thus one chip [7]. By implementing a system on a chip, the microcontroller becomes more diverse in the operations it can do, which allows it to have different means of communication as stated above for example. It also allows for more diverse tasks to be integrated into one component because the microcontroller has different components.

Implementation of Low Power Microcontrollers

Hardware and software adjustments need to be made to implement a low power microcontroller. To use microcontrollers with other components like sensors in a portable household appliance, there needs to be hardware to be able to have communication between the parts. Similarly, software needs to be implemented for extracting information from the microcontroller to process and send out to other components. This typically means that specific registers for memory and pins for different parts of the microcontroller will need be enabled for it to function properly [8]. For example, a component to communicate with the microcontroller, it might need to use I2C. As a result, the proper pins need to be connected between the component and the microcontroller. Also, the microcontroller needs to be programmed to make sure that it can receive the data properly from the component so that it can relay the information to the end user. The communication between the microcontroller and the end user might be through USB, which would mean enabling different pins than those used for I2C on the microcontroller to communicate over USB to the end user.

Sunny Patel
Douglas Williams and Thomas Michaels
S9 - Automated Spice Mixer
ECE 4011 – Section A05

References

[1]   STMicroelectronics. (2015). *STM32L151C6* [Online]. Available: http://www.st.com/web/catalog/mmc/FM141/SC1169/SS1295/LN962/PF252048?s_searchtype=partnumber#.

[2]   Digikey. (2015). *STM21L151C6T6* [Online]. Available: http://www.digikey.com/product-search/en?WT.z_cid=sp_497_0928_buynow&Enterprise=44&lang=en&Vendor=497&mpart=STM32L151C6T6.

[3]   *MSP430x4xx Family User's Guide*, Texas Instruments, Dallas, TX, 2013.

[4]   Texas Instruments. (2015).*16-bit Microcontroller* [Online]. Available: http://www.ti.com/lsds/ti/microcontrollers_16-bit_32-bit/msp/ultra-low_power/msp430f2x_msp430f4x/overview.page.

[5]   Digikey. (2015). *MSP430FG439IPN* [Online]. Available: http://www.digikey.com/product-detail/en/MSP430FG439IPN/296-17013-ND/657732

[6]   C. Chen, G. Novick, K. Shimano, (2000). *RISC vs. CISC* [Online]. Available: http://cs.stanford.edu/people/eroberts/courses/soco/projects/risc/risccisc/

[7]   P. Jain, *CISC & RISC Architecture* [Online]. Available: http://www.engineersgarage.com/articles/risc-and-cisc-architecture

[8]   A. M. Adedoyin, O. I. Olopade, O. O. Shoewu, A. O. Ogunlewe. "Design and Implementation of Microcontroller Based Calculator," *Journal of Computation in Biosciences and Engineering*, vol. 1, no. 2, Apr. 2014.