Project Proposal
Automatic Volume Control

2/19/2007
Gedare Bloom: gedare AT gwu DOT edu

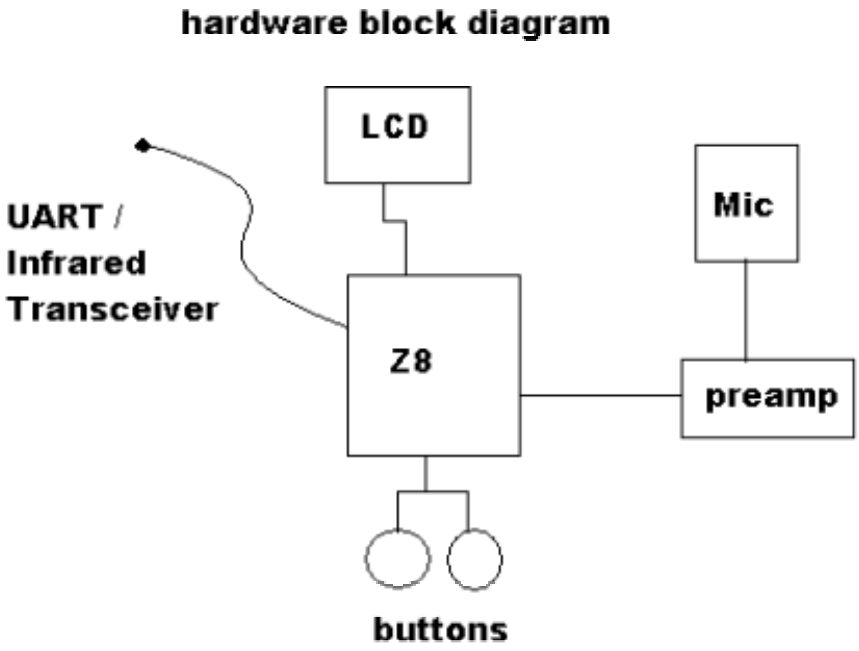
Project Abstract

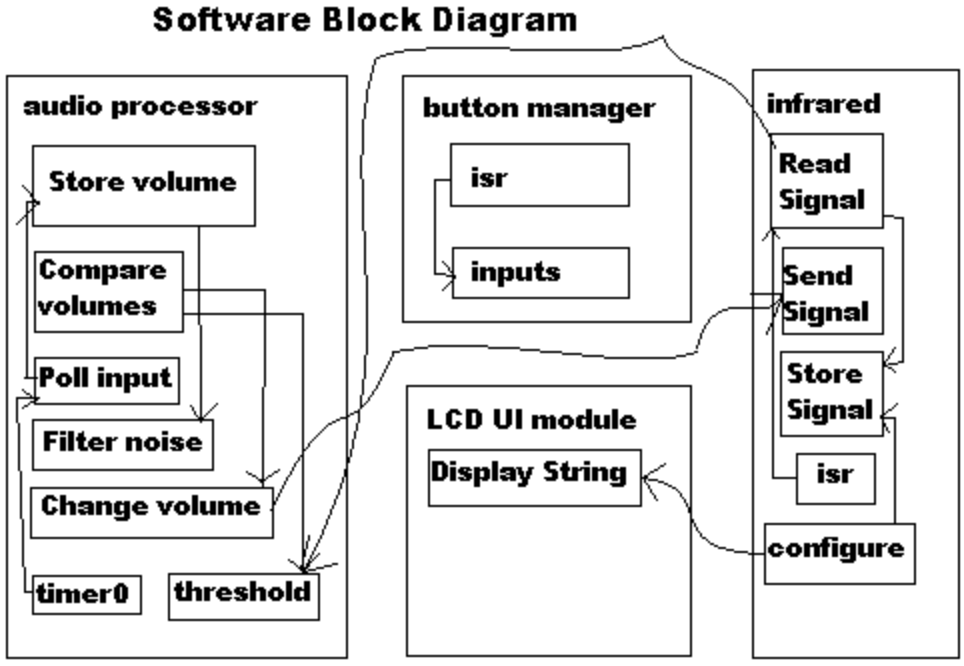
Automatic Volume Control (AVC) is primarily for active use with a television set in order to maintain a specific level of volume. A user will select a comfortable volume level from their multimedia device, and the AVC will use infrared remote capabilities to maintain the comfortable volume (within some threshold). I will use a microcontroller with an infrared transceiver, and will attach a microphone and mini-amplifier (if necessary) in order to capture external sounds. Ideally, I'll be able to measure the amplitude of the input waves in order to determine volume level. I may need to investigate some different means of performing the volume sampling measurements.

Strategy

Description: As above.
Platform: Zilog Z8 Encore chip and development platform. I may need to purchase one, but I will be choosing from the Zilog family because I am familiar with the brand and the development tools.
Capabilities: GPIO, Infrared Transceiver (UARTs), timers, interrupts, analog inputs, ADC (if necessary)
External hardware: Microphone, preamplifier, buttons, LCD (possibly)
Software Modules: Audio processor, button manager, LCD user interface module (possibly), Infrared (UART) manager

If time and resources permit, I will attach an LCD to the AVC in order to give a user interface for the system; this would enable the user to initialize the system using their remote control. I will need to figure out how to store the specific infrared signals that correspond to the type of remote control that the user's multimedia device utilizes. I'm going to need a simple microphone for capturing sound, but I have not begun evaluating different types. Unless I do some very sophisticated sound analysis such as background noise filtering, I should not need a very good microphone. However, depending on the voltages that are provided as output by the microphone I may need a preamp in order to increase the gain so that I can actually sense when the volume change is enough to require action. I have also looked at differential amplifiers, but I'm not sure that hardware is the right solution to figuring out the change in volume level; some background noise filtering is likely to increase performance and correctness, but I think a differential amplifier on my signal would ruin any attempts at analysis. If I do need to analyze the input sound signal, I'll need to use an ADC to get the signal into a digital format; then I will need to figure out how to find the amplitude of the analog signal in the digital format. These are some problems that remain to be explored, and I'm not ready to make any commitment to solving them in any particular fashion.





Unknowns

Infrared Signals: I may need to create some type of configuration system using a simple user interface to allow users to match their remote control with the AVC. This should

only need to be done once, so I'll need to figure out what kind of non-volatile media I can use to store the information. I think that receiving infrared signals will cause an interrupt service routine to occur in order to block the audio processing, so as to not interfere with the user's remote control choices.

Capturing the volume level: I have only some sketchy ideas about how the volume is going to be obtainable from the signal. I know that volume is represented as the amplitude of the sound wave, but I'm not sure how that is going to be presented by the microphone/pre-amp. After I examine some microphones and read the spec sheets I should be able to make some decisions. If I need to use the ADC, then hopefully the digital signal will contain a representation of the amplitude of the analog signal, otherwise I may need to pre-process the analog signal in order to capture the volume level. I'll also need to investigate the effects of background noise, and be prepared to write some noise filtering into the audio processing.

Demonstration: I'll need something that generates sound and is controllable with a remote.

Implementation Plan

I will build my project in pieces, testing each module individually for correctness. I will need to begin gathering my materials shortly for all parts, but I already have enough material in the development lab kits to begin some exploration.

1. Purchase parts: Zilog Z8 kit, microphone, pre-amplifier, LCD (maybe)
2. Attempt to capture and reproduce remote control signals using the infrared devices on the Z8.
3. Attach microphone to Z8 and examine the signal strength; attach pre-amplifier if necessary to boost the signal.
4. Investigate how to capture the amplitude of the sound wave, to record volumes
5. Implement and test simple audio processing: capture a sound, store volume, capture another sound, display difference.
6. Implement button handler to enable a simple, low-level user interface to the system
7. Using the previous two steps, trigger step 5 using a button.
8. Build on step 7 by causing the second captured sound to trigger either a volume increase or decrease.
9. Build on step 8 by only performing the volume increase or decrease if the change in volumes between the two sounds is sufficiently large.
10. Put step 9 into a loop, recording sounds and comparing to the previous to see if a volume change is necessary.
11. If LCD available, implement a more sophisticated user interface.
12. Test for the effects of background noise on the AVC. If noise is severely impacting the system, implement a noise-filtering mechanism as part of the audio-processing software module. This may require some signal processing, or could be as simple as making sure the volume change caused by the system is actually causing a change in the signal being sampled. (i.e., if the dominant signal is not the multimedia device, don't keep attempting to change the volume)

13. External infrared signals should cause the AVC to become quiescent, when the external signals are sensed complete, a new volume level should be read and the monitoring process begun anew.

Milestones are listed above in the enumeration of what needs to be accomplished. I will still need to decide if noise-filtering is necessary, and also if I will be using an LCD for the final user interface. Software components will be tested individually before being integrated, and then I will perform integration tests as outlined in the above steps (particularly steps 5-10).

Resources

I will be purchasing a Z8 board, a microphone, preamplifier, and an LCD; for demonstration purposes I will also need some type of remotely controlled apparatus. I will be purchasing the materials for my own project, but I will be depending on the Zilog compiler and development kit support. Not sure what I will use for my demonstration.