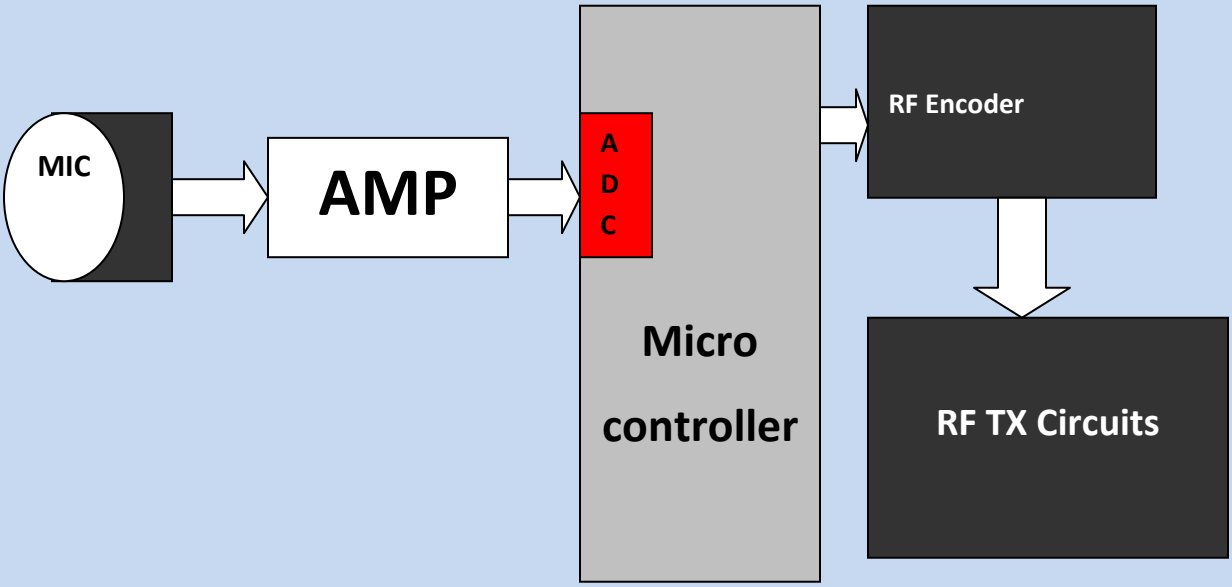
Wireless Voice Recognition Door Open Close

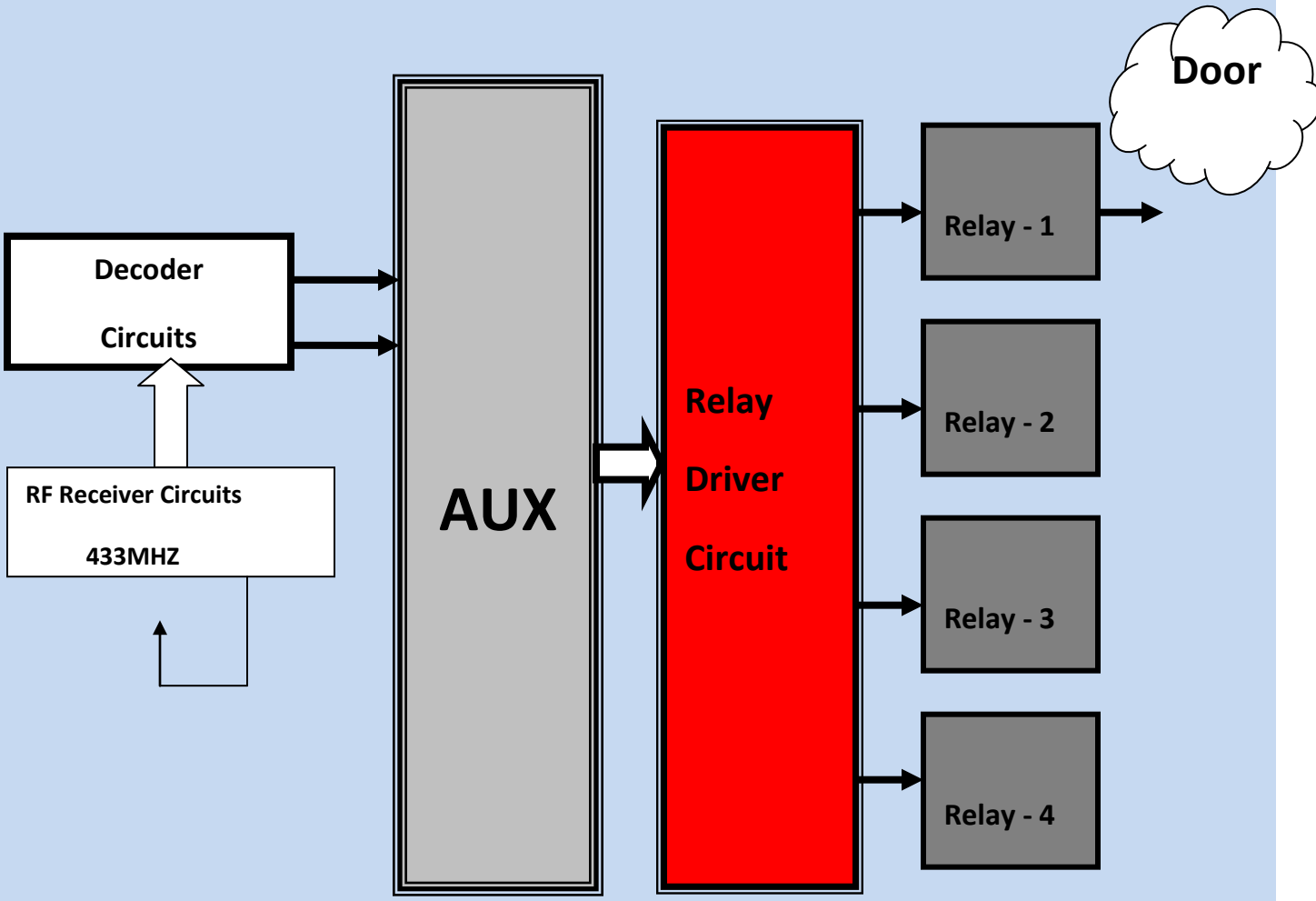
Introduction:

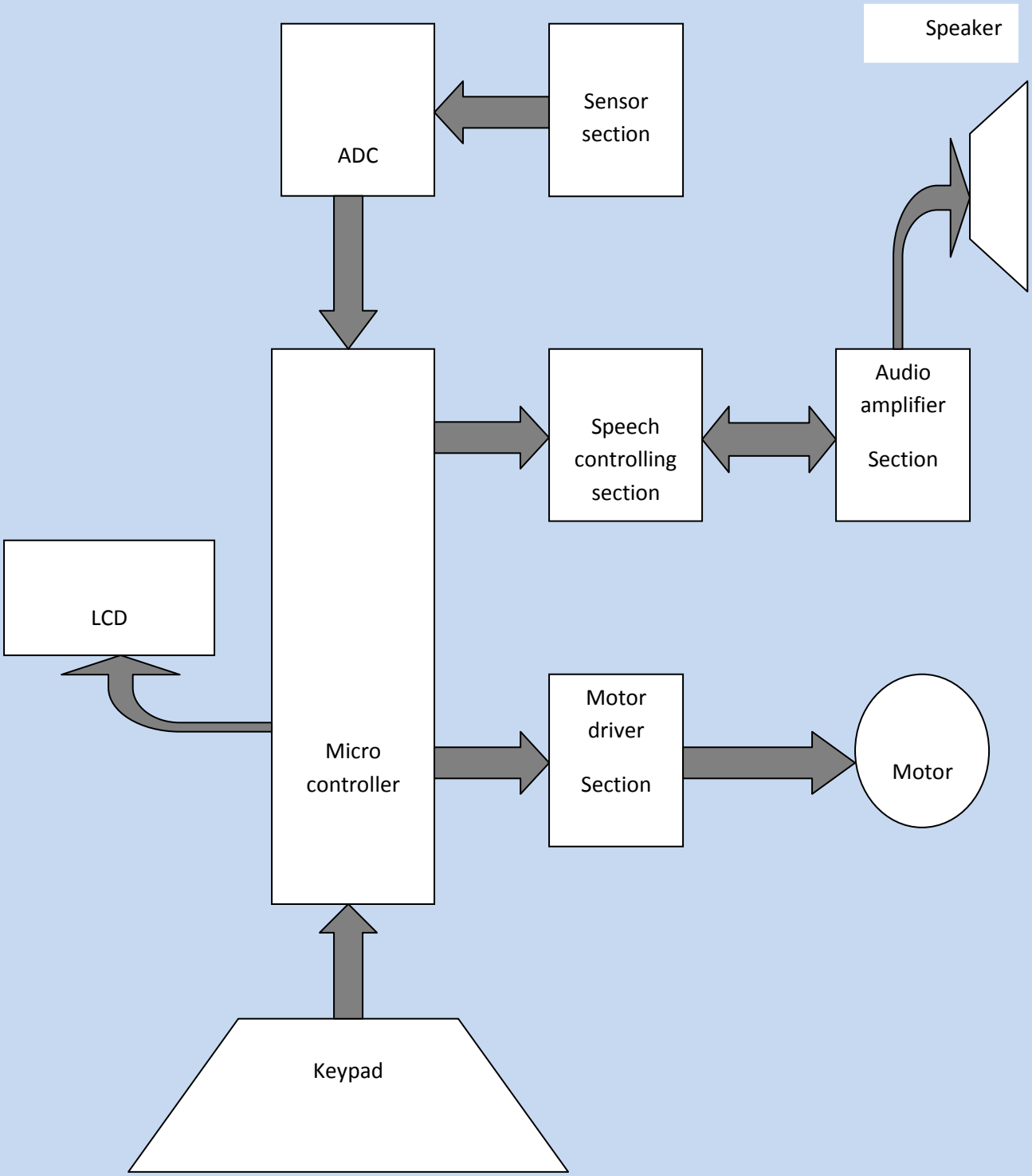
Think about a home door control by wireless which would be controlled by your voice. By giving a command, to light on /off you to your destination. The voice recognition algorithm we used could be applied to daily life; for example it would be most helpful to disabled people to perform their daily work. We created a speech controlled using various electrical and mechanical domains such as digital signal processing, analog circuit design with the Microcontrollers.

1) Wireless Transmitter Unit:



Block diagram of device driving circuits:




Speaker
ADC
Sensor section
Audio amplifier Section
Speech controlling section
LCD
Micro controller
Motor driver Section
Motor
Keypad

Objective:

- ***Rationale and sources of your project idea*:**

Background math:

Speech Analysis:
In order to analyze speech, we needed to look at the frequency content of the detected word. To do this we used several 4^{th} order Chebyshev band pass filters. To create 4^{th} order filters, we cascaded two second order filters using the following "Direct Form II Transposed" implementation of a difference equations.

Where the coefficient a's and b's were obtained through Matlab using the following commands.

[B,A] = cheby2(2,40,[Freq1, Freq2]);

(Where 2 defines a 4^{th} order filter, 40 defines the stop band ripple in decibels, and Freq1 and Freq2 are the normalized cutoff frequencies).

[sos2, g2] = tf2sos (B2, A2,'up','inf');

Fingerprint Calculation:
Due to the limited memory space on the Mega32, we needed a way to encode the relevant information of the spoken word. The relevant information for each word was encoded in a "fingerprint". To compare fingerprints we used the Euclidean distance formula between sampled word fingerprint and the stored fingerprints to find correct word.

Where P is a dictionary fingerprint and Q is the sampled word fingerprint and p i and q i are the data points that make up the fingerprint. To see if two words are the same we compute the Euclidean distance between them and the words with the minimum distance are considered to be the same. The formula above requires squaring the difference between the two points, but since we are using fixed point arithmetic, we found that squaring the difference produced too large of a number causing our variables to overflow. Thus we implemented a "pseudo Euclidean distance calculation" by moving the sum out of the square root reducing the equation to

Control Functions:

There are three things that must be done in order to control to change channel, Volume, Brightness, on /off and color properly on the TV.

- ***Hardware/Software tradeoffs*:**

The signal coming out of the microphone needed to be amplified. We had two different versions of operational amplifier, LMC 711 and LM 358. The LMC711 has a slew rate of 0.015 V/μs, on the other hand LM 358 has 0.3V/μs. The LM358 has a better slew rate and it gave us better response to input signal, so we used it when we designed our amplification circuit.

The signal processing of speech requires lot of computations, which implies we need fast processor, but we had to operate at 16 MHz. In order to minimize the number of cycles we used filtering the audio signal we had to write most of the code in assembly. We wrote all of 10 digital filters in assembly which made them very efficient and significantly improved our performance over a C code implementation.

Software/Hardware Design

1) Software Description

The Basic algorithm of code is to check the ADC input at a rate of 4 KHz. If the value of the ADC is greater than the threshold value it is interpreted as the beginning of a half a second long word. The sample word passes through 8 band pass filters and is converted into a fingerprint. The words to be matched are stored as fingerprints in a dictionary so that sampled word fingerprints can be compared against them later. Once a fingerprint is generated from a sample word it is compared against the dictionary fingerprints and using the modified Euclidean distance calculation finds the fingerprint in the dictionary that is the closest match.

Methodology of this Project:

1. **RF Communication-433MHZ**
2. **Embedded DSP**
3. 4th order Chebyshev band pass filters

References

- Speech Recognition Algorithm: Tor's website.
- Prof. optimized 2nd order IIR code
- LM358 Datasheet: Dual Operational Amplifier
- Atmel 89C52 Data sheet:
- Custom Prototype: custom PC board
- Matlab: To generate second order coefficient.

Background Reference:

- Fixex Point Math: Fixed point math
- IIR Design: IIR design