



Portland State
UNIVERSITY

MASEEH COLLEGE OF ENGINEERING

T01 411 PRACTICUM PROJECT

SYNTHESIZER GLOVE

UML Design Diagrams

Team Members:

Ali ALAVI

Nathan BRYANT

Steve PEIRCE

Nicholas SAYRE

Professors:

Dr. Mark FAUST

Andrew GREENBERG ‘

Teachers Assistant:

Cody GABRIEL

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Synthesizer Glove Overview

The synthesizer glove consists of a glove wired with push-buttons at the contact point for each of the five digits of the user's dominant hand. The glove is plugged in to the control unit, which is strapped to the forearm near the glove. The rectangular control housing, called the vambrace, holds three more push buttons, a volume control interface and an analog thumb-stick.

The system is to be designed in such a way that it will create tones when the user operates dominant hand as if playing a piano with out keys. It should additionally offer the user to move the notes list, called the current scale, up or down to the next set of notes. Finally the user should also be able to adjust the output volume and make reasonable changes to the pitch and tone to suit desire.

Terms Used

- ADC: analog to digital conversion.
- Button(s): single pole momentary switch(es).
- MCU: Micro-controller unit.
- PWM: pulse width modulated or pulse width modulation
- OCR: output counter register
- Thumb-stick: 2-axis Sony Playsation[®] mini joystick.
- Vambrace: traditionally a modular piece of armor worn on arm that extends from wrist to near elbow. Herein used to describe the rectangular device enclosure worn in the same fashion.

Entire System: Level 0 Design Diagram



Level 0 Synthesizer Glove Design

Module:

- Synthesizer Glove

Inputs:

- **Power:** 9V DC battery
- **Button inputs:** Normally open momentary contact switches
- **Volume control:** Variable volume control
- **Pitch/ tone** Variable pitch and tone control

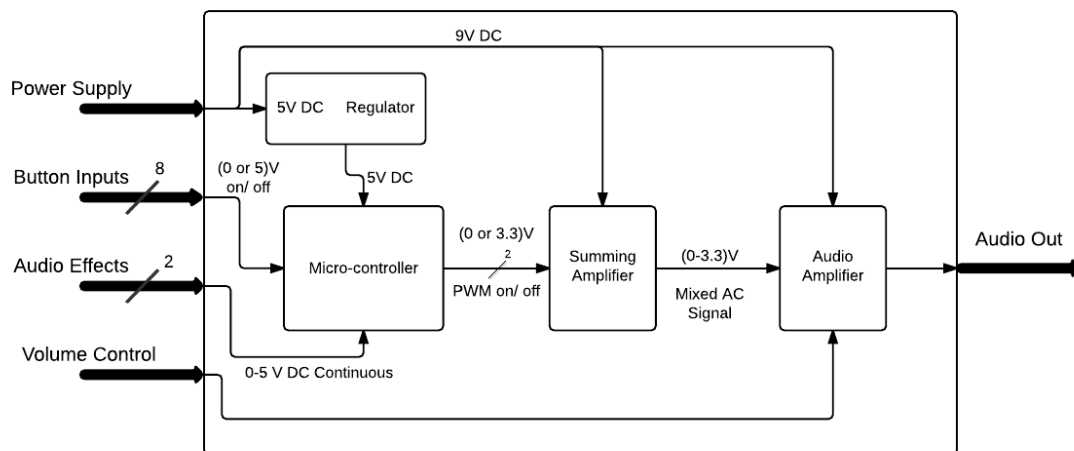
Output:

- **Audio output:** 0-9V audio signal

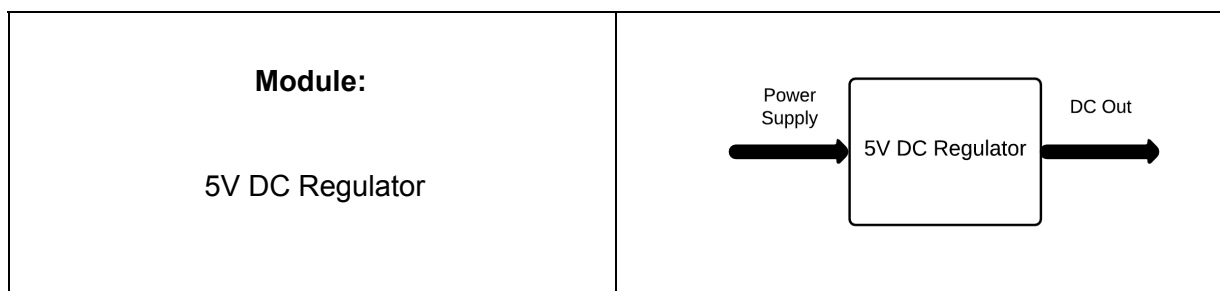
Functionality:

- Produce audio tones based on button and volume/pitch/tone control.
- Tones should be variable based on button status and audio quality should be variable on volume/pitch/tone control status.

Entire System: Level 1 Design Diagram



Level 1 Synthesizer Glove Design



Inputs:

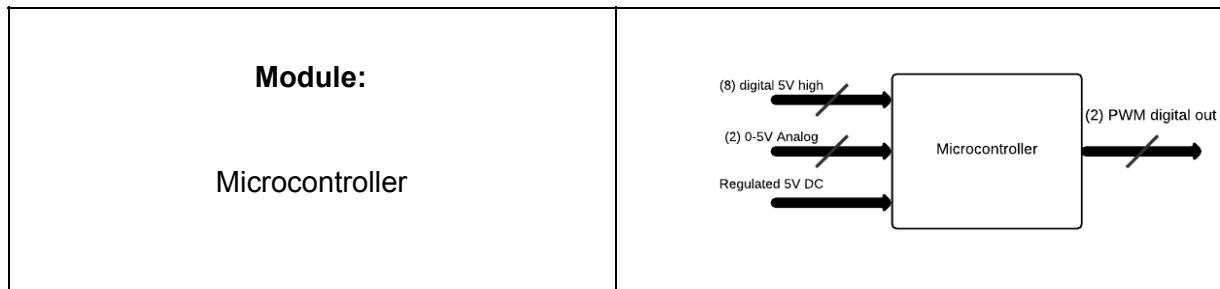
- **Power Supply:** 9V battery

Output:

- **DC Out:** Regulated 5V DC signal

Functionality:

- The input signal enters a 9 to 5 V linear DC to DC voltage regulator.
- The signal is then smoothed using a capacitor $\geq 10\mu\text{F}$.
- The signal is then filtered through a passive RC low-pass filter.



Inputs:

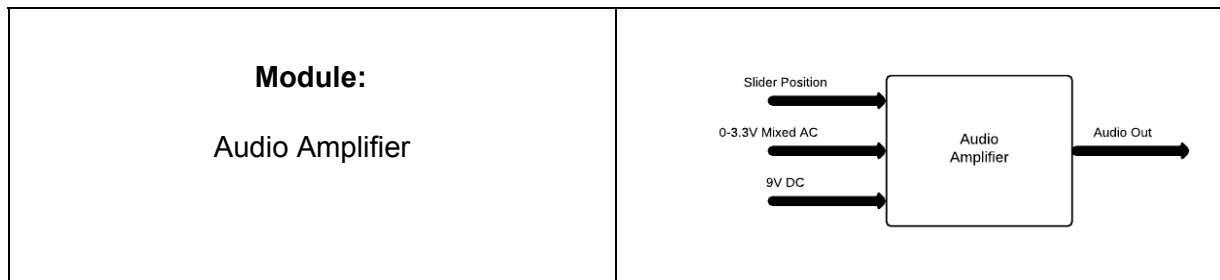
- **Digital 5V High:** 8 total digital signals with a 5V logic high. 3 signals from the vambrace control unit, and 5 signals from the push buttons in the glove.
- **0-5V Analog:** 2 analog signals ranging from 0 to 5 volts from the vambrace control unit.
- **Regulated 5V DC:** Regulated 5V DC voltage from the voltage regulator block for power.

Output:

- **PWM Digital Out:** 5 total pulse width modulated signals outputting to the summing amplifier.

Functionality:

- Produce one or two simultaneous pulse width modulated tones (PWM) based on programmed glove button pushes.
- Shift tones to the next scale up or down, programmatically assigned to the buttons on vambrace unit.
- Read two individual analog voltages based on a two axis joystick. One voltage will shift the programmed PWM tones up and down by pitch, and the other by tone.



Inputs:

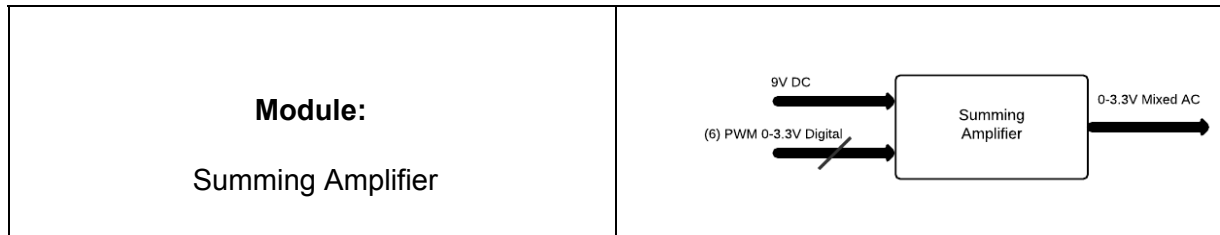
- **Slider Position:** The output of a slider potentiometer controlling the output gain of the amplifier.
- **0-3.3V Mixed AC:** The 0-3.3V mixed AC output of the summing amplifier.
- **9V DC:** 9V DC output of the battery for power.

Output:

- **Audio Out:** An amplified 0-3.3V PWM mixed AC signal.

Functionality:

- Amplifies the 0-3.3 V PWM tones produced by the microcontroller and added together by the summing amp based on the position of the slider potentiometer.



Inputs:

- **9V DC:** 9V DC output of the battery for power.
- **PWM 0-3.3V Digital:** up to six 0-3.3V PWM tones generated by the microcontroller.

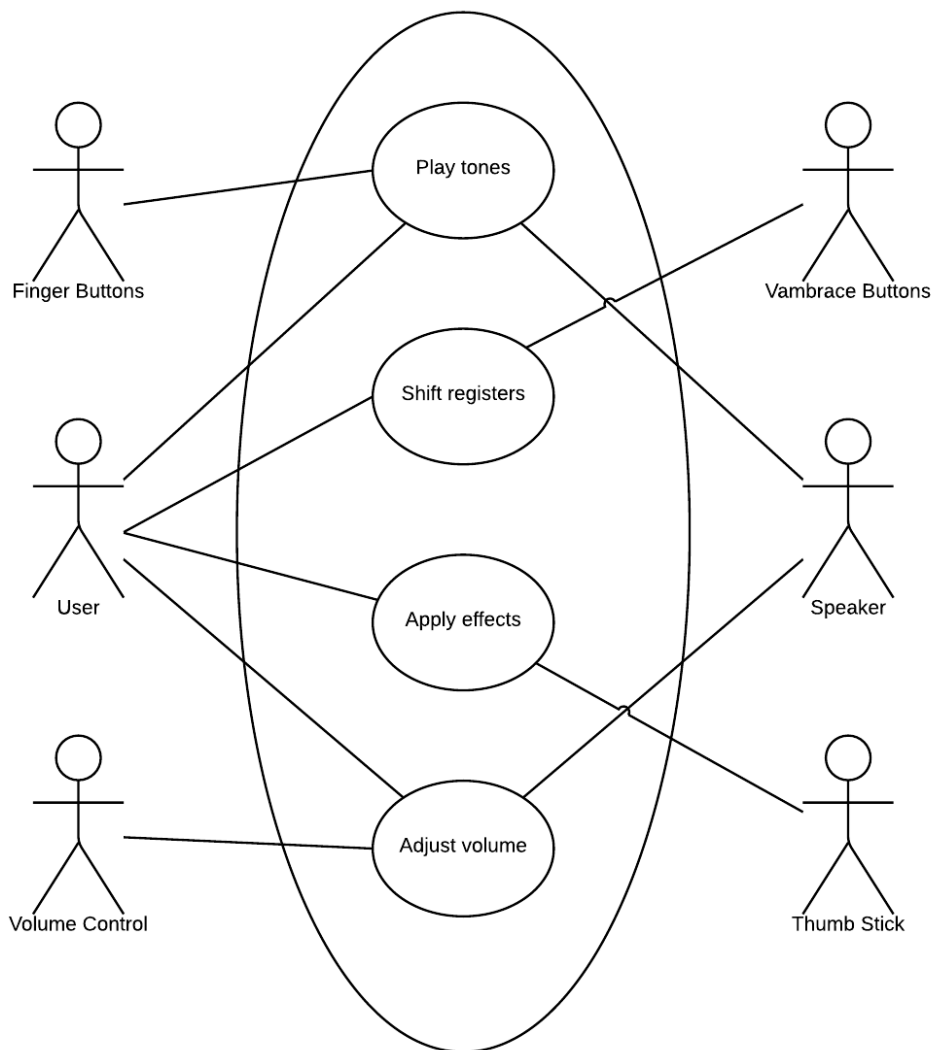
Output:

- **0-3.3V Mixed AC:** 0-3.3V mix of two PWM tones.

Functionality:

- Outputs the sum of the first two generated PWM tones produced by the microcontroller. Only two tones can be played simultaneously.

Entire system: Use Case



Synthesizer Glove Use Case Diagram

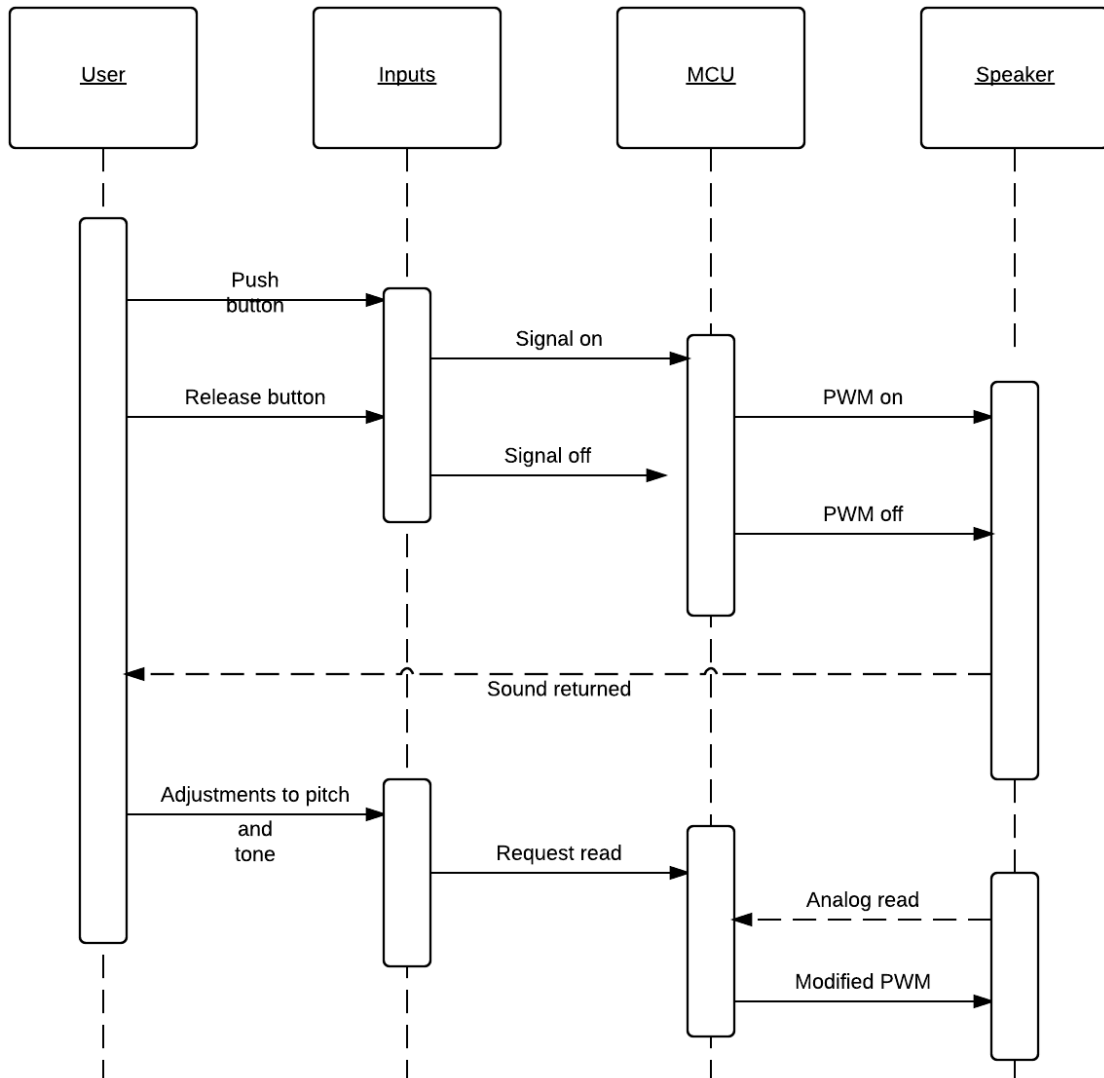
Use Case:	Play Tones
Actors:	User, Finger Buttons, Speaker
Description:	User makes music with right hand playing “piano” style, in glove.
Stimulus:	User presses finger(s) onto a hard surface, forcing momentary switch at finger tip to make contact.
Response:	Speaker produces multiple, scaled, PWM tones in real time corresponding to button pushes and ends tone in real time corresponding to button release.

Use Case:	Shift Registers
Actors:	User, Vambrace Buttons
Description:	User moves current scale (pre-programed notes at fingers) up or down to the next register (continuing the scale in that direction).
Stimulus:	User presses up ,or down, button on surface of Vambrace.
Response:	New base tones are loaded from the tone index into the main program.

Use Case:	Apply Effects
Actors:	User, Thumbstick
Description:	User applies pitchbend and changes tone by moving a small 2 axis joystick located on vambrace.
Stimulus:	Analog voltage applied to pins in micro-controller has shifted do to positional of joystick attached to potentiometers.
Response:	Output response counter is increased or decreased by up to $\pm 12\%$ for one axis, and duty cycle of PWM is varied from 20-80% (centered at 50) in response to the other axis.

Use Case:	Adjust Volume
Actors:	User, Volume Control
Description:	User changes the audible level of the outputted sounds by changing the position of the volume control potentiometer.
Stimulus:	Resistance in the feedback loop of the final amplifier changes.
Response:	Gain is changed according to $V_{out} = \frac{R_{feedback}}{R_{in}} (V_{in})$

Entire System: Sequence Diagram



Micro-controller: State Space Diagram

