

Naturally Augmented Guitar

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Overview

The augmented guitar is an electric guitar which uses sensors in combination with software processing to modulate sound frequencies. The guitar itself may or may not be used as the initial sonic source. In the latter case it can also function as various controllers, such as a midi controller. I will be creating the Naturally Augmented Guitar.

The issue I find with many augmented instruments, especially the augmented guitar, is that implementations generally require a completely different approach to physically playing the instrument. I would like my augmented instrument to fulfill two criteria. The first is that the instrument should remain fully functional as a non-augmented instrument. Second, The augmentations should happen naturally as a consequence of playing the instrument, not by methods which are unrelated to the base instrument when played normally.

For example, if I create an augmented drum kit then perhaps any modulations in software should arise from natural artifacts of drumming, such as the force of each hit. This is preferred in my model to some external motivation such as the level of light in the room or the temperature of the environment in which the drums exist.

Taking Enda Bates' guitar as another example, his augmented guitar is not at all natural. First, it is not in any standard tuning, rendering it useless for 'normal' use. His performance modulations come from the spatial location of the right hand and orientations of the guitar body. Both of these things he modulates after actually strumming, which is why I define them to be external to any natural guitar playing gesture.

My augmented guitar is going to perform software modulations based entirely on the natural aspects of guitar playing.

Sensors Used

A 1.5 in x 1.5 in square force sensitive resistor (FSR) will be attached to the guitar on the back of the neck, below the head and behind the nut.

Another 0.5 in diameter circular FSR will be attached to the guitar pick.

Three soft potentiometer (SoftPot) strips will be attached to the back of the neck of the guitar. Two of them will be 200 mm and one will be 500 mm. When constructing, the 500 mm strip may be a HotPot instead of a SoftPot, depending on sensor availability. They both should be functionally equivalent for this instrument. Three different strips allow more data and better positional accuracy due to the electrical properties of membrane potentiometers. Pressing two points on one strip will give the same value as pressing on some other single point on that same strip.

A six-axis MPU6050 gyroscope/accelerometer will be attached to the head of the guitar. It will be running with onboard Digital Motion Processing (DMP) to derive Euler yaw, pitch, and roll values from the six axis. These values are vulnerable to gimbal lock, however due to the angular nature of the position of a guitar head, this should rarely occur.

A flex sensor will be fitted into a lightweight glove to measure the curvature of the left wrist. This may or may not be implemented depending on how cumbersome the glove is to the playing of the guitar. There is also a possibility that the glove affects the SoftPots.

Performance Gestures Required

I want my instrument to focus on augmenting sounds based on natural performance gestures and style of the guitarist playing it. Therefore, there are no special performance gestures required, aside from use of the hardware.

The FSR on the back of the neck will measure the pressure with which open position chords are played. The FSR on the guitar pick will measure the amount of pressure applied to the guitar pick by the right hand.

Soft potentiometer strips on the back of the neck will be used to measure position of the fretting hand on the guitar.

The MPU6050 on the head of the guitar will technically measure the guitar's orientation, not an actual performance gesture. However, some gestures, such as vibrato, can be derived from this data.

Artistic References

Guitar is an instrument I played heavily for about ten years, from ages eight to eighteen. It is the closest musical extension of myself. By creating an instrument which responds naturally to the performance gestures of the performer, I feel that I can use the guitar as a platform to gain a higher level of expressiveness than if I were to augment some other instrument.

Sound Outcome

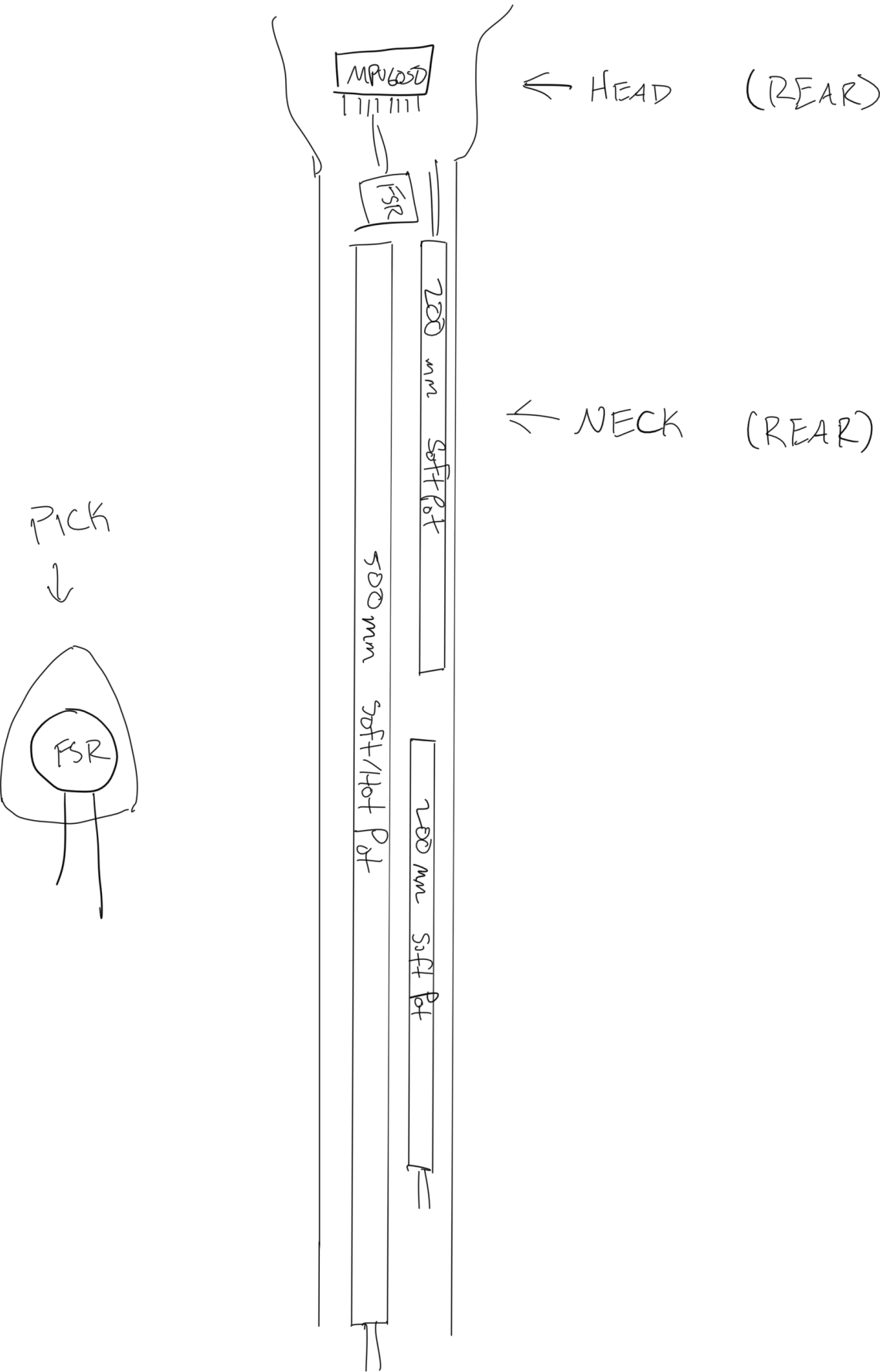
The goal of the Naturally Augmented Guitar is simply to generate data in accordance with the natural performance gestures of guitar playing. Thus, there are no strict sound outcomes associated with the instrument.

One example of a sound outcome could be to use the yaw, pitch, and roll values to control the envelope of the guitar signal itself. I could map yaw to attack, pitch to decay, and roll to release.

The FSR on the neck might map to some time/phase effect commonly found with guitar such as chorus, delay, or reverb. The other FSR on the pick will possibly be mapped to the distortion level of the signal.

While I could continually map the values of the SoftPots to other effects, I will do something different here. Values coming from the SoftPots will be used to synthesize some sort of accompaniment for the guitar. This will demonstrate how the augmented system can be used as a general controller as well as a signal processor.

Diagram



Links

Square FSR

https://www.amazon.com/gp/product/B00B887DBC/ref=oh_aui_detailpage_o01_s00?ie=UTF8&psc=1

Circular FSR

https://www.amazon.com/SENSING-RESISTOR-CIRCLE-1oz-22LB-FLEXIBLE/dp/B00B887CLS/ref=sr_1_3?s=industrial&ie=UTF8&qid=1524955596&sr=1-3&keywords=0.5+in+fsr

500 mm HotPot

https://www.amazon.com/SPECTRA-SYMBOLLINEAR-HOTPOT-500-MM/dp/B00FPXIBXU/ref=pd_sbs_328_2?__encoding=UTF8&pd_rd_i=B00FPXIBXU&pd_rd_r=E5E02TDHPB4VSEH7Y0HQ&pd_rd_w=PgOp5&pd_rd_wg=oZd96&psc=1&refRID=E5E02TDHPB4VSEH7Y0HQ

200 mm SoftPot

https://www.amazon.com/SPECTRA-SYMBOL-SoftPot-Membrane-Potentiometer/dp/B004G4XUT4/ref=pd_sbs_328_1?__encoding=UTF8&pd_rd_i=B004G4XUT4&pd_rd_r=B74A8996831R26MG8PDR&pd_rd_w=vE1AN&pd_rd_wg=yHmvE&psc=1&refRID=B74A8996831R26MG8PDR

MPU 6050

https://www.amazon.com/gp/product/B008BOPN40/ref=oh_aui_detailpage_o04_s00?ie=UTF8&psc=1

Flex Sensor

https://www.amazon.com/Adafruit-Long-Flex-sensor-ADA182/dp/B01BNNNS5Q/ref=pd_sbs_147_2?__encoding=UTF8&pd_rd_i=B01BNNNS5Q&pd_rd_r=N8E1BA231KX5JFVCEGPQ&pd_rd_w=agg10&pd_rd_wg=E6QIS&psc=1&refRID=N8E1BA231KX5JFVCEGPQ

Enda Bates

<http://endabates.net/EndaBates-AugmentedGuitar.html>