**GuitarBot  
A RobOrchestra VII Project**

Andrew Burks, Gerald Carlson, Daniel Curhan, Philip Bailey, Young Won Kim

**ABSTRACT**GuitarBot is a new project under the RobOrchestra umbrella that consists of multiple individual string modules that interact both with each other and with the rest of the RobOrchestra. There are two versions that we are going to create – a sliding fret version and an articulated arm version – and we will compare the performance of each, and replicate the better version to create the final GuitarBot assembly. There is a complex software aspect to the project as well, where the software will need to distribute the notes that the instrument is given across the various string modules that are connected together.

**RESEARCH SIGNIFICANCE**Traditional guitars use human fingers to press a string against a fret to confine the vibrations of a string to a certain length of the string, producing a note of a specific frequency. If we want to break this down and simplify it so that a machine can replicate the sounds of a guitar, there are two aspects of guitar playing that are significant.

The first is the pressure of the finger on the string. How hard do our fingers press the strings down to play a note cleanly? What happens when there are no frets? Does the string need to be held by something soft to emulate a human fingertip, or can it be clamped between two hard surfaces?

The second aspect of our research will be to look into producing pitches from the string. What is the best way to confine the string’s vibrations to a specific length? Would sliding a single fret applying constant pressure to the string work better than articulated fingers against a fretboard? Or would a single articulated finger mechanism fixed at the end of the neck be able to play notes in all the positions on the fretboard for a single string?

Finally, once we have several working versions of an isolated modular string mechanism, how should the algorithm to join the strings together be approached? Since each string will have some overlap of notes with one or more of the other strings, how will the program determine which string to play the note on? When a chord is given, which strings get which notes? We need to develop an algorithm to autonomously distribute a wide range of notes over several strings. The end goal is to be able to present the robot with a MIDI input and have it play what is given, automatically making decisions about note and string distribution and timing.

**PROJECT DESIGN AND FEASIBILITY**GuitarBot is a guitar playing robot that will consist of modular single-string mechanisms that combine together to be controllable as one unit. There are two planned versions of this mechanism – a sliding fret version that uses a sliding carriage to apply constant pressure to the guitar string at various positions along its length, and an articulated arm mechanism that uses a linkage mechanism with two or three degrees of rotation to press against the string at various positions along its length.

As a sub-project of RobOrchestra, the GuitarBot team is experienced with designing robots and seeing them through to completion. We are planning on adding GuitarBot to our growing collection of instruments. We learned quite a bit last year from our Whamola project about making guitar pickups, string plucking/picking mechanisms, and sensors, so we are planning on using many similar ideas in GuitarBot.

In particular, we plan on capitalizing on what we learned about the idea of finite vs. relative sensors. A relative sensor, such as an optical encoder, may be a good option for a pick-wheel mechanism, but when a mechanism needs to travel to very specific absolute positions, an absolute sensor may be better. There is nothing like an optical encoder sold as an absolute “sensor,” but we have found that a multiple-turn potentiometer works well on an absolute sensing scale, simply mapping an absolute voltage (or resistance) to an absolute position. This will be utilized in the sliding fret version of the pitch selection mechanism.

For the articulated finger/arm mechanism, we will be utilizing the ideas of kinematics to determine the position of the finger along the string, and write software to map pre-specified positions to the servo motors controlling the mechanism. This method has a certain aesthetic appeal as well – a moving, articulating arm looks quite “robotic” and will give a certain authenticity and “cool factor” to the GuitarBot.

The pick-wheel mechanism will involve an IR LED pair looking through holes in an aluminum part, providing a variable photoresistance as feedback to the microcontroller. This will let the controller know when the wheel has completed a quarter of a turn. It is essentially the same picking mechanism we used with success on Whamola.

RobOrchestra has also done significant work in unifying the computer interfaces to all our instruments, and in writing algorithms to allow them to play together. GuitarBot would utilize these programs, as well as develop new GuitarBot-specific programs to distribute notes among several strings that may have ranges which overlap by a few notes. This will allow GuitarBot to synchronize with the rest of the RobOrchestra effortlessly, and help to diversify the “orchestra.”

**APPLICANTS**

Project Leader: Dan Curhan

Senior Members: Andrew Burks, Gerald Carlson

Junior Members: Philip Bailey, Young Won Kim

**FACULTY ADVISOR**

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**FEEDBACK AND EVALUATION**Since GuitarBot is a sub-project of RobOrchestra, the group meets both with RobOrchestra, to discuss the “big picture” and the RobOrchestra project as a whole, as well as integration of each instrument with the orchestra, and separately to discuss GuitarBot specifics and do physical work on the project. Thus, GuitarBot members meet twice each week to discuss progress, plan our next steps, and actually work on the robots.

**DISSEMINATION OF KNOWLEDGE**RobOrchestra puts on several “performances” each year, of which GuitarBot will be a part. These performances display our robots collaborating together, and allow us to introduce our project and answer any questions the audience may have regarding it. We also have demonstrations for grade school students who are interested in robotics, and post full documentation on our website. This documentation details our algorithms and instrument designs, and includes photos of the build processes and videos of our performances.

**TIMELINE**Fall Semester:

* secure funding
* finalize designs
* order parts
* begin preliminary programming work
* have working mechanical system for sliding fret mechanism

Spring Semester:

* complete sliding fret version
* complete articulated arm mechanism
* integrate GuitarBots into RobOrchestra
* replicate the version that works best
* complete algorithm for note selection

**BUDGET**

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| --- | --- | --- | --- |
| **Description** | **Qty** | **Price** | **Total** |
| Arduino MEGA | 2 | $64.95 | $129.90 |
| PK27 Geared Motor 27:1 | 1 | $47.99 | $47.99 |
| ML-50 Geared Motor 50:1 | 2 | $26.95 | $53.90 |
| Timing Belt – XL 50in | 1 | $9.75 | $9.75 |
| Timing Belt Pulleys – XL 24 tooth | 2 | $23.47 | $46.94 |
| Savox SC-1251MG Servo | 3 | $62.99 | $188.97 |
| 12V 29A Switching Power Supply | 1 | $78.00 | $78.00 |
| 304 Stainless Flat Bar – 0.25” x 3” x 36” | 2 | $45.62 | $91.24 |
| 6061-T6 Aluminum Angle – 2” x 2” x 0.125” x 12” | 3 | $2.96 | $8.88 |
| 6061-T6 Aluminum Angle – 3” x 3” x 0.1875” x 12” | 2 | $5.99 | $11.98 |
| Guitar Tuning Pegs | 1 | $5.99 | $5.99 |
| Polycarbonate – 0.5” x 4” x 48” | 1 | $38.14 | $38.14 |
| 0.25” ID Ball Bearings | 6 | $10.17 | $61.02 |
| 0.5” 1/4-20 Machine Screws (25x) | 1 | $8.13 | $8.13 |
| 1.5” 1/4-20 Machine Screws (10x) | 1 | $6.45 | $6.45 |
| Delrin – 1” x 3” x 12” | 1 | $32.31 | $32.31 |
|  |  | **TOTAL:** | $792.64 |

**PARTIAL DESIGN RENDERS:** sliding fret mechanism

