

RoboTune

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Group 14

1 Problem Statement

In order to play with any degree of tonal accuracy, a brass instrument's tuning slide must be adjusted to a position in which any desired note can be played in tune. A musician will typically center their tuning around a given note, which will tune the other notes by proxy. However, regardless of which note the instrument is tuned to, there will always exist notes that will be out of tune without the conscious adjustment of the pitch by the musician via their embouchure. Even with skilled musicians, this adjustment will never produce perfect intonation. This product seeks to change this by using the power of computation to produce an auto-tuner that listens, interprets, and adjusts the pitch of brass instruments via a device that continuously pushes and pulls the tuning slide.

2 Background Information

- One of the greatest factors in producing a quality sound in music is ensuring that all instruments are tuned to a common pitch. However, slight individual variations in tuning can lead to a reduced sound quality. You could imagine how 10 people singing the same pitch sound much better than 10 people singing slightly different pitches. The latter will not sound as good or project as well as the prior group. This device is a tool that can make micro-adjustments in pitch in order to make a brass instrument play perfectly in tune. On an individual level, a tuner that makes such small adjustments has little practicality. However, on the scale of a large marching band, giving the band the ability to play perfectly in tune will lead to a much bigger and purer sound that projects much better than usual.
- Tuners have existed for a long time and the same can be said for auto-tuners. However, auto-tuning a brass instrument is something that has never been done before. Since the sound does not involve any electronics, the only way to auto-tune the horn is to make mechanical adjustments.
- Typically a musician will adjust the pitch by listening and using their embouchure or slide. This is limited by a musician's ear. A musician doesn't have the ability to play any note perfectly in tune at all times, but computers do.

3 Requirements

Functional Requirements

Software

1. As a user, I would like my brass instrument to continuously tune itself while playing.
2. As a user, I would like an auto-tuning device that can be compatible with as many brass instruments as possible via software and hardware configurations.
3. As a user, I would like a desktop application that I can use to configure the device to my specific needs.
4. I would like to be able to reinstall the software on my tuner via the desktop application if the software becomes corrupted (if time allows.)
5. As a user, I would like to know the note the tuner reads. (Desktop App)
6. As a user, I would like to be able to visualize the tuning analysis in a graphical format that shows me how far off pitch I am. (Desktop App)
7. As a user, I would like to be able to easily find the specifications of the hardware. (Desktop App)

8. As a user, I would like to be able to regulate the speed that the tuning slide is adjusted. (Desktop App)
9. As a user, I would like to see my tuning tendencies for specific notes over a given playing period. (For example: B3 is 7 cents sharp on average when played.) (Desktop App)
10. As a user, I would like to be able to access the CAD designs of any custom built parts. (Desktop App)
11. As a user, I would like to input the length of the tuning slide so that the tuner doesn't push it farther than it can go. (Desktop App)
12. As a user, I would like the tuner to turn off after a desired period of inactivity.
13. As a user, I would like the tuner to enter sleep mode after the instrument has not been played for a desired period (if time allows.)
14. As a user, I would like to define limits on the tuning slide's range for certain performances (if time allows.) (Desktop App)
15. As a user, I would like to save sets of hardware configurations for easier instrument swapping. (Desktop App)
16. As a user, I would like a way to export my saved settings. (Desktop App)

17. As a user, I would like a way to import saved settings. (Desktop App)
18. As a user, I would like the tuner to stop moving if it encounters significant forces that oppose the movement of the tuning slide.
19. As a user, I would like to have mode that does not automatically correct the tuning, but will play a reference pitch for the note that I'm trying to play instead (if time allows.)
20. As a user, I would like to have multiple settings that allow me to configure the precision that the device will attempt to tune with. (Desktop App)
21. As a user, I would like to have a manual that explains how to use the device. (Desktop App)

Hardware

Note: most unessential hardware can fall under "if time allows." We are focused on developing the software above all else. Although this is a software project, the hardware is an important aspect of creating a functional device, so we included it as well.

1. As a user, I would like the hardware to not apply any damage to the instrument.
2. As a user, I would like the hardware to be removable.
3. As a user, I would like the hardware to be easy to attach to the instrument.

4. As a user, I would like the hardware to fit reasonably within the dimensions of the instrument.
5. As a user, I don't want a lot of hanging wires that could interfere with my performance.
6. As a user, I would like the tuner to be able to withstand damage.
7. As a user, I would like the tuner to be water resistant.
8. As a user, I would like to be able to turn the auto tuner on and off easily.
9. As a user, I would like the motor to not stall during play.
10. As a user, I would like an indicator that battery life is low.
11. As a user, I would like an indicator that there is too much resistance.

Non-functional Requirements

Software

- The product's user interface for visualizing data and setting the product's configurations should be intuitive and easy to navigate. It will be run on a Windows desktop application. The device itself will be connected via USB. There will be different tabs that allow the user to access things like tuning analysis, configuration settings, and the user manual.

- The product should be able to bring the instrument within 5 cents of the desired pitch. The software should be able to interpret the pitch of the horn in well under 1 second. This will vary depending on the complexity of the tuning algorithm. There will be multiple options for algorithms, which will be how the device will tune with a configurable amount of precision. The software will stop the movement of the slide if it does not detect a change in pitch after adjustments are made. It will assume that the slide is stuck. This will be to keep the tuner from damaging the instrument.

Hardware

The hardware should be minimal and not interfere with the musician's ability to play. This includes not exceeding more than 1 kg in weight and not being distracting in any way. It should also be conveniently stored away and be able to be attached and removed without damaging the horn. The battery should also last at least three hours in order to last through most performances.