



# The Flote: An Instrument for People with Limited Mobility

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## ABSTRACT

The Flote is a wind instrument designed for people with limited mobility. Past work in this area has failed to deliver the musical expressiveness expected of an instrument while maintaining the low cost required for wide adoption. Using only head movement and breath control, both calibrated to match the player's abilities, the Flote is an avenue for creative expression and an enjoyable form of physical therapy. The software is available as a free download at <http://www.theflote.com>, and the hardware can be easily built by anyone with minimal familiarity with circuits.

## Categories and Subject Descriptors

H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems; H.5.2 [Information Interfaces and Presentation]: User Interfaces; H.5.5 [Information Interfaces and Presentation]: Sound and Music Computing

## General Terms

Design, Experimentation, Human Factors

## Keywords

Musical instrument, expressiveness, limited mobility

## 1. INTRODUCTION

The main hardware component of the Flote is a headset with a boom microphone [fig.1]. Notes are produced when the player blows directly onto the microphone. An infrared emitting diode (IRED) on the boom arm allows a webcam to track the player's head movements. As the player tilts his or her head up and down, the pitch rises and falls. Software tracks the head movement and breath input and provides a visual interface for the player.



Figure 1. The adapted headset, with IREDs.

One of our main goals is to create an instrument that is accessible in terms of both playability and cost. To accomplish this, we needed to design an instrument that could be easily fabricated from readily available parts. The Flote can be easily built by people regardless of their experience with electronics, with the help of online instructions.

## 2. PREVIOUS WORK

Projects such as Hyperscore [1] have helped people with disabilities express themselves creatively as composers. Though they offer an enjoyable experience, such projects lack the real-time interaction offered by a musical instrument. Work done by the Adaptive Use Group at the Deep Listening Institute [2] uses a webcam to track distinct points on the user's face, mapping them directly onto a piano keyboard; moving one's head left to right triggers different notes. However, without a method to access non-sequential notes—to vary intervals—the interaction has limited musical potential. The Magic Flute [3] attempts to address this, adding breath control to increase potential expressiveness. But while the Adaptive Use project is freeware, The Magic Flute requires expensive proprietary hardware. Our early attempts used a Nintendo Wiimote for IR tracking, an air pressure sensor for breath control and a micro-controller. While this was successful as an expressive instrument, it required extensive specialized skills to build. With the new version, we simplified the process of

creating a musical instrument while maintaining full expressiveness.

### 3. THE SOFTWARE

#### 3.1 Breath Input

The Flote works like any traditional wind instrument: the harder the player blows, the louder the note. A calibration process, performed each time the software is loaded, adjusts the sensitivity of the breath control to a range that is comfortable for the individual player. The audio input from the microphone is sent through a low-pass filter set at 5 Hz, filtering out the audible range while retaining breath pressure information. This eliminates false triggering by both external sound sources and feedback from the instrument itself.

#### 3.2 Motion Tracking

Using a webcam and a simple visible light filter for motion tracking makes the Flote inexpensive and easy to assemble. The filter itself is a sheet of developed, unexposed slide film, which blocks most visible light and isolates the IRED. This way the computer can easily differentiate the IRED's light and track its movement. In order to ensure that anyone can use the Flote, the tracking system is customized on a per-user basis. Initial calibration of the instrument allows users to define their comfortable range of movement, either on a vertical or horizontal axis. The range of linear movement is then mapped onto the scale of playable notes; regardless of the user's range of motion, each individual is capable of accessing the same range of notes.

#### 3.3 User Interface

Our goal with the interface is to provide straightforward visualizations and feedback for the head tracking, for different playing modes, and for the calibration sequence (Figure 2). The focus of the interface is the staff and the note indicator. The staff reflects the current note, responding to the player's head movement. Above it, the note name is displayed, surrounded by a green rectangle that darkens with increased volume. A visualization of the tracking position is displayed to the right of the staff; a yellow border around the tracking figure warns when the player has moved out of the webcam's view. The Flote has two performance modes, which are selected using a checkbox labeled "mode" via the control panel on the user interface. In the default mode ("unlocked"), the player's movements directly change the pitch of the instrument. In locked mode, once a note has been begun, the player is free to move without changing the pitch. The larger note indicator will remain static, reflecting the current pitch output, but the smaller indicator will track the change in movement. This allows the player to move into position to prepare for the next note while still playing the current note.

The default key for the Flote is C major (no sharps or flats). Clicking on the "menu" button, and then the "set root" button, changes the key. All notes become available to the player and the first note triggered becomes the new root. The majority of the people who participated in user testing had little or no musical

training. They approached the instrument by moving their heads and reacting to the sounds this produced. As they continued to play music, they remembered and responded to the written musical notes. Several users indicated an interest in composing music. The Flote could potentially be used as a teaching tool for learning to read sheet music.

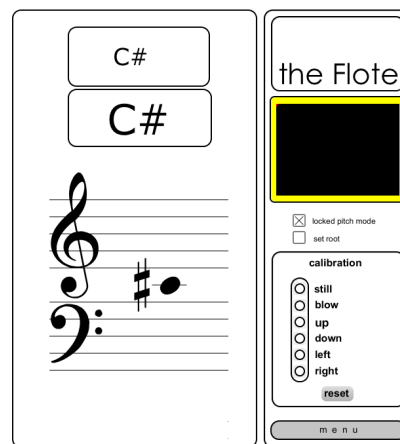


Figure 2. The software interface.

### 4. THE HARDWARE

Besides the headset, the main electronic component of the Flote is a simple circuit consisting of an IRED, a power source (battery or USB), and a single resistor. The IRED is mounted on the mic boom arm of the headset for maximum visibility by the webcam. Optionally, a cluster of three IREDs can be used to ensure consistent tracking.

### 5. FUTURE WORK

Future versions of the Flote will add a feature that outputs MIDI to an external synthesizer for a much broader tonal palette. One possible way to implement this would involve including a VST host. The addition of automatic calibration will allow the player to be more independent.

### 6. ACKNOWLEDGMENTS

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