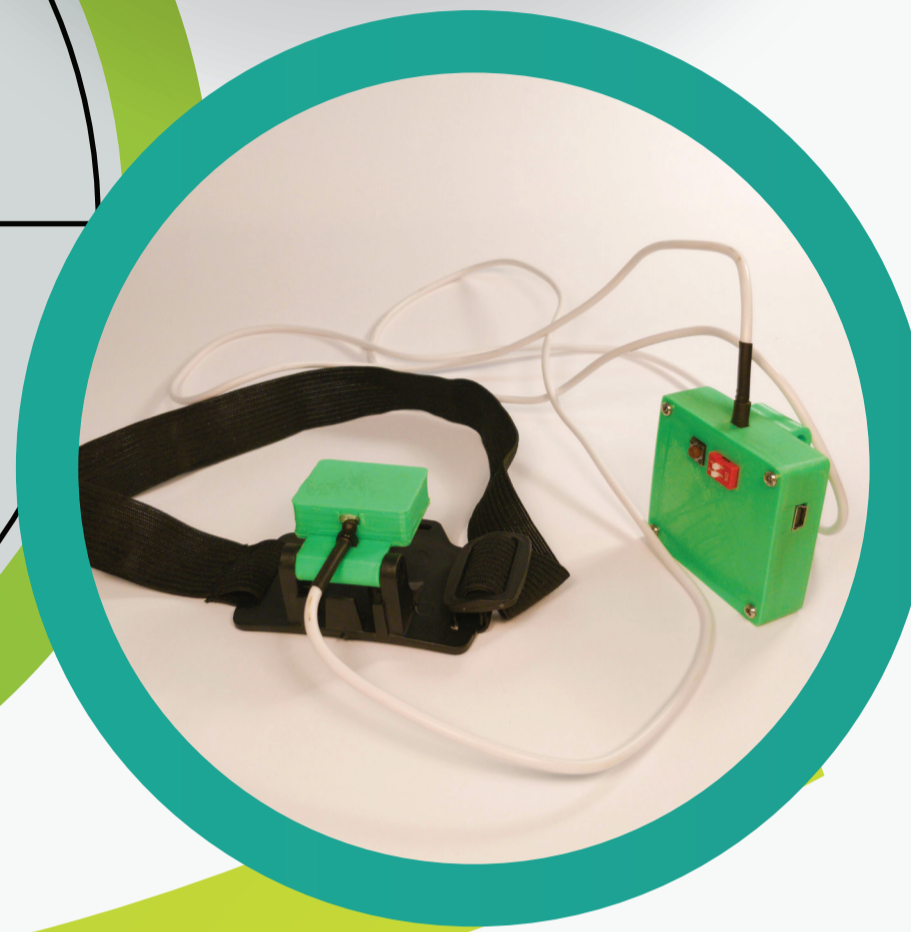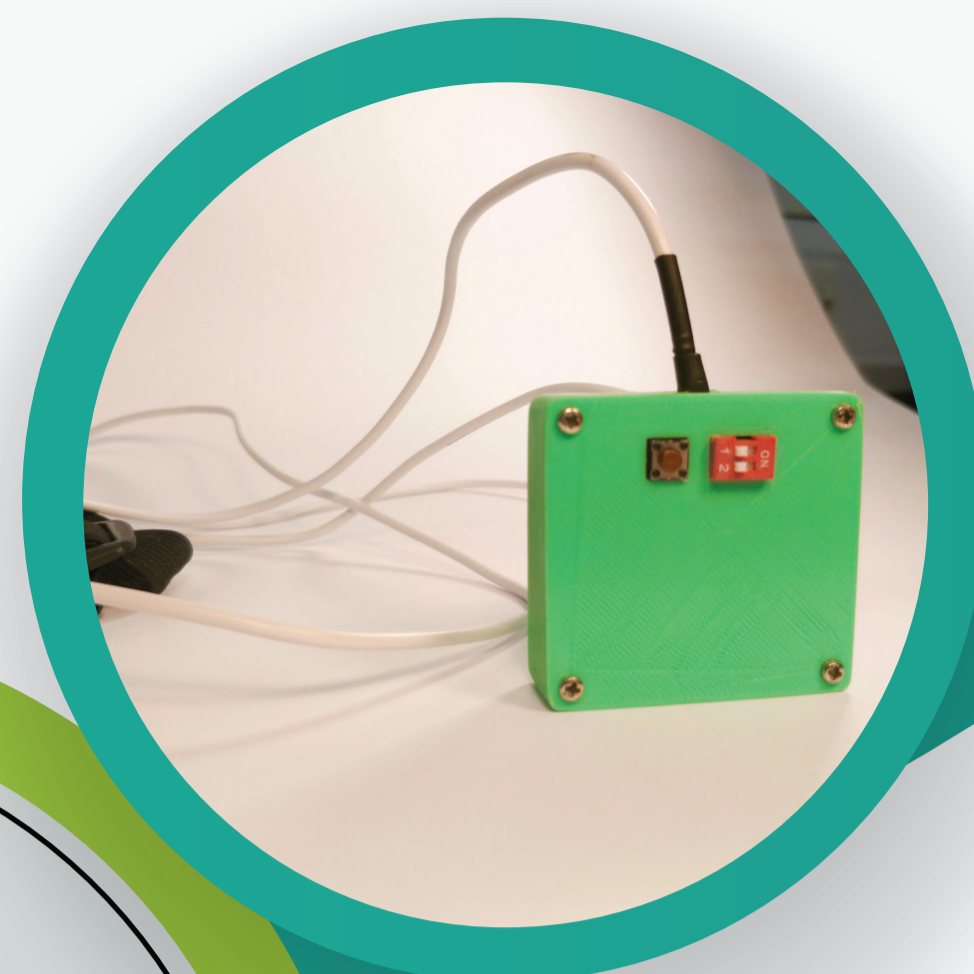# IMPLEMENTATION AND EVALUATION OF BINAURAL MONITORING FOR LIVE MUSIC PRODUCTION

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BACKGROUND RESEARCH

Previous research underlines three important aspects to be considered for a better binaural representation: Using reverberation results in a significant difference in the sound externalization, with 79% of the sources being perceived "outside the head" in reverberant conditions, as opposed to 40% for an anechoic situation.

An additional increase of 16% in sound externalization and solving the front-back confusions is the help of visual cues, which in a live performance situation can take the form of dummy monitors, amplifier cabinets and even musicians themselves.

A final important help for a better binaural rendering is head tracking. Experiments show an improvement of around 17% in sound localization when head movements are allowed and an improvement from 59% to 29% for front-back and back-front confusions.

INTRODUCTION

In-ear monitoring is becoming more and more popular with touring musicians, slowly taking over the well-established wedge monitoring system.

Obvious advantages such as a better **clarity** and **control** of the individual mix, better perceived **segregation** of the instruments as well as increased **portability** and **consistency**, make this system the preferred way of increasingly more artists. However, some drawbacks were observed for the in-ear monitoring system, in the form of a **decrease in the perceived space** and the feeling of being **detached** from the rest of the band.
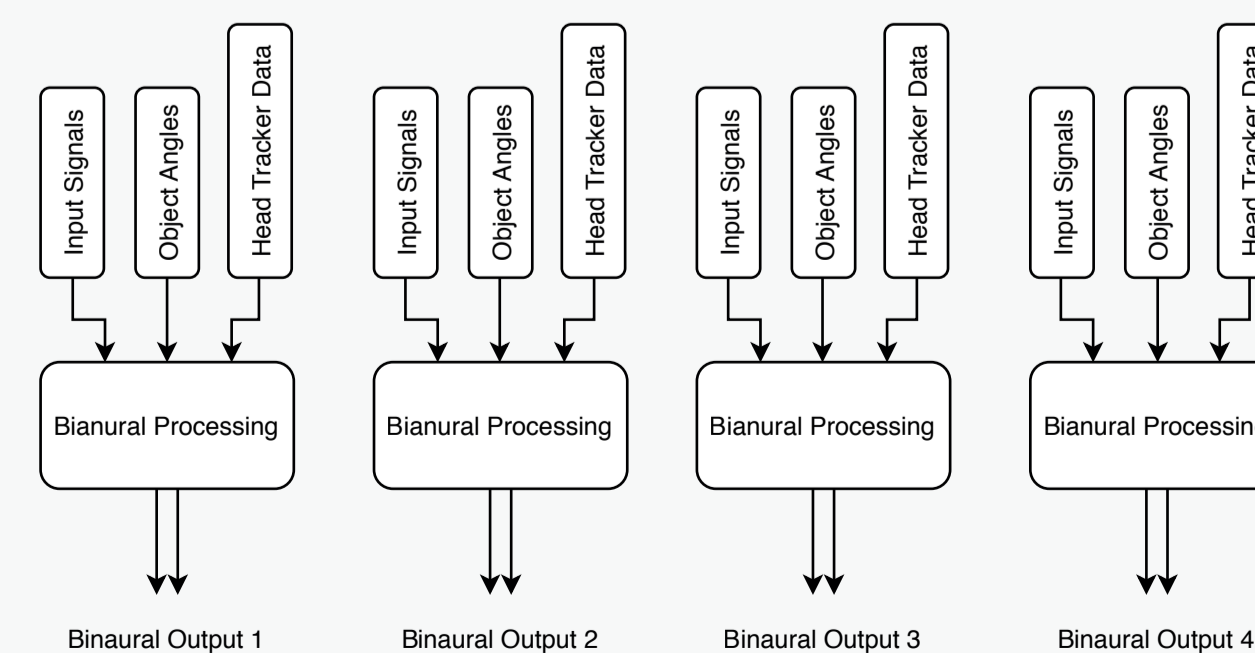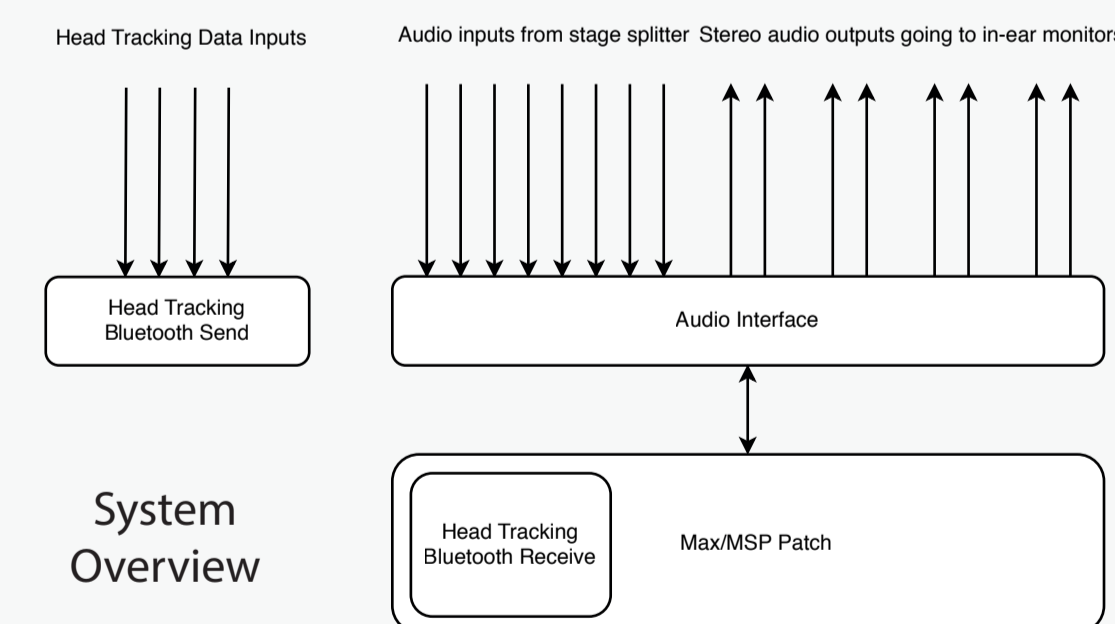
MOTIVATION AND RESEARCH AIMS

Binaural rendering can offer a multitude of possibilities in order to solve some of the existing shortcomings in the stereo in-ear system. The ability to pan the sound sources in a fully immersive sphere, along with real time head tracking should give a very natural feeling of the performance. The usage of personalized HRTFs (Head Related Transfer Functions) along with custom RIRs (Room Impulse Responses) can also have a big impact on the overall quality and musical experience.

Two important research questions are:
- ◆ Do artists prefer binaural in-ear monitoring to the traditional stereo method?
- ◆ Which is the preferred binaural monitoring set-up?
  - ◇ Wedge position
  - ◇ Fully immersive object position

IMPLEMENTATION AND SYSTEM OVERVIEW

The monitoring system was developed in MAX/MSP and allows for 8 input channels to be processed in real time, for up to four musicians. Four head trackers were developed and built, which connect to the MAX patch via Bluetooth. They transmit information about the position of an artist's head, allowing the sound sources to remain fixed, relative to the stage.
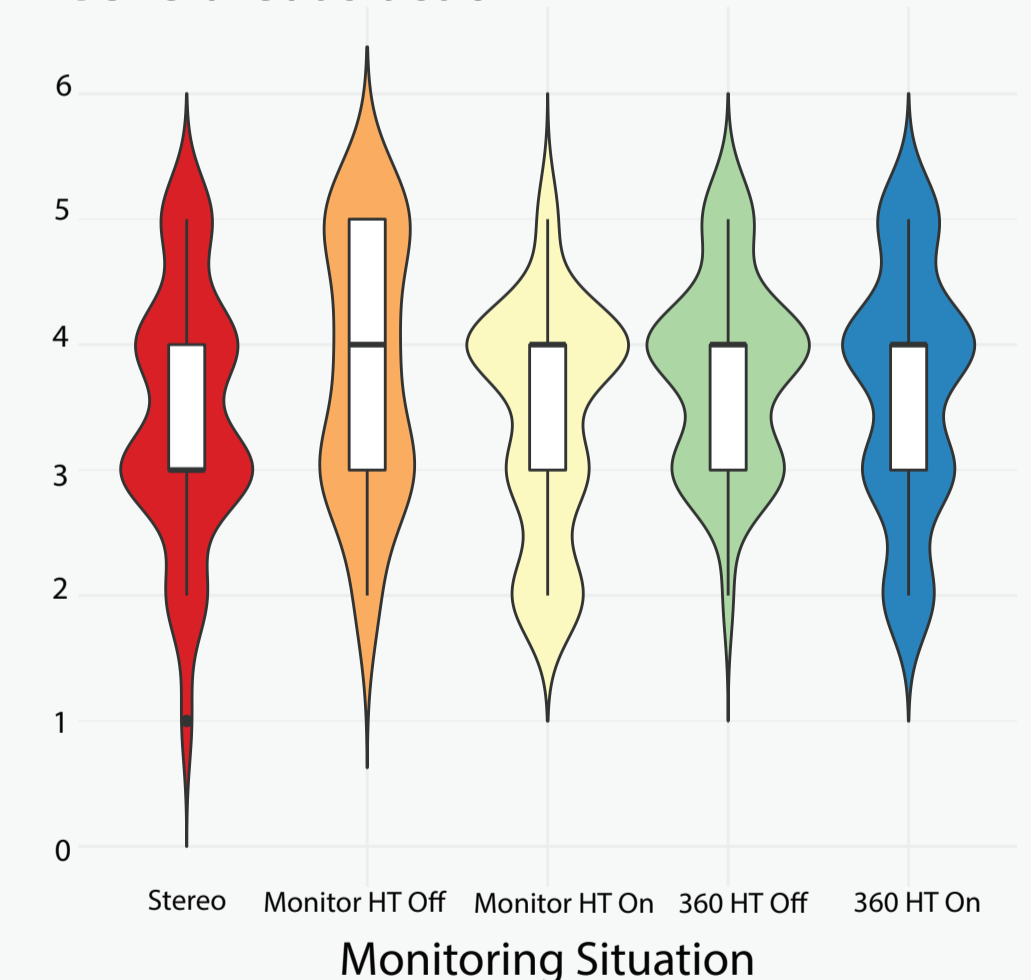
Head Tracking Data Inputs   Audio inputs from stage splitter Stereo audio outputs going to in-ear monitors

Head Tracking Bluetooth Send

Audio Interface

System Overview

Head Tracking Bluetooth Receive   Max/MSP Patch

Input Signals | Object Angles | Head Tracker Data
Input Signals | Object Angles | Head Tracker Data
Input Signals | Object Angles | Head Tracker Data
Input Signals | Object Angles | Head Tracker Data

Bianural Processing   Bianural Processing   Bianural Processing   Bianural Processing

Binaural Output 1   Binaural Output 2   Binaural Output 3   Binaural Output 4

MAX/MSP Patch

TESTING AND RESULTS

Three bands took part in testing this system, by playing short musical fragments under different monitoring conditions and grading certain aspects of the performance on a scale from 1 to 5. A brief look at the results shows that even though there is no significant difference in terms of user satisfaction, there is however a slight increase in satisfaction with using the binaural method over the stereo one. These results are encouraging, opening the possibility for more in-depth research and for understanding how each variable affects the overall experience of a musician.

General Satisfaction

Stereo | Monitor HT Off | Monitor HT On | 360 HT Off | 360 HT On

Monitoring Situation

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Berg, J., Johannesson, T., Löfdahl, M., & Nykänen, A. (2017). In-Ear vs. Loudspeaker Monitoring for Live Sound and the Effect on Audio Quality Attributes and Musical Performance. Presented at the Audio Engineering Society Convention 142, Audio Engineering Society.

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