PAPAGEI: An Extensible Automatic Accompaniment System with User-Defined Parametric Mapping

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ABSTRACT
PAPAGEI (Parametric-Algorithmic Patchbay-Accompanist for Generating Events by Improvisation) is an automatic accompaniment system developed by Salman Bakht and based on the algorithmic music composition methods of Clarence Barlow. This paper describes details about the system design, software implementation, and composition and performance details for the realizations presented at the Workshop on Media Arts, Sciences, and Technology (MAST) held at UC Santa Barbara on January 29-30, 2009.

Keywords
Automatic accompaniment, parametric music, algorithmic music, interactive performance, improvisation, pitch detection.

1. INTRODUCTION
PAPAGEI (Parametric-Algorithmic Patchbay-Accompanist for Generating Events by Improvisation), an automatic accompaniment system, was developed initially for use in Clarence Barlow's improvisational flute and electronic piece *resonancia flautomática*, performed by Alan Fabian, Thomas Frey, and Christoph Seibert as part of the sixth annual *COMPUTING MUSIC Concert Series* held in Cologne, Germany on November 9, 2008 (http://www.computing-music.de/english/). However, the system is designed to be flexible and extensible, allowing for compositional and performance experimentation by those with and without programming expertise. At the same time, the system suggests the construction of a unified set of music pieces or performances, which are being presented at the MAST Workshop.

2. SYSTEM DESIGN
In the piece *resonancia flautomática*, a flutist performs improvisationally, the performance being recorded via microphone to be processed in real-time by the PAPAGEI software. The instantaneous pitch of the flute input is detected using a weighted autocorrelation function, a method particularly effective in high-noise environments [2]. The instantaneous pitch along with the RMS level of the signal are used to calculate a number of musical input parameters including pitch register, note density, and loudness. The system maps these input parameters to similar but not equivalent output parameters (note density, metric strength, degree of tonality, respectively). For example, an increase in the input's pitch register will cause an increase in the note density parameter of the output.

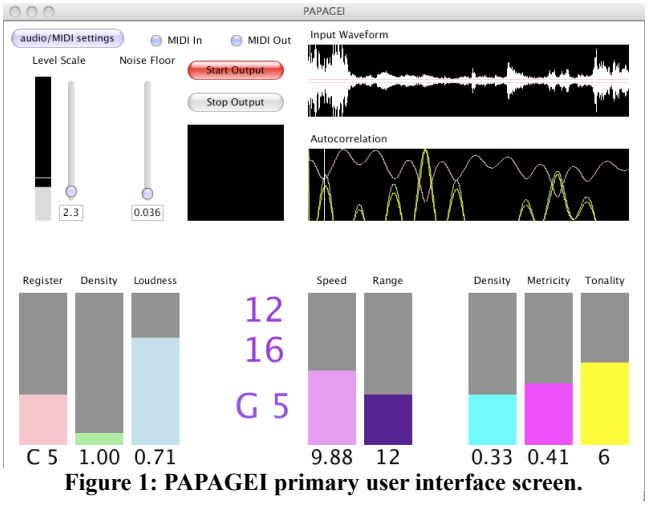

Figure 1: PAPAGEI primary user interface screen.

These output parameters are used to generate a melody that is played with pre-recorded flute samples as an accompaniment. The algorithm for generating this melody is based upon pitch and rhythmic theory developed by Clarence Barlow [1]. The pitch is chosen using a probability function dependent on the keynote (tonic), the previous output pitch, and the desired degree of tonality. The rhythm is also determined by a stochastic process, which depends on the time signature, output density, and desired degree of metricity (metric field strength).

3. MUSICAL COMPOSITIONS
The performance at the MAST Workshop consists of two short pieces that use the the PAPAGEI system. The first piece, written by Clarence Barlow, is closely related to the piece *resonancia flautomática* as it was performed at the *COMPUTING MUSIC Concert Series*, using a live acoustic performer accompanied by a computer-generated melody performed with flute samples as in the first performance. The parameters are mapped the same way as previously although, as an improvisational piece with a different performer, the result may differ greatly.

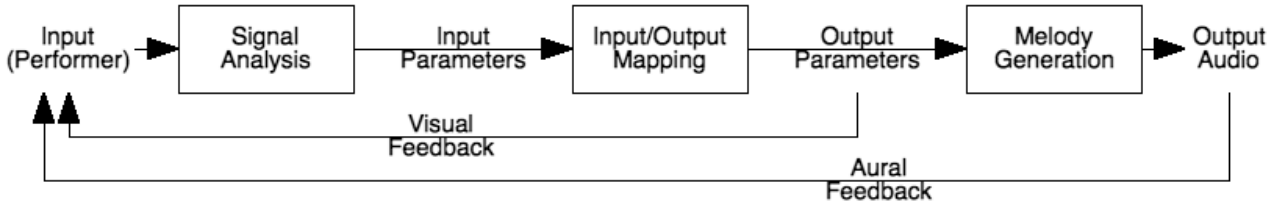

Figure 2: PAPAGEI functional model.

The second piece is a new piece written by Salman Bakht. This piece is for MIDI (Musical Instrument Digital Interface) player piano, which is played simultaneously by a human performer and the computer-generated accompaniment. In this case, the pitch detection and sample playback software modules are not used. Instead, MIDI input messages, derived from the human performer, are processed to generate output MIDI messages that are played acoustically. The parametric mapping in this piece is significantly different from that in the first piece. Additionally, as the piano is polyphonic, the piece considers the possibility of a human performer playing multiple simultaneous notes. Likewise, multiple accompaniment melodies are generated for simultaneous playback (although not in a one-to-one relation).

4. FUTURE WORK

The software was designed with the expectation that future methods of audio analysis and algorithmic composition will be implemented for future compositional needs. Specific plans for extension of the software include:

- Real-time (performance-time) segmentation of input audio for use in output sample bank.
- Implementation of stochastic methods for choosing between multiple output samples.
- Detection of timbral properties of input audio.
- Implementation of parametrically controlled audio processing of output.

When possible, existing audio analysis software packages will be used to add this functionality.

5. REFERENCES

[1] Barlow, C. 1980. Bus Journey to Parametron, Feedback Papers 21-23. Feedback Studio Verlag, Cologne, Germany.

[2] De la Cuadra, P., Master, A., and Sapp, C. 2001. Efficient Pitch Detection Techniques for Interactive Music. In Proceedings of International Computer Music Conference (La Habana, Cuba, September, 2001).