Game of Tones: Learning to Play Songs on a Piano Using Projected Instructions and Games

Linsey Raymaekers
Hasselt University – tUL – iMinds
Expertise Centre for Digital Media
linsey.raymaekers@student.uhasselt.be

Kris Luyten
Hasselt University – tUL – iMinds
Expertise Centre for Digital Media
kris.luyten@uhasselt.be

Jo Vermeulen
Hasselt University – tUL – iMinds
Expertise Centre for Digital Media
jo.vermeulen@uhasselt.be

Karin Coninx
Hasselt University – tUL – iMinds
Expertise Centre for Digital Media
karin.coninx@uhasselt.be

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Abstract
Learning to play a musical instrument such as the piano requires a substantial amount of practice and perseverance in learning to read and play from sheet music. Our interactivity demo allows people to learn to play songs without requiring sheet music reading skills. We project a graphical notation on top of a piano that indicates what key(s) need to be pressed and create a feedback loop that monitors the player's performance. We implemented *The Augmented Piano* (**TAP**), which is a straightforward combination of a physical piano with our alternative notation projected on top. *Piano Attack* (**PAT**) extends TAP with a shooting game that continuously provides game-based incentives for learning to play the piano.

Author Keywords
piano; learning; gaming; music

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous; K.3.1 [Computers And Education]:Computer Uses in Education – Computer-assisted instruction (CAI); H.5.5. Sound and Music Computing.

Introduction

Have you ever wanted to play a song on the piano, but were unable to because you lacked the skills to read and play from the sheet music? Did you hear that new *Muse* song on the radio and wanted to try out the piano part? Our work starts from the frustration that playing most piano pieces requires a certain level of proficiency in reading musical notation. Achieving this level of proficiency takes some time, which can be discouraging to aspiring pianists. We want to democratize piano playing by making it easy and fun to learn music pieces without requiring sheet music reading skills. Although we use an alternative notation, we do not aim to replace sheet music; reading music scores remains an essential skill for versatile pianists. TAP and PAT were created as an incentive for learning to play the piano – especially for people who lack the fluency to read and play from sheet music.

Our demo shows two different ways to employ an alternative notation to sheet music for practicing music pieces; in both cases the alternative notation is projected on top of the piano (Figure 1). One is *The Augmented Piano*, which uses a visualization that is common in many sing- and play-along videogames. The keys that need to be pressed are visualized as blocks that move down towards the physical keys. We will refer to this notation as the '*scrolling note*' notation in the remainder of this paper. The other is *Piano Attack*, which uses the piano keys as a game controller to prevent an alien invasion of the piano. In the next sections we elaborate on both modes.

The Augmented Piano (TAP)

The Augmented Piano (TAP) is the first setup we created. Our scrolling note notation is based on the notation that is well known in piano training software such as Synthesia [1] and in music-rhythm games. These types of games and training software have proven to be a popular way for people to make practice more fun. Recently, Weing et al. presented P.I.A.N.O [2] – a setup that is quite similar to TAP – in which they emphasize how their note notation can be an alternative to the traditional music notation. Other researchers have experimented with different types of visual aids, such as Mirrorfugue [3] that displays recorded piano gestures alongside the actual keys and SynthAR [4] that uses traditional "see-through" AR techniques to augment musical instruments.

Figure 1: The Augmented Piano (TAP) being used by one of the authors to train for right-hand playing.

Figure 1 shows TAP being used by one of the authors. An important advantage of our setup over existing software like Synthesia [1], is that the scrolling note notation and feedback about played notes are mapped onto the keys of a full-size physical piano. Our software generates the scrolling note notation from a MIDI file. The notation is projected using a short-throw projector that is mounted above the piano. The scrolling notes are then projected on a projection surface that is placed on top of the digital piano. The visualization can be scaled according to the

Figure 2: Keys that need to be played are highlighted with a colored circle. The circle's opacity gradually increases as the scrolling note gets closer. When the scrolling note reaches the key, the entire key is highlighted.

piano width (thus piano type) and the available projection surface.

Using the setup is straightforward: when the scrolling note reaches the key, that specific key needs to be pressed. The key itself is gradually highlighted as the note approaches the key (Figure 2). Wrong key presses are highlighted in red. A note's length is represented by the length of the corresponding note bar. The system records how many "hits" and "misses" the user makes and shows a result screen when the song is finished.

Piano Attack (PAT)

On top of TAP, we built *Piano Attack* (PAT): a shooting game that uses the piano as a game controller. In the game, each key (i.e., a single note) or combination of keys (e.g., chords) fires a laser to terminate an incoming alien, as show in Figure 3. Lasers have a limited shooting range, which means that aliens have to be shot in a "shooting area". This concept of a laser with a limited range assists the piano player in keeping the correct tempo, as the piano keys need to be hit when the alien is in the middle of this shooting range. Aliens that survive the shooting zone attack a piano key and can eventually destroy it, resulting in a non-functional key. This implies that the better one plays the game, the more complete and correct the song is played.

There are single aliens (Figure 3 – right) and groups of aliens (Figure 3 – left). Single aliens represent a single note and target only one key. Hitting the corresponding key at the right time can destroy them. Groups of aliens represent chords or intervals and require a player to play the corresponding combination of notes to destroy them. Single aliens might also attack in formation, representing an arpeggiated chord (Figure 3 – top right). The names of notes and chords are explicitly indicated in the visualization. By introducing this game element, PAT also trains for playing chords and chord changes.

Figure 3: In Piano Attack (PAT), playing the song correctly can save your piano. The aliens want to destroy your piano keys. The grey bar in the middle indicates the "shooting area" in which aliens can be hit. Small aliens (right) are killed using single notes, while groups of aliens (left) require a combination of notes to be played simultaneously (e.g., a D chord).

System Setup

The setup consists of four components: (1) a piano, (2) an Epson short-throw projector (EMP-400W, WXGA resolution of 1280 x 800 pixels), (3) a laptop computer, and (4) a projection surface. The piano and projector are connected to the laptop that steers the projection and monitors the performance of the piano player. The piano and laptop communicate using the MIDI protocol. When a piano key or a combination of keys is pressed, the piano sends a MIDI event to the laptop, which then compares it to the currently required key or key combination and timing in the music piece.

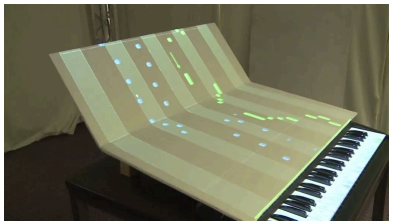

Figure 4: Projection on a sloped surface.

Our setup doesn't require a fixed size surface, but works with pianos of different sizes. We experimented with 61-key and 88-key pianos, as well as with different shapes for the on-top projection surface. Figure 4 shows an alternative surface with about one third of the surface sloped. The slope angle can be changed to fit the players' preferences. Using a sloped surface allows the system to exploit the peripheral view of the pianist. We imagine this can also be useful for other game concepts than the ones presented here.

Tryouts

Both TAP and PAT were demonstrated to and used by a diverse audience: we performed informal evaluations to get early feedback on our approach and tested TAP and PAT at a public event. For TAP, we asked both novice players as well as trained musicians to try the system out and provide feedback. Among those users there were non-proficient piano playing youngsters and young adults that were immediately enthusiastic and expressed the desire to use the system for a longer period of time. Interestingly though, the notation seemed to be confusing for certain experienced pianists who expressed that they would rather not want to use it for pieces that they already know. However, several piano players with some experience also enjoyed using TAP to engage in a "piano battle" to compare their playing skills.

We noticed that people were more likely to engage with our setup if the speed of a song was slowed down and only gradually increased. This way, they were more confident they could keep up with the game. During our try-out at the public event, people using our installation were clearly having fun, and it attracted several spectators that then also queued up to try it.

Our informal evaluations and try-outs suggest that beginner piano players are motivated to practice more with our system and that they were able to master simple music pieces without any knowledge of sheet music.

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