

## Solid state ensemble II for 16 smartphones and a smart speaker

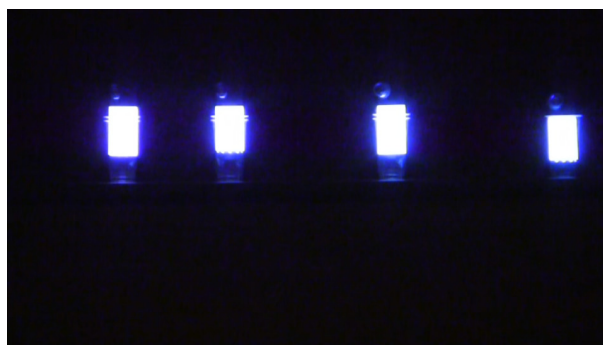
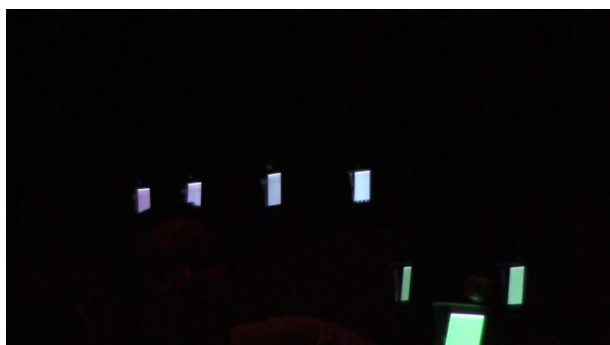
It is natural to use smartphones, very common sound-emitting devices in our daily life, which have the function to perform various information processing including bridging between artificial intelligence and a human, as means for realizing electronic music works, especially when designing a work that will be established only with participation of the audience.

In my previous smartphone pieces, no dedicated apps were used (only built-in web browsers were used) so that audience can easily participate in the pieces using their own smartphones. Unlike that, I developed an Android app dedicated to this piece. Instead of asking the audience to participate using their smartphones, I decided to have quite a few smartphones prepared in advance. By using a dedicated application, the smartphones are able to play each different part synchronously, appealing to the audience from various positions in a room, by their less loud but clear sound.

In addition to smartphones, smart speakers like Amazon Echo or Google Home are becoming rapidly common as a digital assistant in our life. Smart speakers also seem to be full of potential usages for musical works as a kind of a musical instrument.

### About the video (solidstateensemble2017-1117-submit.mp4)

The video shows how the piece (the first version) was premiered in a concert. The sound was generated from each of the 16 smartphones in the hall (without using PA loud speakers). Before the piece began, the audience heard an explanation that 8 smartphones were located on the stage and other 8 smartphones were located on the audience side at distributed positions in a hall. The audience were told that they might feel free to take a near-by smartphone and shake it to make sound to join the piece performance when sound of strings began.



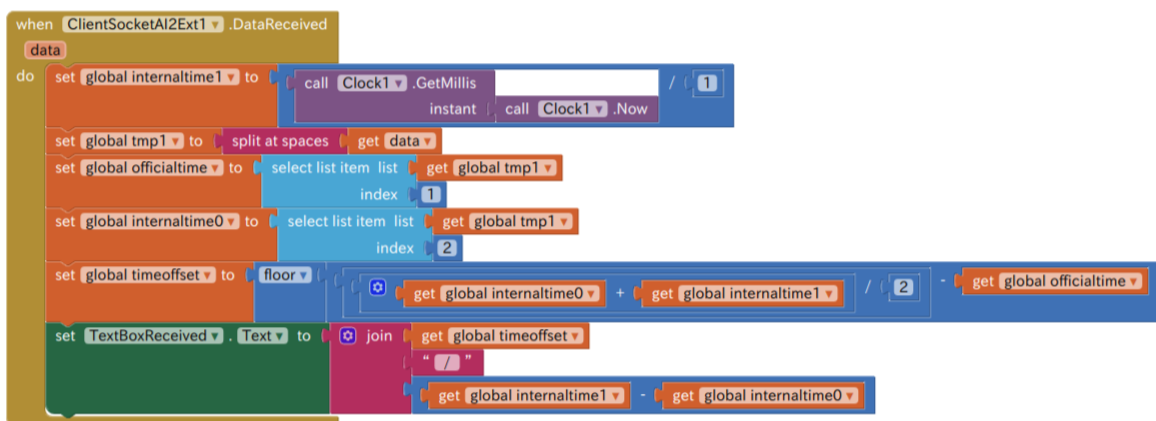
Not only the sound from each smartphone but also the slow screen blinking with different colors of every smartphone is synchronized.

For ICMC2018, the piece is modified and optimized for installation in a smaller space. A smart speaker is introduced into the new version of the piece to enhance audience's interactivity. The

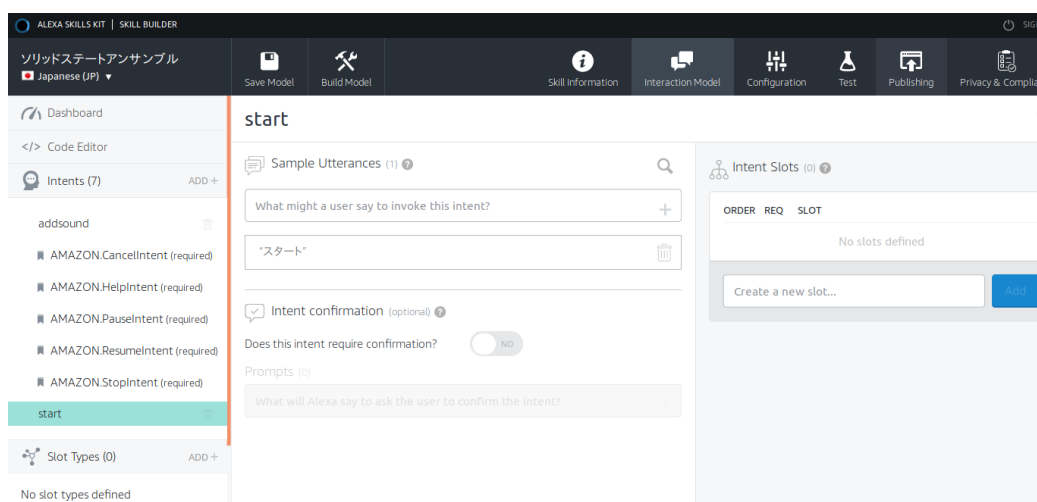
installation is configured for being played on-demand whenever a participant comes to the installation place and says some voice commands (to start playing, to add new overlay sound, and so on) to a smart speaker like Amazon Echo to control the 16 smartphones. The smartphones deployed around the audience in this installation also have interactive characteristic to respond to audience's actions like walking around the smartphones, shaking or touching the smartphones. The installation piece has been designed to convey the feelings that a cluster of smartphones sounds and looks like existence with some intention although they are just commonly used small smartphones.

### Technical aspect of the piece

Instead of using a method like sending OSC data to each smartphone, to synchronize the timing of the sound playing and screen blinking at every smartphone (which has a larger latency to respond to realtime packets), the internal clock of each device is used as a reference of playback timing. It is of course necessary to adjust the internal clocks of each device without deviation (more than 10msec) from each other. However, once the internal clocks have been matched, synchronized playback is possible even if there is no network connection. To achieve this, a dedicated Android app which can play audio files at arbitrary timings (even if the root privilege is not available) was created using MIT App Inventor. The following figure indicates the time adjustment part of the app.



The audio files for each of 16 smartphones are created with a PHP script and Csound 6. The Skill (e.g. app) for the smart speaker is created with Amazon Alexa where user's utterances are assigned to external commands for controlling the smartphones.



Amazon Alexa includes Natural Language Understanding technique that can enhance audience's interactions with the installation, participating the piece by naturally talking to a smart speaker.