[Proposal Form for Venture Research Program for KAIST Ig-Nobel Prize]

<제안서는 국문 또는 영문으로 작성 (총 5페이지 이내)>

Mathematical discussion of articulation in music

1. Information on Research Team

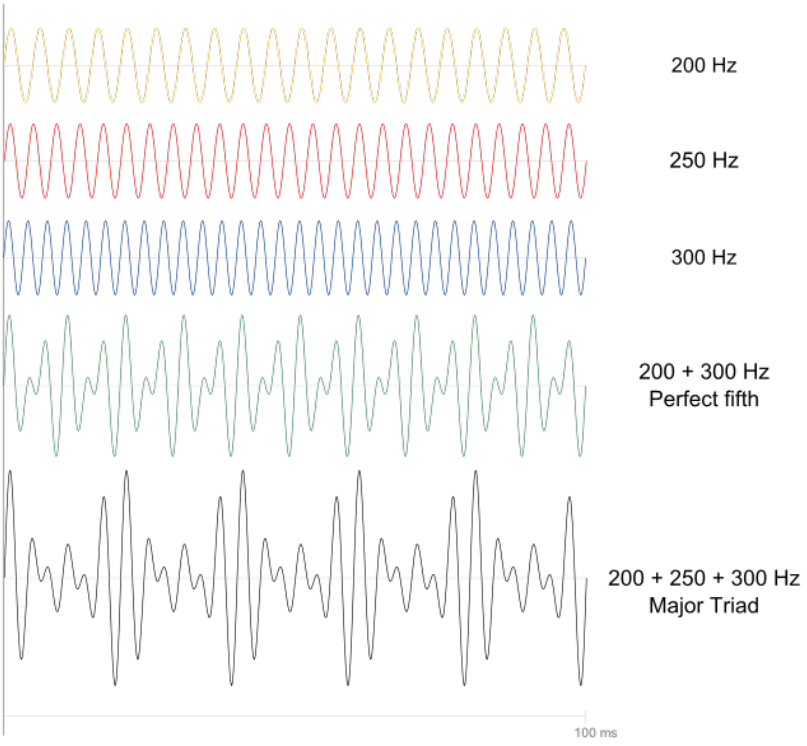
Name	Student ID	Department	Career	Role
임현진	20158092	Mathsci.	수리과학과 석박통합과정 2015년 전기 입학	I proposed the topic and am the sole member in research, who models, designs the whole and makes the simulation

2. Project Summary

Objective	Study the effect of musical articulation in its harmony and texture.
Description	As an introduction to this exotic topic, there is long history of music, and also is shorter history of musical theory. This is because it had been the subject of only those geniuses who could feel, understand and compose those famous pieces. Then there were many music theorists who formulated various musical elements; tone, note, harmony, scales, progressions, musical forms and ideas and so on, which is taught in colleges of music. Many mathematicians have been exploring and formalizing the music, from mathematical point of view. The basics of music are known in math and physics, such as that each tone comes from different frequency and that harmonies come from ratios of different frequencies. There are so various discussions and paper, which I found during preliminary investigation.

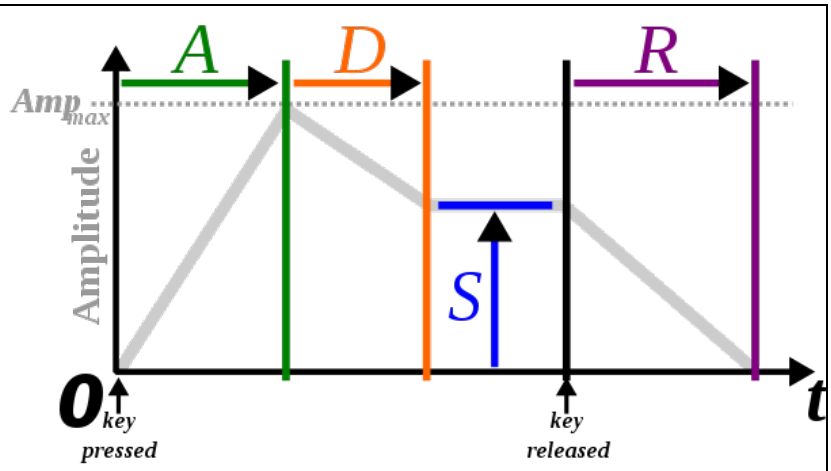
My main issue targets musical articulation. In music, one can articulate differently to give different impression. One can amplify in certain portion (call forte) or diminish (call piano). The melody can be smooth (legato) or be sharp and cutty (staccato). And various others (vibrato, pizzicato, dolce, permatta, and some dynamics as decay, attack, drone and so on)

Harmony is about addition of 2 tones. It gives the feel of consonant/dissonant sound, tension or harmony. On the other side, we don't perform the music as it says, and composers cannot fill every details in sheet (악보). There are other details.



[Harmony is adding to different frequency, from https://en.wikipedia.org/?title=Harmony#/media/File:Major_triad.svg]

With the computer, we have sound processing, such as synthesizer, which can mimic the real instrument sound or synthesize some new. The effect mimics musical impression of the original.

	 [ADSR envelope from https://en.wikipedia.org/wiki/File:ADSR_parameter.svg] Such certain effect may correspond to choice of different instruments; strings vs pipes or use of percussions. One can think from audio engineering side; using filtering, reverbs, fadings, etc. I want to discuss how the effect or articulations can perturb or change or picks different impressions; How they deform the sequence of numbers into real feelings.
Novelty / unusualness	Surely, it's so novel in here, in KAIST, but this "mathematical music" is popular outside, So and is why I chose disparate topic from the pop. There have been so much discussions and papers relating math and music, so various; some about entropy in music, group theory in music, mathematical theory about musical compositions. I searched so many after I think of my topic in this field. The mainstream is about explanation of harmonies and forms; how different frequencies match to give consonant sound, and how can we expect music to progress and what flow of melody is natural. Ultimately, this aims to make composing machine and algorithms to build music itself. I disagree about the point; it's the details and the small that give impression. As my discussion and target differs from majority, I believe this would be new addition to the mathematical music.
Scholarly profundity	I think this field is by itself, full in depth; Music is listened in everyday life, but we don't know why it sounds like so. It is always

	said there are math and patterns but not known exactly. The understanding of that will be more than enough to be called applied math. Among the field, my topic is in part of that, to try understanding of delicate details of music; would talk of what the musical expressions means to be physically in real, and may suggest other possibility in advance.
Research plan	First, study and understand the musical elements, where I can model and define energy, complexity, entropy, and tension that the music gives as a function of 2 tones (different) Second, advance to the streams of the tones; to study how 2 different melodies (or 멜로디 with 반주) can merge naturally or not. Extend the functions from above to give natural temporal relation sequentially. In this part, I expect to use machine learning and some analysis with spectrograms. After then, I can go into my topic, start with analysis ADSR of synthesizer and electronic sound. This is the simplest one that I can start with, apply the functions to see the effect and also other effects of audio engineering. After all then, I can go into musical details and articulations. Those can be modeled, tested, programmed and simulated to see how they work, especially sound and impress. The fundamentals, which I design and expects, would be the 3 domains; musical domain of notes and sheets, the signal domain (analog or digital waveform) and the math and physics (where I extract the function of harmony, tension, entropy, so on)