COMPOSITION WITH PATH: MUSICAL SONIFICATION OF GEO-REFERENCED DATA WITH ONLINE MAP INTERFACE

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ABSTRACT

This paper introduces a unique online-map based software tool for geometric data sonification as well as creative music making. The program, named COMPath, allows the user to create musical events from various types of geo-related data with simple and familiar actions on an online map interface; by specifying a path on the map, the user can collect a set of local information along the route, which is then mapped to musical properties. We discuss the potential of interactive online map service as a musical interface, and describe the design and implementation of the user interface, data collection mechanism, and possible sonification mappings.

1. INTRODUCTION

Sonification, or auditory display, is defined as the use of non-verbal sound to convey information [9]. Because the interpretive mapping decisions from data to sound are diverse, sonification could be applied in various applications depending on a particular purpose. Especially, in the context of algorithmic composition, the term sonification is used to refer to the process of turning non-aural information into sound for essentially artistic purpose[5]. It also has been called as 'musical sonification' to refer to the composer's creative engagement and exploration of the multiplicity of musical ideas that are the potential resultants of a given sonification[2].

In this paper, we present *COMPath* (Composition with Path), an interactive map interface for musical sonification with georeferenced data collected through major OpenAPIs. Using COMPath, users can specify an arbitrary path by marking *nodes* - reference points for local data collection - on the map. Various local information (e.g., traffic volume, temperature, wind speed, and social events) obtained at each node is then converted into sounds (or musical events) sequentially as the "playhead" moves along the route. Since local information can reflect the characteristics of a region, COMPath could be a new approach to musical sonification which can express the regional atmosphere at many different scales.

2. LITERATURE REVIEW

2.1. Related Works

Over the years, there have been many attempts to use the sound to interpret geographical data - mostly for navigation purpose. Zhao et. al. proposed an "interactive sonification" strategy to present the geographical distribution patterns of statistical data, which enabled people with vision impairment to perceive geographical data patterns on both familiar and unknown maps with the help of interactive sounds[17]. For enhanced location awareness, Ontrack[16] provides navigation cues by modifying the spatial balance and volume of mobile music player sound to lead listeners to their destination. Similarly, Strachan et. al. presented a PocketPC-based system which combines the functionality of a mobile Global Positioning System (GPS) with that of an MP3 player to guide the user via continuously adapted music feedback[15]. City Map[8], an interactive three-dimensional sonification interface for visually impaired users to explore city maps, also falls into the same category.

In this paper, however, we focus on sonification for a musical purpose rather than practical navigation. Several researchers have suggested methods for musical sonification; Lodha et. al. presented MUSE (Musical Sonification Environment), which generates musical and engaging sounds allowing interactive and flexible mapping of scientific data to six different sound parameters such as timbre, rhythm, volume, pitch, tempo and harmony[11]. Marry Quinn's The Climate Symphony[13] was an attempt to sonify the climatic elements, such as solar intensity, ice sheets, and volcanic activity, derived from 110,000 years of ice core history into music.

In the context of above musical sonfication, Gaye's Sonic City[6] was one of the efforts to explore the field of psychogeography through musical sonification of a city space. With many kinds of sensors, Sonic City converts aspects of the city into generative electronic music in real time by walking through and interacting with the urban environment. Similarly, McCallum showed Warbike[12], a project that sonifies local Wi-Fi coverage while riding a bike. Also, although not strictly classified as sonification, the Copenhagen Channel audio application[10] and Davos Soundscape [14] serve as examples of location-based musical creation in the urban field.

It should also be noted that data mapping scheme of COMPath is highly similar to that of wave terrain synthesis [3][4] in that it is a mapping from a path on a surface (i.e., a two-dimensional space) to music/sound (one dimensional data space), but at a higher level and a larger scale.

2.2. Map as a Musical Interface

Music is considered as an “art of time:” some philosophers even used the term *musical time* (which is distinct from ordinary time) to mark off its temporal characteristics[1]. Various musical elements, including traditional musical notes, computer-generated sounds, etc., are presented to the listener progressively over time. Similarly, tracing routes on a map is also time-dependent; while moving along a path with multiple nodes on it, we encounter each of them sequentially. This temporal feature of route tracing makes itself an “organization of events (i.e., nodes) in time” and, by adjusting the distances between adjacent nodes and tracing speed appropriately, this could become more “musical.”

Therefore, in addition to its popularity and familiarity, online map interface has a strong musical implication; users can move around and place nodes on a map with little training, and intuitively understand that the rhythmic structure and tempo of the resulting music are determined by node positions (i.e., distances between them). Figure 1 illustrates this conceptual analogy between a route on a map and a sheet music.

Furthermore, various types of information associated with each node on the path can be mapped to different musical elements (e.g., pitch,loudness, timbre, and even tempo). Since local information used for musical sonification can reflect the unique characteristics of the area, different paths lead to different music. Also, results from the same path could vary depending on time. This space- (or path-) and time-dependent feature makes COMPath an unusual (and interesting) tool not only for music creation, but also for practical applications such as identifying local social charecteristics by sound.

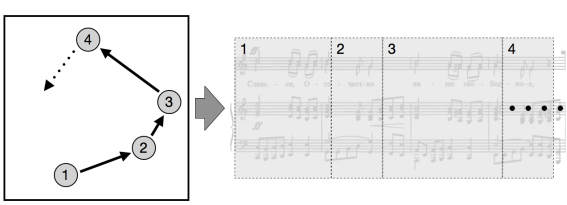


Figure 1. Conceptual analogy between a map (left) and music (right).

3. SYSTEM DESIGN AND IMPLEMENTATION

COMPath consists of three parts: user interface, data mashup module, and data mapper for sonification. A block-diagram of the system is illustrated in figure 2.

3.1. User Interface

The user interface of COMPath is based on Google Maps API, one of the most widely used online map service platform. Users can select a node by placing a marker, and consequently a path by selecting multiple nodes in series. Once the path is determined, COMPath starts to send queries to get various information such as traffic, weather, temperature, local news, from internet. Results of these queries are displayed on the screen. After collecting information for every node on the path, COMPath performs sonification along the route. Figure 3 shows a screenshot of the user interface.

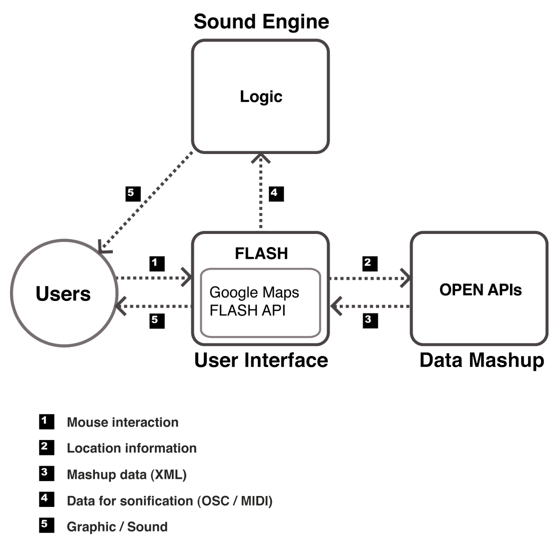


Figure 2. Schematic diagram of COMPath.

3.2. Data Mashup

Mashup means the process of creating a new application by taking pieces from two (or more) different websites and mixing them together. Currently, major commercial web services such as Amazon, Google, and eBay, offer public Application Programming Interfaces (APIs), thereby allowing people to mix and match information from any of them [7].

For each user-marked node on the map, COMPath retrieves its geographic location and performs mashup operation to obtain desired information. Table 1 summarizes the list of websites that provide OpenAPIs for mashup and the

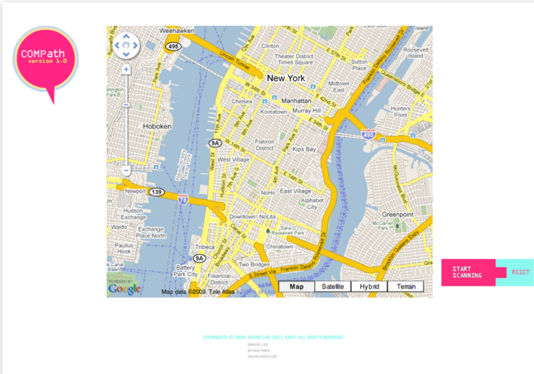


Figure 3. COMPath user interface.

type of information (it should be noted that, for each data type, multiple data values can be gathered at more than one location around a node).

Website	Type
Yahoo traffic	Real-time traffic
Flickr	Location of picture
NOAA (National Oceanic & Atmospheric Admin.)	Weather information (e.g., max./min. temperature, wind speed, etc.)
Eventful	Culture events
Outside.in	Local news at a certain region
Socialight	Comments and reviews

Table 1. List of major OpenAPIs.

3.3. Sonification Mapping

For sonification mappings, selected mashup datasets are processed and arranged in time by COMPath and then transmitted to a sound synthesis engine - either as OSC (Open Sound Control) or MIDI (Musical Instrument Digital Interface) messages. Currently we use VSTis (Virtual Studio Technology Instruments) via MIDI as the sound source.

Numerous mappings can be made from the aforementioned mashup results to various musical elements. Obviously, different mappings with different objectives will produce different results, and it would be virtually impossible to suggest one ideal solution to this problem. In any case, however, it is crucial to understand the nature of the data to be sonified for music. For example, most of the mashup data values we obtain change slowly over a long period of time, and they do not vary at the same speed. These characteristics, as well as the range of each dataset, must be considered in order to map them to appropriate elements of music. Below is a typical example of sonification mapping with COMPath:

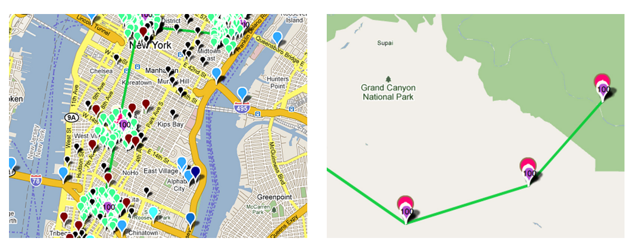
- Each type of mashup data is associated with an instrument. Data from each point are mapped to instrument pitch, while the distance from each data collection point to current node determines the loudness level of instrument sound. Each instrument is controlled separately through a dedicated MIDI channel.
- Geographical location of each node (i.e., latitude and longitude) is related to spectral variable; latitudes are mapped to the cutoff frequency, while longitudes determine resonance of a bandpass filter.

COMPath also features "looping" functionality, allowing the user to repeat the same sonification process along a route as many times as desired.

4. RESULTS

To test the performance of COMPath with the mapping scheme described above in section 3.3, we selected several areas with different geographic and social characteristics and conducted user test. Figure 4 shows the screenshots of mashup query results at two contrasting locations - one in Manhattan, New York 4(a) and the other at Grand Canyon National Park, Arizona, USA 4(b); due to the large amount of data in Manhattan area, numerous markers are shown on the map and a complex music with various sonic gestures is generated. On the contrary, there are only few data points at Grand Canyon National Park, resulting in a poor (in fact, almost silent) sound. Similar experiments were conducted at the same area but with different routes, resulting in highly similar - but not exactly the same - pieces of music. More sound/video examples of COMPath experiments are available at `http://aimlab.kaist.ac.kr/COMPath`.

In general, we received highly favorable responses from the users; almost every subject understood the concept instantly, valued its potential as an interface for music composition/performance, and were satisfied with the result. Some subjects, although not many, were able to identify certain local characteristics on the routes in Manhattan area.



(a) Manhattan, New York City, NY. (b) Grand Canyon Nat'l Park, AZ.

Figure 4. Comparison between two contrasting areas: Manhattan, New York(a) and Grand Canyon National Park, Arizona(b).

5. CONCLUSION

We have introduced COMPath as a method of using interactive map interface to create music that could evolve in musically meaningful ways. This intuitive musical sonification tool utilizes virtually unlimited amount of geo-referenced data for music, and has a strong potential as a new musical interface which could also be used for practical applications

In addition to designing more sophisticated mappings, future work will include:

- user-controllable trace. With full control over the speed and direction of route tracing process, users will be able to construct the rhythm and tempo of music with high precision. This is perhaps the most essential part of composition paradigm with COMPath.
- simultaneous sonification of multiple paths. This will allow users to construct multiple independent streams, which may be similar to the polyphonic texture of music.
- control by mobile devices. With COMPath on mobile devices, users can perform tracing (and real-time sonification) by physically "walking" on the route.

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