The Krasnodar Public Transport Orchestra

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ABSTRACT

This paper describes the work of artist Max Alyokhin called "Concerto for public transport orchestra in four movements" and the web technologies used in its creation.

1. INTRODUCTION

The rapid evolution of web technologies has given us new opportunities for creativity in general, and for creating music in particular. The work under consideration uses the Web Audio API technology to dynamically synthesize sounds and create a musical composition based on uncontrolled data.

2. ABOUT THE PROJECT

The Krasnodar Public Transport Orchestra is a set of algorithms that download live data on the speeds and coordinates of public transport in the city of Krasnodar (Russia) and interpret (sonificating [1]) this data into sounds. The algorithms are accessible through a browser and implemented on web technologies, that is, the Orchestra is essentially a website [2]. This site 24/7 intercept updates from the server that serves the platform [3] which collects data from GPS/GLONASS installed in each vehicle cabin. From these, the algorithm extracts information about speeds, vehicle types (bus, tram or trolleybus), routes and coordinates. Then, depending on the speed of traffic, another algorithm determines what sounds, in what order, of what duration and frequency will sound.

The salons whose tone is being played at the moment are highlighted on the map. A detailed description of all of the actions and a report on the movement of transport can be observed in the score, which is formed right during the performance (although it could be argued about score: if we proceed from the fact that the score is an algorithm of actions for extracting sounds, then the program code itself can be called a score, which determines the sound; on the other hand, the score can be understood as a record of notes that actually sounded in a particular sequence, which is in fact a textual documentation of the composition).

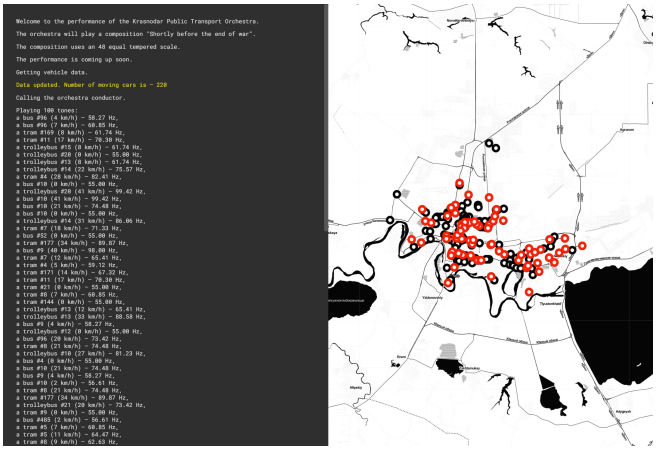

Figure 1. The Krasnodar Public Transport Orchestra. Works in the browser Google Chrome.

3. TECHNOLOGIES ARE USED AND DESCRIPTION OF THE ALGORITHM

The algorithms are written in Javascript. When developing this project, Web Audio API was used. This web standard appeared back in 2011 and has been actively developing ever since. It allows you to synthesize and manipulate sound right in your browser. Considering that the execution context of the algorithm is a browser, we can use all the capabilities of the Internet, especially the ability to get live data that can be used as input parameters for the generation of sounds and composition strategy. Below is a scheme of composition generation.

Each algorithm, at the start of its work, generates a equally tempered scale [4] — an array of tone frequencies calculated according to the following formula:

$$f(i) = f_0 \cdot 2^{i/n}$$

where f(i) — is the frequency in Hz,
f0 — base frequency,
i — index number of tone in the octave,
n — amount of tones in the octave.

Each part of the Concerto uses a different musical scale:
— for the first part: from the small octave note D (146.8324 Hz) upwards in a quarter-tone scale (24 notes per octave);

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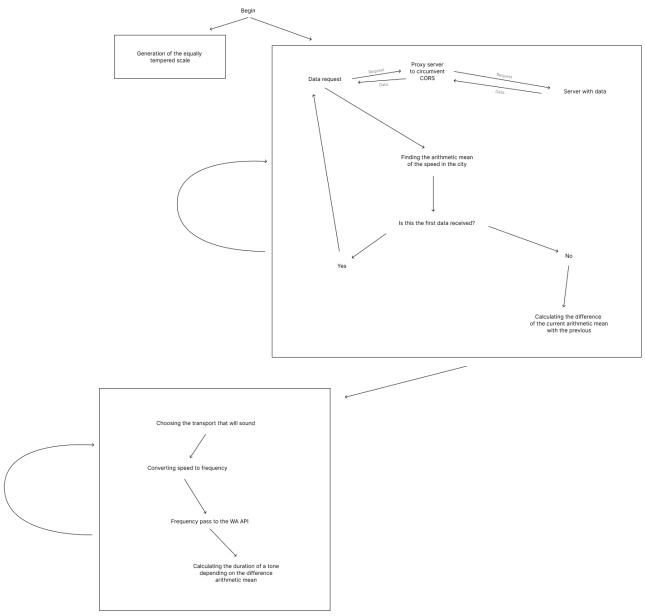

Figure 2. The algorithm

— for the second part: from the note A of the contra-octave (55.0000 Hz) upwards in semitone scale (7 notes per octave);
— for the third part: from the note in A of the contra-octave (55.0000 Hz) upwards in an eighth-tone scale (48 notes per octave);
— for the fourth part: from the B note of the first octave (493.8832 Hz) upwards in 300-tone scale (300 notes per octave);

In the following, the algorithm will map each of the tones to a velocity in km/h such that the higher the velocity, the higher the tone.

Next, the traffic data is requested. However, it should be noted that the "mining" of the data is not done directly, but through a proxy server due to the fact that the traffic data is stored in another domain and is therefore protected by CORS policy [5]. To circumvent the restrictions, the Node.js platform and Express web server was used, as requests from the server are not blocked, but from the client (browser) are blocked. The web server acts as an intermediate node, performing transport data requests and passing them to the user's frontend.

Having received the traffic data, the algorithms of the first two parts of Concerto calculate the arithmetic mean of all speeds, i.e. something like the average speed of traffic in a city.

Getting the data and calculating the arithmetic mean is done in an infinite loop, in each iteration comparing the current arithmetic mean with the previous one, calculating the difference. In case the average speed of traffic in the city increases, the distance between tones in time decreases (tones are played more often). In case the average city speed decreases, the distance between tones increases (tones are played less frequently). Tone duration is determined randomly in the range from 0.1 second to a value depending on the difference between arithmetic averages. In this way the intensity of the composition is related to a certain average tempo of traffic in the city.

In the third and fourth parts, the distance between tones is fixed.

Next, the vehicle that will sound is selected at random from a list of all vehicles. The speed of this vehicle is converted to a frequency in hertz: each kilometer per hour corresponds to an index number in the tone array, e.g:

0 km/h = 0 Hz,
1 km/h = 55,000 Hz,
2 km/h = 61.735 Hz,
3 km/h = 64.406 Hz,
etc.

The calculated frequency is transferred via the Web Audio API, where an oscillator is created for each tone, generating a damped sine wave of the calculated duration.

Actions from selecting the vehicle, calculating the duration and frequency of the tone and synthesizing it are also performed in an infinite loop, using the updated motion data in each iteration.

4. REFERENCES

[1] Sonification is the use of non-speech audio to convey information or perceptualize data. See Gregory Kramer, Auditory Display: Sonification, Audification, and Auditory Interfaces (Santa Fe Institute Studies in the Sciences of Complexity. Proceedings Volume XVIII. Reading, MA: Addison-Wesley, 1994) pp. 127-151.

[2] “Concerto for public transport orchestra in four movements”, <orchestra.stranno.su>, accessed 20 April 2022.

[3] A site that tracks the movement of public transport, <https://www.marsruty.ru/krasnodar/#krasnodar/map>, accessed 20 April 2022.

[4] The equal tempered system uses a constant frequency multiple between the notes of the chromatic scale, <https://pages.mtu.edu/~suits/scales.html>, accessed 20 April 2022.

[5] Cross-Origin Resource Sharing (CORS) is an HTTP-header based mechanism that allows a server to indicate any origins (domain, scheme, or port) other than its own from which a browser should permit loading resources, <https://developer.mozilla.org/en-US/docs/Web/HTTP/CORS>, accessed 20 April 2022.