SKATEBOARDING SIMULATOR

CS 4590 Final Project
Deliverable 6

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ABSTRACT

This paper describes the methodologies and findings for my CS 4590 final project, a skateboarding simulator that sonifies the action of popping an "ollie" on a skateboard over an object. And ollie is the basic "jumping" trick on a skateboard, the action of clearing an object while riding. The project includes a simulator, and user testing of the simulator to show that the auditory sonification provides improvements to physical performance.

CCS Concepts

Information systems → Audio Systems → Sonification Systems → Physical Simulations

Keywords

Audio, simulator, project, Georgia Tech, Georgia Institute of Technology, physical, skateboarding, sonification

1. INTRODUCTION AND BACKGROUND

I have been skateboarding for most of my life, and it is an identity I closely align with. I am fascinated by the professional skaters of the world, and even more so inspired by the disabled and skaters that push the limits. For my first iteration of this project, I will present my domain as skateboarding, primarily for blind skaters. While rare, there are many disabled professional skateboarders, such as American skateboarders Justin Bishop and Dan Mancina, and Japaneese skateboarder Ryusei Ouchi, who are visually inmpaired and legally blind (Tarrant, Burnett, Butler). These people are incredibly talented and were able to push the limits of their capabilities. I think that an accessible audio system could be created for primarily blind skateboarders, that could offer additional information for the users, and increase the opportunity for people to skate. The main difficulty with a physical sport such as skateboarding is that it relies on the environment around the skater. This makes it incredibly difficult for blind people, as sight is the easiest way to be able to assess the environment, they skate in. Blind skaters will typically use canes, as they do with walking and other activities, to sense and feel their way through the world and through obstacles. Overall, its seriously impressive, but I think there is a way to bring higher functionality to the canes and the board, to give the user a better prediction of their environment.

Skaters need to know if the terrain ahead of them is skateable (concrete or asphalt usually), if they are lined up correctly for obstacles, the height of obstacles if they are ollieing (ollie is the basic jumping trick) over it, and how far across or how deep a gap or drop is. These are just some examples, but I think there is a lot of room for audio accessibility in this sport. My primary idea is using smart cane with proximity sensors, a 3D spatial audio soundscape could be created for the blind user using headphones. This would allow the user to sense the distances of objects around them, and know the heights and depths as well, in order to approach these obstacles effectively

According to Justin Bishop, he currently uses a BeeperBox, which is a beeping device that allows blind people to mark areas as they can hear the sound through a certain beam (Burnett, Thrasher Magazine). He uses this to know where the coping is (the end of a ledge, or the lip of a bowl or pool) through audio. Justin and Dan also use a cane with a bearing on the end, which allows them to feel the slopes and curves of what they skate (Butler, The Be My Eyes Podcast). Possibly, there is a way we could add this functionality completely the cane or the board and be able to make it more functional and accessible for skaters.

Another main need would be a way to scan the surrounding area to make sure an area is safe to skate. Dan Mancina talks about his process of scanning an area using a sweeping motion of the cane, to plot out obstacles and figure out where things are (Butler, The Be My Eyes Podcast). One thing I found interesting was the accessible skatepark Alt Route, which has accessible features that make the park easier to use for the physically and visually impaired, by putting high contrast coloring on the coping of transitions and adding tactile strips to increase feel on these areas (Ruttle, CNIB Foundation). Possibly, tools such as this could be used to communicate with the audio interface, and aid in communicating with the user, so as a skater goes up and down a transition, they would have direct feedback of what's going on.

2. OVERVIEW OF THE SIMULATOR

2.1 User Interface

Figure 1: simulator in manual mode view

from top left to bottom right: help toggle, help text, alignment mini map, side scrolling visualizer, UI buttons, manual mode sliders, debug text

2.2 Adjustable Data Points

Table 1: Data Points

Skater Data	Environment Data
Skater Total Pushes	Obstacle Thickness
Skater Push Power	Obstacle Height
Skater Pop Height	Ground Angle
Skater Pop Distance from Obstacle	
Skater Initial Alignment	

2.3 Sonification Scheme

1. Skater Y height by pitch of sound
2. Skater X position / distance from optimal popping position from (sonified by a beeping sound that increases in speed)
3. TTS that reports back if the attempt was successful or unsuccessful
4. Pushing sound on each push, pop sound effect on pop, land effect on land
5. Left to right panning of the sonification based on the alignment of the skater (mini map in the top right)

3. METHODS

3.1 Simulator User Scenarios

The general goal of the simulator is to showcase a well popped ollie over an object. The simulator allows for adjustment of many variables, in order to influence the environment and the skateboarding of the skater. The user interface features a side scrolling view of the skater moving towards the object. Below this view, there are user interface elements for all the options available in the simulator. Additionally, all the buttons can be controlled via keyboard input. In the top right, a mini map can be found to show the forward-facing view from the board. This mini map allows for alignment of the skater, to make sure the board is straight on with the object. The overall goal is to push to get enough speed, keep the board aligned with the obstacle, and pop both at the correct time and with the correct power to clear the object, in order to achieve a successful ollie.

3.1.1 JSON #1 - Flat

This JSON file showcases an example of a flat scenario. This is also the default scenario. This scenario has a flat ground, with no incline, three pushes, and a normal pop height and pop positioning. The board pops over the obstacle with relative ease and normal speed. This file can be loaded with the button on the UI, or with the "1" key on the keyboard.

3.1.2 JSON #2 - Incline

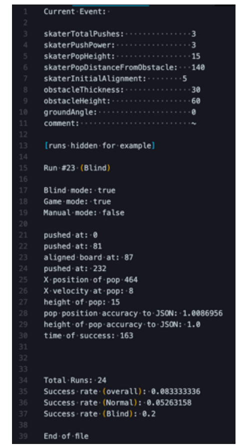
This JSON file showcases an example of an uphill scenario. This scenario is more difficult, because it requires more precise pushing power due to incline gravity and drag and has a tighter window to pop over the obstacle. This file can be loaded with the button on the UI, or with the "2" key on the keyboard.

3.1.3 JSON #3 - Decline

The last JSON file showcases an example of a downhill scenario. This scenario requires less pushing power, as there is less drag against the skater. However, the board rolls pretty fast, so the skater has to pop earlier to compensate for the arc of the pop and the speed. This file can be loaded with the button on the UI, or with the "3" key on the keyboard.

3.1.4 Record Mode

This mode allows for user testing. This mode will track almost all data relevant to a user test and save them to a text file under the "results" folder of the project. The text files for each enabling and disabling of the recording are named by number. Recording mode is enabled using the "TAB" key on the keyboard, or the button on the UI. Note: recording mode will disable switching JSON files, and enabling/disabling manual mode. This is to keep recording data accurate, as the mode records for one data set at a time, whether loaded by JSON or inputted manually with sliders in manual mode.



```
Current Event: 

skaterTotalPushes:                3
skaterPushPower:                  3
skaterPopHeight:                  15
skaterPopDistanceFromObstacle:    140
skaterInitialAlignment:        5
obstacleThickness:                30
obstacleHeight:                   60
groundAngle:                      0
comment:                          ~

[runs hidden for example]

Run #23 (Blind)

Blind mode: true
Game mode: true
Manual mode: false

pushed at: 0
pushed at: 81
aligned board at: 87
pushed at: 232
X position of pop 464
X velocity at pop: 8
height of pop: 15
pop position accuracy to JSON: 1.0086956
height of pop accuracy to JSON: 1.0
time of success: 163



Total Runs: 24
Success rate (overall): 0.083333336
Success rate (Normal): 0.05263158
Success rate (Blind): 0.2

End of file
```

Figure 2: example of recording output

3.1.5 Game Mode

Game mode allows for user input of the keyboard to control the skater pushes and pop. This is used in conjunction with record mode to allow for user testing. The player can use the ENTER key to push, and the SPACE key to pop the board. The LEFT and RIGHT arrow keys will allow the user to adjust the alignment into the alignment box. The user cannot push while in the air and cannot pop while pushing. To pop higher, the user must hold space on the keyboard, in order to "charge up" the pop, and pop higher to clear the obstacle. This is to simulate bending down the legs on a real skateboard. Additionally, the user must align the board manually with the obstacle, using the mini map in the top right corner. This is to simulate forward view of the skater, in order to line up with the obstacle correctly.

3.1.6 Manual Mode

Manual mode allows for custom simulations not given in preset JSON files. By enabling manual mode, the UI reveals a new section of sliders that allow for complete customization of the simulation. Additionally, the UI will show some real-time debugging data for more information. Note: manual mode cannot be enabled or disabled while in recording mode, the option will be greyed out, and the sliders will be locked until recording mode is disabled.

3.1.7 Blind Mode

Blind mode hides visual data from the user, in order to allow for sonification testing. This mode requires the user to rely only on the sonification of the data to make successful attempts at the simulation.

3.2 Research Questions

- Will skater using the simulator have a better understanding of their board?
- Will sonifying the distance from the obstacle help with real life timing of the skateboard?
- What are the common variables the skater needs meet to clear an obstacle? Including pop distance, pop height, and speed (pushes).
- Does the height sonification help the skater know if they would clear the obstacle successfully?
- Is the beeping sonification familiar to the user? Was it easy to gauge when to pop, or did it make it more difficult?
- Did the user gain a better understanding of how an ollie works in real life by visualizing the event?
- Do skaters find the sonification uninviting / annoying while using the simulator?

These questions are relevant for the project goals, as the goal of this project is to serve the intermediate skater in improving their ollies. Many skaters find difficulty in the timing, angle, and technique in moving ollies, especially when it comes to ollieing over obstacles. These questions lend themselves towards the goal, and hopefully will help skaters practice and become for confident in their skating.

3.3 Participants and Recruiting

The type of person I would evaluate is any kind of skateboarder with minimal experience. As long as the person understands the mechanics behind how an ollie is supposes to work, they should be able to respond with success to the simulation. Ideally however, an intermediate skateboarder would be the most useful for the evaluation as that is the target audience.

3.4 Measures

The simulator will record this data using recording mode, in order to have an accurate quantitative analysis:

- Success rate of each trail in each mode (visual and blind modes, and in each user story)
- Change in success rate versus visual mode and audio only mode
- The buttons and choices the user makes for each run
- The specific data for each run that is successful and failed, the simulator will log, for example, the pop height, the speed, the pop position, and numerous other data points.
- The total time it takes to complete each run on each mode

Additionally, I will ask the participant for commentary and feedback on the success of the simulator and the evaluation

3.5 Protocol

For my evaluation, I will take each participant, and walk them through my evaluation process. First, I will show the participant the baseline, correct simulation. Then, I will switch the simulator to game mode, and enable recording mode (this will track the data for each attempt the participant makes). Next, I will allow the participant to experiment with the timing of the skater's pop, while the simulator records each attempt the evaluator takes. The participant will use the keyboard to complete the task, using the enter key to simulate pushing the board, and the spacebar to simulate popping the board. The user can increase their pop height by "charging up" the pop, by holding the spacebar, and releasing when they want to pop the board. Lastly, I will let the evaluator try the simulation blind, by enabling blind mode, and only relying on the sonification. This will simulate what the simulation will feel like if used in real life. The evaluator will use the sonification cues to determine the timing of the ollies pop, and the charge up of the ollie. The simulator will record numerous amounts of data, including their success rate, the button presses of the player, the time it takes to complete, and numerous other data points. Lastly, I will ask the participant what they thought of the simulation. I will ask them what could be improved, and what was good and successful in the simulation.

3.6 Shortcomings and Analysis

There are definitely both strengths and weaknesses to this simulation. One advantage is that the simulation will provide direct feedback on the effectiveness of the sonification, as by letting the user learn the sonification using visual cues, and then removing the visual cues and retesting, the simulator will be able to see how successful the sonification is at providing real world feedback and information without a visual display. A downside, however, is that the user stories are not very dynamic. The cases being tested are a case on flat ground, a case on a slight incline, and a case on a slight decline. There is a lot more variation in real life, as there could be multiple obstacles, terrain types, wheel types, and more that would heavily affect how the simulation feels when being applied in real life.

4. RESULTS

4.1 Sample Size

I tested three student participants I know following the research method, and allowed them to run through each trial sonification, and recorded them using record mode.

4.2 Data

4.2.1 Success Rate (in percent success)

Table 2: Recorded Success Rate for JSON 1 (flat)

Participant	Visual	Blind	Percent Change
A	9.09%	25.00%	275.02%
B	16.67%	50.00%	299.94%
C	12.43%	37.50%	301.68%

Table 3: Recorded Success Rate for JSON 2 (incline)

Participant	Visual	Blind	Percent Change
A	14.20%	10.00%	70.42%
B	16.67%	5.56%	33.35%
C	8.33%	25.00%	300.12%

Table 4: Recorded Success Rate for JSON 3 (decline)

Participant	Visual	Blind	Percent Change
A	14.28%	25%	175.07%
B	12.50%	100%	800%
C	13.45%	36.36%	270.33%

4.2.2 Total Time to complete (in seconds)

Table 5: Recorded Total Time for JSON 1 (flat)

Participant	Visual	Blind	Percent Change
A	1842	423	22.96%
B	1642	180	10.96%
C	1423	340	23.89%

Table 6: Recorded Total Time for JSON 2 (incline)

Participant	Visual	Blind	Percent Change
A	690	1203	174.34%
B	879	1913	217.63%
C	1390	506	36.40%

Table 7: Recorded Total Time for JSON 3 (decline)

Participant	Visual	Blind	Percent Change
A	889	729	82.00%
B	1072	142	13.24%
C	943	342	36.26%

4.2.3 Commentary (paraphrased)

Table 8: Comments from Each Participant (if any)

Participant	Comments
A	"The learning curve was a bit high; I found the alignment difficult to achieve"
B	"Overall I felt this was a good simulation, the experience translated well to audio."
C	"The beeping was pretty annoying but it was functional."

5. DISCUSSION

I found it interesting that the results tended to show success when in blind mode. Overall, the participants were more successful and prepared for the audio only simulation, other than the incline scenario, which was more difficult due to drag. I think my design could have been a bit better if I provided multiple trials for each participant and showed their change over time as they practiced. However, overall, I think this study provided great insight into my sonification's success. In the future, I would conduct more testing, perform trials on participants, and build the calculation of change directly into my simulator.

6. CONCLUSION

This project was a measurable success, and I learned a ton about user testing and developing an interactive, coding simulator solution to test a physical process. Overall, I think my simulator worked very well, and provided many options and data points to both sonify and test accurately. The recording feature was cool, because it let me just let the user do the trials, and I just looked over the data at the end without any manual intervention. I would hope skaters would appreciate by implantation!

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