

DRS REPORT

Data Art:

Creating music with fish position



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Interaction Design M.Des (2014 -16)

Guide

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Declaration

I declare that this written document represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/ source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Abstract

From the beginning, Human beings have exercised their creativity to make Art. It evokes an emotion in the audience. In performing arts the emotion is even more vivid due to the presence of the artist. Music is one such performing art. Today It has evolved into a diverse and sophisticated art form. Technology has played an important role in this development. Artists have started using technology to develop novel ways of creating music. A number of artists have successfully used mundane numbers from Data into a work of Art. Some of these artists are even creating music using Data. Data can be extremely diverse and interesting. Tracking organisms like fishes can bring out interesting patterns as well. Tracking fishes is important for a number of scientific researches and there are a number of ongoing researches on the subject. Recent studies are working towards easier, cheaper and accessible methods of tracking fishes accurately.

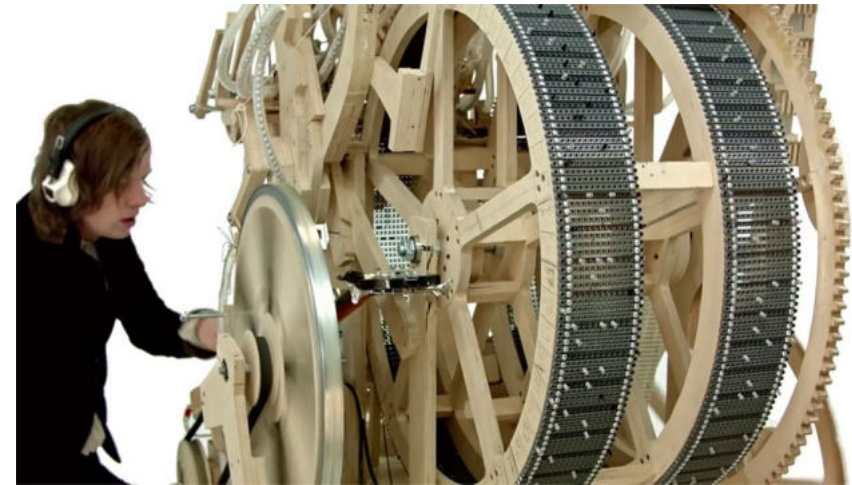
This research project is a pursuit to analyse and prototype an instrument that uses position of a fish in water to generate music.

1. Literature Review

“Art is creative activity resulting in the production of artefacts like paintings, drawings, or sculpture produced by human creative skill and imagination.” - Oxford Dictionary

Activities like painting, sculpturing can be classified as plastic art which uses materials such as paint and clay. Plastic art almost always results in a tangible artefact that is also referred to as a work of art. On the other hand there is performance art. Performing arts are a specialised art form where the artist uses their body to orchestrate the performance. Singing, playing musical instruments, and dancing are some common examples of performing arts. Creation of music is a prevalent performing art that is also the inspiration behind this project

Music is one of the oldest discoveries by humans. It's history is so exhaustive that schools like Oxford, Princeton and BHU have graduate programs for the same. (the study is referred to as 'Musicology'). Musical instruments have evolved into sophisticated instruments over the years. Swedish musician Martin Molin recently presented a musical instrument Wintergatan's Marble Machine that runs on 2000 marbles and is completely analog. But one instrument that stands out of the crowd is a Synthesiser. Synthesisers can create a diverse set of sounds electronically. {Apple.com, 2016 #1} These sounds can vary from unique frequencies, sound of other instruments, human voices or even sound effects. They also have a unique ability to create sounds that are not common in natural environment like percussion or wind instruments. This ability to create music digitally makes synthesiser a goto musical



Martin Molin: Wintergatan's Marble Machine



MiniMoog: The first portable synthesiser

instrument for Data art.

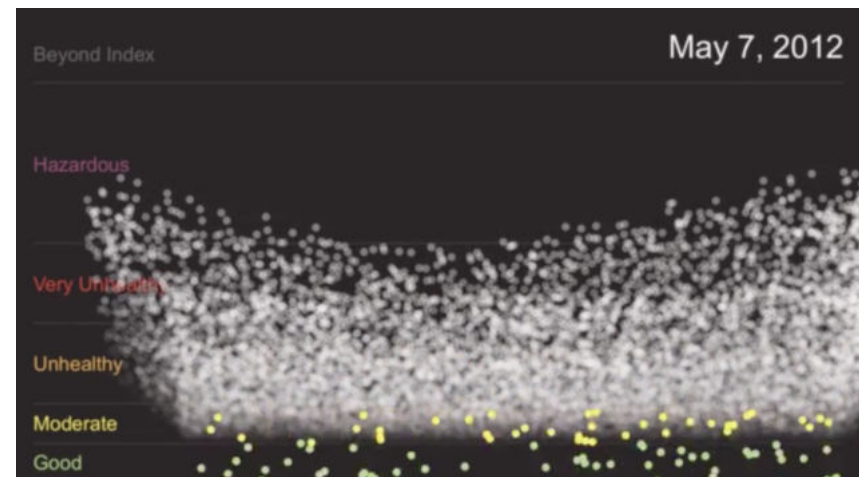
Jacoba Urist establishes the relationship of Art and Technology {Urist, 2016 #7}. Technology has been empowering artists to create art. From paintbrushes to modern cameras, tools and technologies have evolved the way art is created. Art and technology have come a long way. Modern artists are open to experimenting with different tools and technologies. There are a number of artists that have started using the information or Data acquired to create art. Therefore the art form of using data sets is also called 'Data Art'.

Data art has been around for a number of years but it is getting more sophisticated as the amount of accessible data is exponentially growing. Nathan Yau in his artwork Kung fu particles have collected motion capture on the body movements of kung fu masters. The data sets have been used to create particle effects that create an aesthetic forms. Nathalie Miebach in her work Changing Waters looks at the meteorological and oceanic interactions within the Gulf of Maine. Using data from NOAA and GOMOSS buoys within the Gulf of Maine, as well as weather stations along the coast. This large installations plot information through the geographic anchors of a map of the Gulf of Maine, as well as a series of large, hanging structures that look at more specific biological, chemical or geophysical relationships between marine ecosystems and weather patterns.

Artist like Brian Foo have attempted to create music using Data. The artwork Smog Music was created With Beijing Air Quality Data for over the last three years. The song duration



Nathalie Miebach: Changing Waters

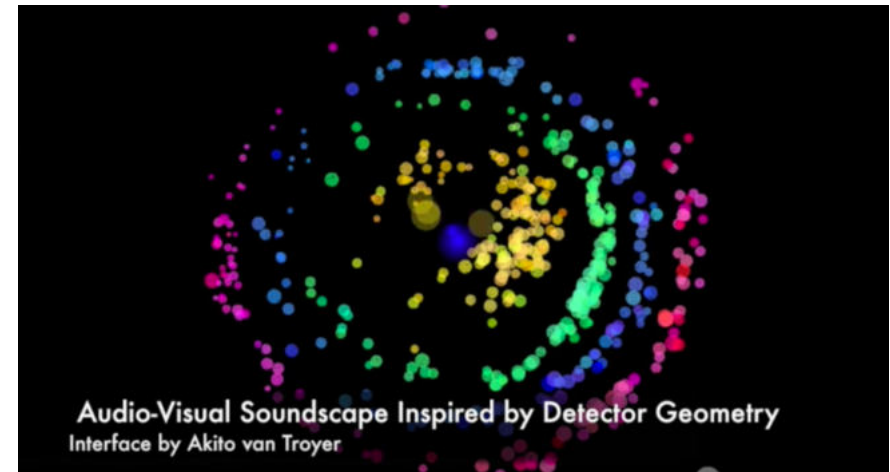


Brian Foo: Smog Music

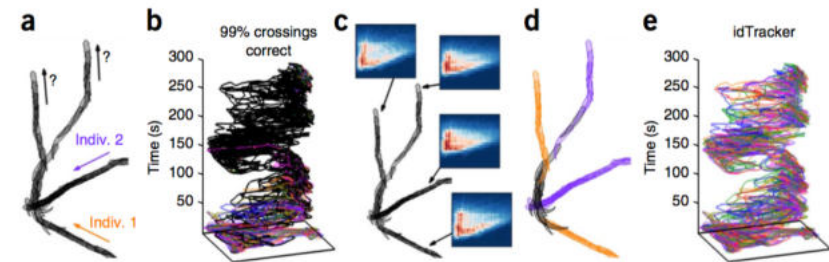
reflects the time of progression in the data. When there are peaks in the data, it plays samples with higher beats per minute. Margaret Evans from MIT Media lab reports that the attempts to create music from Data is not a recent happening. Even centuries ago philosophers believed the motion of the celestial bodies to be musical in nature and called it Musica universalis. Further on she elaborates on MIT Quantizer, which live-streams music driven by real-time data from research that explores the beginnings of our universe from the ATLAS project.

Such artistic endeavours are a great source of motivation to pursue the subject forward. The diversity in the sources of data used for the music synthesis encouraged us to scout different possibilities. One of the sources that stucked was the position of a fish in water. The data from the position of the fish in the three dimensions under water over the period of time appeared to be valuable for generating music. Therefore the project was pursued to identify ways to track fish in water and then use the data to create music.

Tracking Fish position is an important activity for a number of scientific research groups. {Hussey, 2015 #16} presents a detailed look into the overview of aquatic animal telemetry. {Perez-Escudero, 2014 #17} Discusses the widespread use of video cameras to track the position of fishes in the laboratory. Furthermore the authors also propose a method of tracking multiple fishes and provide a sample of the data after a pilot test on real fishes. The sample data looks promising for its use in music synthesis.



MIT Media Lab: Quantizer project



idtracker: tracking and identification of unmarked animals

Video cameras only capture in 2D and therefore have no depth data. 3D cameras that can capture depth data such as stereo cameras or Infrared cameras can be used to add an extra dimension for tracking. Microsoft Kinect is one of the many options in the market which is powered with an infrared depth camera and an RGB camera as well. A number of researchers have used Microsoft Kinect for its accuracy, ease of use and easy availability.

M.M. Saberioon et al. have used the algorithm from idTracker and presented an inexpensive and an efficient machine vision system for monitoring and analysis of fish behaviour using Microsoft Kinect {M.M. Saberioon1*, 2016 #21} The accuracy of Kinect in tracking the fishes was observed to be comparable to the video techniques which require a 2 camera setup(top and front). The ability to acquire the position of the fish using a Kinect opened doors for its creative use. Due to popularity of Kinect, there are many libraries that allow it to be accessed by many Open Source development environments such as Processing. Processing is a valuable IDE for quickly prototyping code sketches and fits perfectly for the short scope of the project. This was the starting point for the experiments that will be carried out to generate music using fish positions.

Tracking fishes was only one part of the project. One of the bigger challenges is to generate music from the data that is acquired. This requirement directed the research towards a robust music synthesiser called Chuck {Ge Wang, #23}. Chuck provides a development environment that can synthesise music by producing frequencies using generators and also play sound samples. Chuck has been used by a

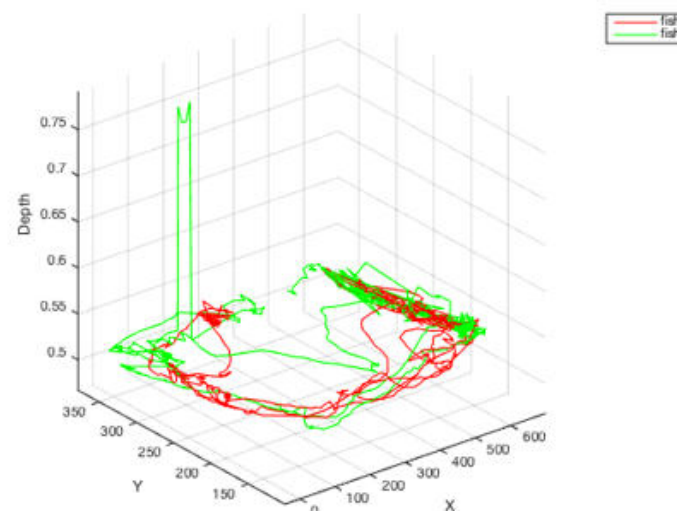


Figure1: two fish trajectory map in 3D space

#21 : Position tracking of fishes using Microsoft Kinect

number of researchers and musicians to create creative instruments. Powerful open source libraries that allow programmers to integrate a number of input sources that can be used for music synthesis have been contributed to Chuck. This project is a successor of a prior project which was aimed at using water as a musical instrument. The position of the finger in water was sent using Arduino to chuck to create music. Therefore Chuck seemed to be a promising choice for music synthesis for the incoming data of the fish position. The project was showcased at Cumulus 2015 {Cumulus, 2016 #26}

After the knowledge of tool for gathering Data and also for its synthesis it was vital to research for communication methods that work best between the tools. Further research on the topic led to discovery of OSC as a compatible solution for the experiment. “Open Sound Control (OSC) is a protocol for communication among computers, sound synthesisers, and other multimedia devices that is optimised for modern networking technology. It brings the benefits of modern networking technology to the world of electronic musical instruments.”{Control, 2016 #28} The discovery of OSC and its features was possible because of detailed work of Rebecca Fiebrink in the coursework of Machine Learning for Musicians and Artists {fiebrink, 2016 #29}

The literature review led the groundwork for a series of experiments that would attempt to bring all the pieces together. The next section covers the experiment in details.



2. Experiment

2.1 Setup

the setup for the experiment can be divided into two logical parts for better categorisation.

2.1.1 Physical Setup

1. Aquarium
2. Fish for tracking(a robot fish was used for the experiment)
3. Microsoft Kinect
4. Computer with speakers

The setup has an aquarium with a top mounted Kinect. The position of the Kinect is favoured to be on the top because that avoids any infrared reflection that could be caused by the glass. Such reflections create false positives that interfere with the detection of the fish. One important thing to note is that the reflection of the IR camera in Kinect on the surface of water creates such false positives as well. A neutral coloured base of grey colour with a matte finish was much better compared to an original glossy blue base.

The size of the fish used for the experiment was 7cm x 2 cm and. The size was almost enough to get good tracking results. Although in a high aquarium, when the fish goes near the bottom, the size in the camera reduces. Therefore it is important to check the observable size of the fish at the bottom of the tank.



The Kinect requires a minimum distance of almost 30cm to focus the object, so it must be placed at a height of more than 30 cm to work. The infra red cameras are not affected by the ambient light in the room. For all practical purposes the setup can work in complete darkness as well (6). Although the RGB camera feed does a good job of allowing us to monitor the accuracy of the blob tracking (5).

2.1.2 Software setup

- Kinect libraries for Processing (Simple Open NI,freeNect)
- Processing IDE
- Chuck IDE with mini audicle
- OSC libraries for Processing and Chuck

Processing and Chuck are the major parts of the setup and are responsible for controlling the input and output respectively. Processing is able to communicate with the Kinect using the freenect library. Freenect library allows us receive and manipulate the kinect hardware.(fig 3)

After the raw data is received in processing it uses an algorithm {shiffman, 2016 #30} to track the fish position. The fish position is then mapped in the coordinate system established by the available width, breadth and depth of the aquarium (fig 4). After mapping the fish to a location on the coordinate system, different types of patterns can be used to generate different patterns for the music synthesis. (discussed in the next section)

The OSC interface allows Processing and Chuck to communicate. OSC packet is broadcasted from Processing and received by Chuck. Both Processing and Chuck require libraries to be able to send or receive OSC messages. After chuck receives the data for synthesis, it can be manipulated to generate frequencies or to play sound loops by writing a program in Chuck and running it.

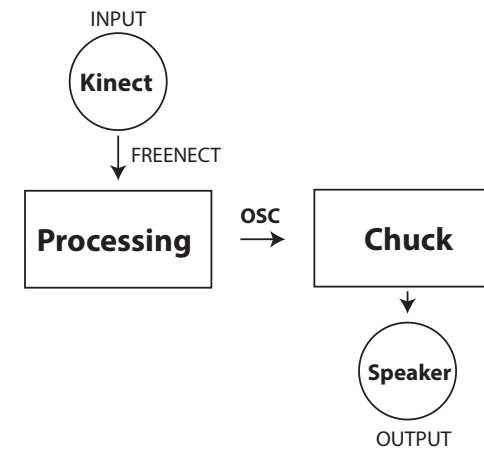


Fig 3:Software setup for the Music Instrument

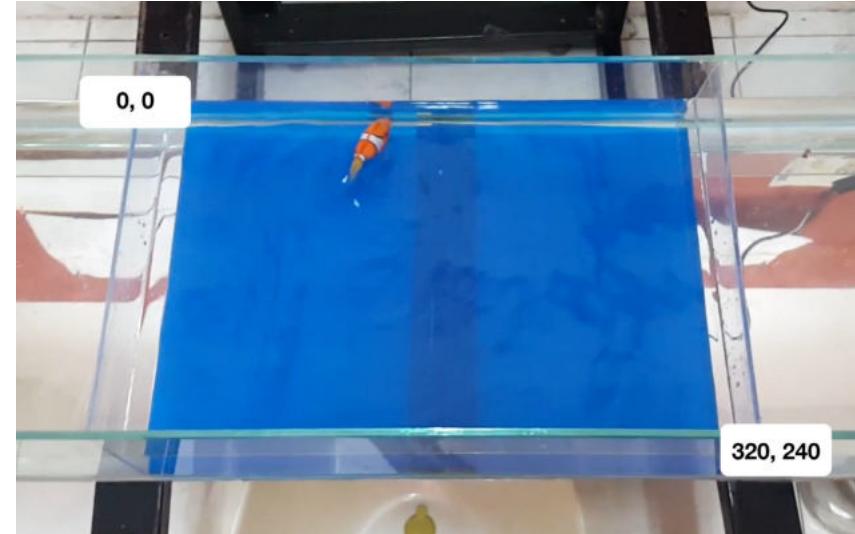
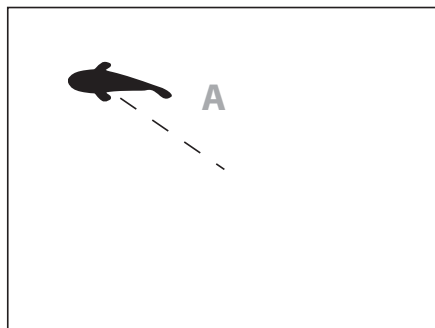


Fig 4: Coordinate system for translating fish position

2.2 Results and Observations

The experiment involved a lot of hit and trial to improve the translation of fish position into musical patterns. With every interpretation of the position into music a layout was created. A layout is the way the program interprets the fish position and instructs the music synthesis. Different layouts can completely change the music out come. Due to the constraints of the size of available aquarium, there was little variation in the depth variable of the fish position. Therefore the choice of note are unfortunately biased on the X,Y position and Z was used for gain. Some of the tested layouts were as mentioned below. The layouts were informally tested with an open group of people who may or may not have a prior experience in music or synthesis of music.

1. Radial Distance



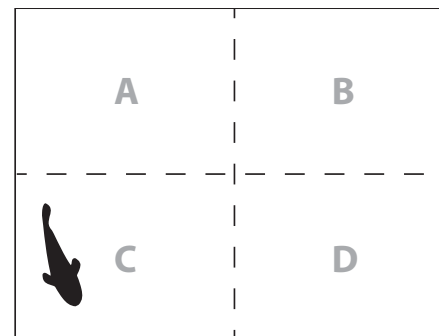
A is directly proportional to the frequency from the sound generator

The first iteration was a simple layout to quickly try the proof of concept. The logic was simple. Higher the distance of the fish

from the centre, higher was the sound of frequencies that were generated. It sounded similar to running your fingers on the piano from the highest note to the lowest and then vice versa.

Although it was elementary to execute, the audience found it difficult to associate the position of the fish to the synthesis of the music. The layout would also run into a problem if the fish has a tendency to run around the glass of the aquarium which is a fairly common pattern in some fishes. Thus it would result in high frequencies for majority of time.

2. 4 Quadrants




A, B, C, D are 4 quadrants which trigger different parts of a drum kit.

To solve for the drawbacks recorded from the first layout, the quadrant layout was developed. The layout starts with a constant sound sound of the base drum kicking in the quadrant A. As the fish moves into other quadrants, different sounds of the drum kit like hi-hat and snare are triggered.

The 4 Quadrant layout solved for the relationship between the location of the fish and synthesis of the music. The correlation was evident and valuable enough to delight the audience. But in the long term the pattern became predictable and the audience lost interest. This could also be partially attributed to the predictable behaviour of the robot fish. But it was evident that the 4 quadrants would not be enough to captivate the audience for a long time.

3. Checkerboard

1	2	3	4	5
6	7		9	10
11	12	13	14	15
16	17	18	19	20

The set is evenly distributed to trigger either a chime note or silence

During the feedback for the second iteration audience members with prior experience in music synthesis shared valuable insight for the project. Music is a very strongly timed activity and utilises patterns to create harmony. Our experiment on the other hand produces inharmonic spectra like the wind chime or bells. The different notes of the wind chime can be calibrated to sound good together.

This led to a redesign of the layout to include number of positions(1-20) that could trigger either the sound of chime note or remain silent. The randomness of wind can be aptly provided by the fish position. The experiment was designed to be positioned as a water chime.

The results of the layout worked for the requirements. The randomness of the chime sound kept the interest of the audience for a much longer time and the notes sound good together. The moments of silence that was triggered on some locations provided an interesting anticipation in the audience. This iteration was a fundamental step in the evolution of this experiment and shall be a guideline for the future work on this project.

2.3 Media samples and resources

For a better understanding of the experiment it is essential to view the fish movements and the audio synthesis to understand the layouts described in the previous section. You can view all the layouts in action on the URL below.

<http://rohan-verma.com/water-chime/>

Future Work

At the beginning of the research project the idea appeared to be a distant goal. Thanks to the open source community the research project materialised into a functional prototype that was presented to live audience. But the scope of the project did not allow a number of things that could have really made a difference to the outcome. As the experiment matured and developed further a lot of feedback was received. The feedback did not make it to the next iteration but has become ground for the future work for this project. Some of the key points to drive future work in this project are described below

- **Data from real fishes**

Although robot fishes don't die they are far from perfect. Studying real fishes and tracking their data is an elementary requirement for this experiment. This would be the starting point for the next set of layout iterations.

- **Better variation in depth**

The depth data can really add to the sound synthesis with modifiers like the scale of notes or even the tempo. The depth data can also be used to understand behaviours like feeding or resting. The tank to be used in upcoming work would allow a greater detail of depth data.

- **Multiple fish tracking**

This was by far the most requested aspect of the experiment. The audience seems to expect it as a pre requisite from any aquarium. Multiple fishes need to be not only tracked but new

layouts are required that inherit their positions to create unique sound triggers.

- **Customisations**

Can i change the drum to a guitar?

Can i change where the sound comes and where it doesn't

Can i set different sounds for different times of the day?

The above questions were continuously asked by a number of different audience members. Music is subjective to the audience. Death metal and country music has a very different set of audience. Therefore any musical device should allow customisations which enable it to serve a large number of people. Customisation of the sounds and designing interactions to do the same will be a major landmark in the development of the project.

References

Reference Type: Web Page

Record Number: 8

Author: Yau, Nathan

Year: 2016

Title: Kung fu particles

Publisher: @flowingdata

Last Update Date: 2016-05-18

Short Title: Kung fu particles

Abstract: Using motion capture methods, Tobias Gremmler collected movement data for two kung fu masters. Then he visualized the results with various interpretations, such as particles, fabric, and scaffoldin...

URL: <https://flowingdata.com/2016/05/18/kung-fu-particles/>

'File' Attachments: internal-pdf://3829176425/idTracker - PerezEscuderoetal_NatMethods2014.pdf

internal-pdf://3006968069/3D Color-based Tracking System for Real-time u.pdf

internal-pdf://1734575198/AE2015_Rotterdam_saberioon.pdf

internal-pdf://3130390644/Saberioon_et_al-2016-Reviews_in_Aquaculture.pdf

internal-pdf://3829176424/2015-cmj-chuck .pdf

Reference Type: Web Page

Record Number: 7

Author: Urist, Jacoba

Year: 2016

Title: How Data Became a New Medium for Artists

Publisher: @theatlantic

Short Title: How Data Became a New Medium for Artists

Keywords: The Atlantic, The Atlantic Magazine, TheAtlantic.com, Atlantic, news, opinion, breaking news, analysis, commentary, business, politics, culture, international, science, technology, national and life

Abstract: For some, self-tracking apps are just a kind of modern paintbrush.

URL: <http://www.theatlantic.com/entertainment/archive/2015/05/the-rise-of-the-data-artist/392399/>

Reference Type: Web Page
Record Number: 4
Author: University, Oxford
Year: 2016
Title: Musicology graduate program
Short Title: Musicology graduate program
URL: <http://www.music.ox.ac.uk/research/disciplines/musicology/>

Reference Type: Web Page
Record Number: 24
Author: THEATER, ROY AND EDNA DISNEY/CALARTS
Year: /TimeGSTCA
Title: KarmetiK Machine Orchestra I REDCAT
Short Title: KarmetiK Machine Orchestra I REDCAT
Abstract: s John Knight's IN SITU,
URL: <http://www.redcat.org/event/karmetik-machine-orchestra>

Reference Type: Web Page
Record Number: 30
Author: shiffman
Year: 2016
Title: Kinect and Processing
Publisher: for v1: AveragePointTracking
Short Title: Kinect and Processing

Reference Type: Journal Article
Record Number: 20

Author: Saberioon, Mohammadmehdi, Gholizadeh, Asa, Cisar, Petr, Pautsina, Aliaksandr and Urban, Jan
Year: 2016
Title: Application of machine vision systems in aquaculture with emphasis on fish: state-of-the-art and key issues
Journal: Reviews in Aquaculture
Pages: n/a-n/a
Short Title: Application of machine vision systems in aquaculture with emphasis on fish: state-of-the-art and key issues
ISSN: 17535123
DOI: 10.1111/raq.12143
'File' Attachments: internal-pdf://4084960732/Saberioon_et_al-2016-Reviews_in_Aquaculture.pdf

Reference Type: Journal Article

Record Number: 17

Author: Perez-Escudero, A., Vicente-Page, J., Hinz, R. C., Arganda, S. and de Polavieja, G. G.

Year: 2014

Title: idTracker: tracking individuals in a group by automatic identification of unmarked animals

Journal: Nat Methods

Volume: 11

Issue: 7

Pages: 743-8

Date: Jul

Short Title: idTracker: tracking individuals in a group by automatic identification of unmarked animals

ISSN: 1548-7105 (Electronic)

1548-7091 (Linking)

DOI: 10.1038/nmeth.2994

Accession Number: 24880877

Keywords: Algorithms

Animals

Ants

*Behavior, Animal

Drosophila melanogaster

Female

Imaging, Three-Dimensional/methods
Locomotion/*physiology
Male
Mice
Oryzias
Social Behavior
Software
Video Recording/*methods
Zebrafish

Notes: Perez-Escudero, Alfonso

Vicente-Page, Julian

Hinz, Robert C

Arganda, Sara

de Polavieja, Gonzalo G

eng

Research Support, Non-U.S. Gov't

2014/06/02 06:00

Nat Methods. 2014 Jul;11(7):743-8. doi: 10.1038/nmeth.2994. Epub 2014 Jun 1.

URL: <http://www.ncbi.nlm.nih.gov/pubmed/24880877>

'File' Attachments: internal-pdf://2442186215/idTracker - PerezEscuderoetal_NatMethods2014.pdf

internal-pdf://3516616717/3D Color-based Tracking System for Real-time u.pdf

internal-pdf://0628175011/AE2015_Rotterdam_saberioon.pdf

Author Address: Instituto Cajal, Consejo Superior de Investigaciones Cientificas, Madrid, Spain.

1] Instituto Cajal, Consejo Superior de Investigaciones Cientificas, Madrid, Spain. [2].

Reference Type: Web Page

Record Number: 27

Author: opensoundcontrol.org

Year: 2016

Title: Introduction to OSC | opensoundcontrol.org

Short Title: Introduction to OSC | opensoundcontrol.org

URL: <http://opensoundcontrol.org/introduction-osc>

Reference Type: Web Page

Record Number: 3

Author: musicology, UCLA Department of

URL: <http://www.musicology.ucla.edu/musicology-graduate-admissions>

Reference Type: Journal Article

Record Number: 21

Author: M.M. Saberioon1*, P. Cisar1, P. Kozak2 and M. Foøt2

Year: 2016

Title: KINECT-BASED SYSTEM FOR MONITORING MULTIPLE FISH IN AN AQUARIUM

Journal: Aquaculture Europe 2015

Rotterdam, Netherlands

Short Title: KINECT-BASED SYSTEM FOR MONITORING MULTIPLE FISH IN AN AQUARIUM

URL: <https://www.was.org/easOnline/AbstractDetail.aspx?i=4071>

Reference Type: Journal Article

Record Number: 16

Author: Hussey, Nigel E., Kessel, Steven T., Aarestrup, Kim, Cooke, Steven J., Cowley, Paul D., Fisk, Aaron T., Harcourt, Robert G., Holland, Kim N., Iverson, Sara J., Kocik, John F., Mills Flemming, Joanna E. and Whoriskey, Fred G.

Year: 2015

Title: Aquatic animal telemetry: A panoramic window into the underwater world

Journal: Science

Volume: 348

Issue: 6240

Date: 2015-06-12 00:00:00

Short Title: Aquatic animal telemetry: A panoramic window into the underwater world

DOI: 10.1126/science.1255642

URL: <http://science.sciencemag.org/content/sci/348/6240/1255642.full.pdf>

'File' Attachments: internal-pdf://0719885386/idTracker - PerezEscuderoetal_NatMethods2014.pdf

internal-pdf://3172686010/idTracker - PerezEscuderoetal_NatMethods20141.pdf

internal-pdf://0304089172/idTracker - PerezEscuderoetal_NatMethods20142.pdf

Reference Type: Journal Article

Record Number: 23

Author: Ge Wang, * Perry R. Cook, † and Salazar, and Spencer

Title: ChuckK: A Strongly Timed

Computer Music Language

Short Title: ChuckK: A Strongly Timed

Computer Music Language

DOI: 10.1162/COMJ

'File' Attachments: <internal-pdf://0719885385/2015-cmj-chuck .pdf>

Reference Type: Journal Article

Record Number: 18

Author: Francisco Jurado, Guillermo Palacios, Francisco Flores

Title: <3D Color-based Tracking System for Real-time using Kinect Sensor.pdf>

Short Title: <3D Color-based Tracking System for Real-time using Kinect Sensor.pdf>

'File' Attachments: <internal-pdf://1129566413/3D Color-based Tracking System for Real-time u.pdf>

Reference Type: Web Page

Record Number: 22

Author: Foundation, Processing

Year: 2016

Title: Overview \ Processing.org

Short Title: Overview \ Processing.org

Keywords: Processing, Sketchbook, Programming, Coding, Code, Art, Design

Abstract: Processing is a flexible software sketchbook and a language for learning how to code within the context of the visual arts. Since 2001, Processing has promoted software literacy within the visual arts and visual literacy within technology.

URL: <https://processing.org/overview/>

Reference Type: Web Page

Record Number: 29

Author: fiebrink, rebecca

Year: 2016

Title: Machine Learning for Musicians and Artists I Kadenze

Publisher: @KadenzeOfficial

Short Title: Machine Learning for Musicians and Artists I Kadenze

Keywords: Machine learning course, arduino, social media data, online machine learning, kadenze, MOOC, interactive art, Machine Art, Goldsmiths, Rebecca Fiebrink

Abstract: Learn more about the online course: Machine Learning for Musicians and Artists on Kadenze

URL: <https://www.kadenze.com/courses/machine-learning-for-musicians-and-artists-iv/info>

Reference Type: Web Page

Record Number: 2

Author: Dictionary, Oxford

Year: 2016

Title: Definition of Art

Short Title: Definition of Art

URL: <http://www.oxforddictionaries.com/definition/english/art>

Reference Type: Web Page

Record Number: 28

Author: Control, Open Sound

Year: 2016

Title: Open Sound Control - Wikipedia, the free encyclopedia

Short Title: Open Sound Control - Wikipedia, the free encyclopedia

Keywords: of Use

URL: https://en.wikipedia.org/wiki/Open_Sound_Control

Language: utschEspañolFrançaisSaisçxx"xxªæ¥æ-èªPolskiĐ ŃŃŃĐ°Đ,Đ¹SvenskaĐŁĐ°ŃĐ°ŃĐ½ŃŃĐ°Đ°Edit links

Reference Type: Web Page

Record Number: 25

Author: CalArts

Year: 2016

Title: KarmetiK Machine Orchestra Concert I CalArts

Short Title: KarmetiK Machine Orchestra Concert I CalArts

URL: <https://www.calarts.edu/event/2011-05-12/karmetik-machine-orchestra-concert>

Reference Type: Web Page

Record Number: 5

Author: Arts, BHU Faculty of performing

URL: http://www.bhu.ac.in/performing_arts/musicology/

Reference Type: Web Page

Record Number: 1

Author: Apple.com

Year: 2016

Title: What Is a Synthesizer?

Series Title: Logic Studio

Access Year: 2016

Short Title: What Is a Synthesizer?

URL: <https://documentation.apple.com/en/logicstudio/instruments/index.html#chapter=A%26section=2%26tasks=true>

Short Title: Music of the (data) spheres

Keywords: MIT, MIT News, MIT Media Lab, Responsive Environments Group, CERN, Atlas, particle accelerator, particle collisions, atomic particles, Music, sonification, Joe Paradiso, MIT research, Quantizer, LHC, Large Hadron Collider, STEAM, sciart

Abstract: A new MIT project taps into particle collisions to generate music and forge harmony between science and art.

URL: <http://news.mit.edu/2016/media-lab-quantizer-particle-collisions-science-art-0628>

Reference Type: Web Page

Record Number: 12

Year: 2016

Title: Incredibly Complicated Musical Instrument That Runs On 2,000 Marbles

Short Title: Incredibly Complicated Musical Instrument That Runs On 2,000 Marbles

Keywords: analog art, analog music, innovative musical instruments, marble machine, martin molin, musical marble machine, one man band, wintergatan, wintergatan marble machine, art

Abstract: Artist has invented a new musical instrument of mind-blowing complexity. He calls it Wintergatan's Marble Machine.

URL: <http://www.demilked.com/otherworldly-music-instrument-wintergartan-marble-machine-martin-molin/>

Reference Type: Web Page

Record Number: 11

Year: 2016

Title: Minimoog Voyager Old School I Moog Music Inc

Short Title: Minimoog Voyager Old School I Moog Music Inc

Abstract: Download Link

URL: <http://www.moogmusic.com/products/minimoog-voyagers/minimoog-voyager-old-school>

Reference Type: Web Page

Record Number: 10

Year: 2016

Title: Data-Driven DJ I Air Play

Short Title: Data-Driven DJ I Air Play

Abstract: Smog Music Created With Beijing Air Quality Data. Data-Driven DJ is a series of music experiments that combine data, algorithms, and borrowed sounds.

URL: <https://datadrivendj.com/tracks/smog>

'File' Attachments: internal-pdf://2426206510/3D Color-based Tracking System for Real-time u.pdf
internal-pdf://1101513929/AE2015_Rotterdam_saberioon.pdf

Reference Type: Web Page

Record Number: 9

Year: 2016

Title: Nathalie Miebach: sculpture

Short Title: Nathalie Miebach: sculpture

URL: <http://nathaliemiebach.com/waters.html>

'File' Attachments: internal-pdf://2044897763/idTracker - PerezEscuderoetal_NatMethods2014.pdf

Reference Type: Journal Article

Record Number: 15

Year: 2015

Title: About the ATLAS Experiment

Date: 2015-03-25

Short Title: About the ATLAS Experiment

Keywords: ATLAS, ATLAS experiment, The ATLAS Experiment, CERN, LHC, Large Hadron Collider, CMS, ALICE, LHCb, experiment, collaboration, international collaboration, scientific collaboration, particle, physics, particle physics, high-energy physics, science, science education, Higgs, SUSY, supersymmetry, dark matter, big bang, extra dimensions, heavy ion, hadron, black hole, universe, STEM, Geneva, Switzerland, Fabiola Gianotti, Peter Jenni, David Charlton

URL: <http://atlas.cern/discover/about>

END OF REPORT

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Interaction Design M.Des (2014 -16)

Guide

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