

# George Poonkhin Khut, *Distillery: Waveforming 2012* – an iPad artwork

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## ABSTRACT

George Poonkhin Khut's interactive sensory artwork, *Distillery: Waveforming 2012*, was the winner of the 2012 National New Media Art Award. *Distillery: Waveforming* is an installation artwork that utilises a prototype iPad application. Khut has an interest in the continued development of the application to the point of making it available as a download from the iTunes App Store to be used in conjunction with specialised pulse-sensing hardware. Its presentation in 2012 at the Gallery of Modern Art included five iPad stations integrated into a long table that faced three monitors, showing video portraits of the artwork application in use. Visitors sat down at an iPad and clipped on a heart rate sensor that actuated mandala-like visualisations that reflect the visitor's real time heart rate patterns.

As the winning artwork it was acquired into the Queensland Art Gallery collection. The Curator of Contemporary Australian Art intended that the acquisition would be structured in such a way as to ensure that the artwork was captured in perpetuity in its prototype state. To achieve this it was necessary to safeguard the independent operation of the five Apple iPad 3rd generation devices and to permanently install a non-expiring copy of the prototype application. In order to acquire the artwork as a prototype the Gallery's audio visual conservator, in consultation with the artist and the artist's technical support, managed the modifications of the iPad 3rd generation devices using jailbreak techniques.

This paper describes the development of the artwork and the issues that were addressed during the acquisition and archiving of an iPad artwork.

**Keywords** George, Poonkhin Khut, app, iPad, preservation

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## INTRODUCTION

George Poonkhin Khut is an artist interested in body-focused interactive art and design and has described himself as a 'practice based researcher' (Khut & Muller 2005, p21). He embeds his art practice within research frameworks and utilises objective methodologies to model and evaluate his work. Khut develops propositions, aims and goals in support of his practice that can be measured, demonstrated and validated.

Khut's 2012 digital artwork *Distillery: Waveforming* is a biofeedback, controlled interactive experience (Figure 1). The artwork was conceived as an iOS 5 (mobile Operating System) application (app) for Apple iPad. Visitors sit down at an iPad station, put on headphones and clip on a heart rate sensor and begin to see coloured oscillating concentric circles forming on the iPad screen. These animated mandala-like visualisations are controlled by the real time heart rhythms of the user. By altering their state of relaxation the user can change the appearance of the visualisations. Participants hear the sound of the pulse, resynthesised via the electronic sound design, and as they relax the corresponding decreases in heart rate trigger chime-like sounds that are fed through the headphones. When the user touches the iPad screen data relating to their heart rate is graphed over the visualisations (Figure 2). The artwork was selected as the winning entry in the 2012 National New Media Award and was subsequently acquired for the Queensland Art Gallery (QAG) collection.

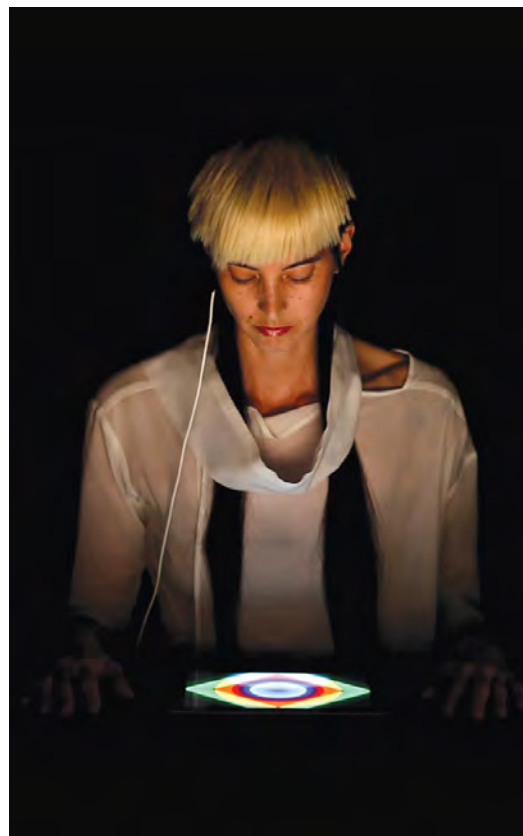


Figure 1. George Poonkhin Khut, Australia b.1969, *Distillery: Waveforming (Portrait of Lian, January 2012)* 2012, HD video: 24 minutes, 9:16, colour, stereo Camera: Julia Pendrill Charles; styling: Troy Brennan, The National New Media Art Award 2012. Purchased 2012 with funds from the Queensland Government



Figure 2. *Distillery: Waveforming 2012*, screen capture of heart rate controlled iPad app

## THE BIOFEEDBACK EXPERIENCE

Biofeedback is 'the use of electronic monitoring of a normally automatic bodily function in order to train someone to acquire voluntary control of that function' (Oxford Dictionary of English 2012). *Distillery: Waveforming* is a biofeedback artwork that focuses on autonomic cardiovascular function. The artwork captures bio-input through a heart rate sensor, where an Apple Mac mini computer processes the heart rate data and maps the sound and visuals that are fed back to the user as animations on an iPad. The user engages with the artwork and can induce changes in the mandala-like visualisations through changes in their state of excitation through to relaxation. Khut's (2012, p2) specific experimental aims with the artwork are that the user:

- Feels able to influence the appearance and sound of the work in some way through adjustment of their overall relaxation/excitement/stress levels.
- Feels a sense of connection and extension of their body – into the appearance and sound of the artwork.
- Experiences occasional ambiguity as to who or what is influencing the appearance and sound of the work (this ambiguity propels a range of reflections and assessments as to 'what is me and what is not me' that are crucial to the experience and effect of the work).

## DISTILLERY: WAVEFORMING PRESENTATION PARAMETERS

The configuration presented at the Gallery of Modern Art in 2012 consisted of five iPad stations built into a long, shallow, tilted table at which visitors could sit on low stools and interact with the artwork. The installation space was designed to effect a sense of calm and contemplation utilising low light levels, soft dark colours and spatial arrangement that situated users in front of three video portraits of the artwork in use



Figure 3. George Poonkhin Khut, Australia b.1969, *Distillery: Waveforming 2012*, Custom software and custom heart rate monitor on iPad and Mac mini signal analysis software: Angelo Fraietta and Tuan M Vu; visual effects software: Jason McDermott, Greg Turner; electronics and design: Frank Maguire, Installed dimensions variable, The National New Media Art Award 2012. Purchased 2012 with funds from the Queensland Government. Image: Mark Sherwood

However, in discussions with the artist, Khut indicated that the artwork could be reconfigured in future presentations to incorporate a minimum of three stations at a table but that the installation as a darkened, quiet, self-reflective space was essential (personal communication, 26 November 2012). The three video portraits - *Portrait of Lian, January 2012*; *Portrait of Bec, January 2012*; and *Portrait of Rob, January 2012* could also be used as individual artworks.

The electronic and technological aspects of this artwork are managed subtly within the installation space. The iPad stations are built into the table, exposing only the touch screens which remain on throughout the day. The heart rate monitors clip onto the participant's ear and the headphones are a non-enclosed headband type that allows the user to focus on self-reflection while still being subconsciously aware of their general surroundings. The video portraits are played on unbranded, clean line monitors hung in portrait orientation and are presented in the manner of traditional portraiture, being compositions in half-length depicting the subjects engaged with the artwork. The processing, analysis and data feedback are driven by equipment that is completely hidden, built into the table and behind walls. This overall discreet use of technology contributes to the tranquillity that the installation achieves.

## THE BIOFEEDBACK PROJECT

Khut has described his approach to the biofeedback project as 'iterative' (Khut and Muller 2005). Each new development in audience experience and technological advance has led to incremental changes in the way Khut can present the interactive artwork. *Distillery: Waveforming 2012* derives from Khut's earlier work on BrightHearts that commenced in 2011 and his *Cardiomorphologies* series from 2004-2006. Khut developed the mandala-like visualisations in his work *Cardiomorphologies* and rewrote the programming for the BrightHearts project. The BrightHearts project proposed the development of a multimedia biofeedback interactive for the control of anxiety in children undergoing recurrent medical procedures (Khut et.al 2011). The BrightHearts iOS app was launched in November 2011 and clinical trials of the app will commence in 2014 at the Children's Hospital, Westmead (personal communication, 14 October 2013).

## THE IPAD APPLICATION

Khut maintains ownership of the biofeedback source code and in 2011 he commissioned Jason McDermott, a multi-disciplinary designer, to re-write the original visualisation software that was developed by Greg Turner in 2005, to enable it to run on hand-held technologies with touch sensitive controls (personal communication, 14 October 2013). In the development of the BrightHearts app, McDermott utilised the online open source tool kit iOS C++ Library and openFrameworks for open source programming to redesign and expand the potential of the original *Cardiomorphologies* visualisation software (McDermott 2013).

The new app, called BrightHearts, is an iOS 5 mobile operating system application for Apple® touch screen devices. The application was developed and written for Apple iPad 3rd generation under a short-term developer's licence that allowed the app to be tested. The licencing arrangement for the BrightHearts app expired in July 2013, 9 months after the artwork was acquired by QAG. However, in November 2012 Khut visited the GOMA conservation laboratory and reinstalled a modified, non-expiring version of the BrightHearts app onto the iPads. Following this procedure, after consultation with McDermott the recommendation from Khut was to jailbreak the iPad devices to allow for management of the software systems for the life of the artwork.

## THE MAX6 PROGRAM

Max6 is the programming software that is used to analyse the heart rate data and control the audio and visuals that are sent to the iPads. Specific technical modifications to the Max6 program were necessary for the installation of *Distillery: Waveforming* in the 2012 National New Media Award. These adjustments exist as individual master patches for each iPad device and were necessary in order to transition the program from a previous version developed for MacBook Pro to the Mac mini 5.2 devices that were used for *Distillery: Waveforming* (Khut 2012, p6).

## COMPONENT OVERVIEW

In this prototype format *Distillery: Waveforming* is an ensemble of parts that includes the iPad app and external data collection and processing services (Figure 4). The combined hardware and software systems include:

- Five Apple 3rd generation iPads running iOS5.1.1, with retina display high resolution (2,048 x 1,536 pixels at 264 ppi) –
- Running BrightHearts app
- Five Mac minis 5.2, 2.5 GHz dual-core Intel Core i5 processor, 4GB RAM, 10.7.5 (OSX Lion) operating system –
- Running Max6
- Running pulse received application run from OSX 'Terminal' utility
- Five heart rate sensor systems that incorporate a Nonin PureSat Pulse Oximeter (ear clip type), a Nonin OEM III Pulse Oximetry circuit (serial interface) and an Arduino Pro Mini 328 – 3.3V/8MHz microcomputer –
- Running OemPulseFrank.pde code onto the Arduino microcomputer

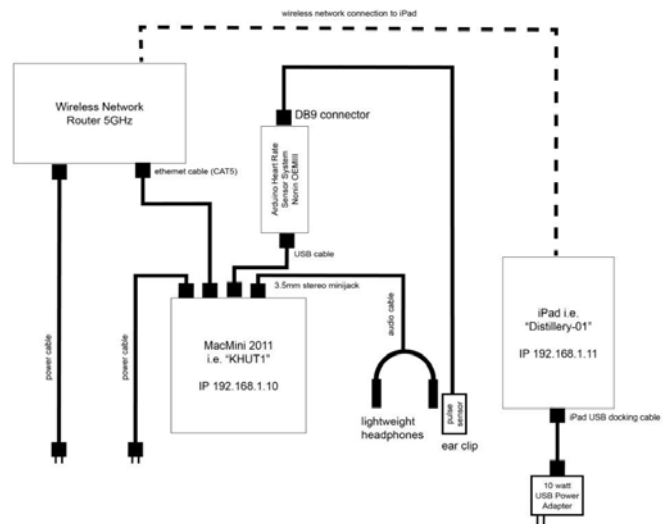


Figure 4. Hardware assembly and installation map (Khut 2012, p18)

- One 5.0 GHz network router that transmits control data from the Max6 software on the Mac minis to the corresponding iPads Three digital portraits displayed on LCD / LED monitors hung in portrait orientation Video files include MPEG-4, QuickTime ProRes and AVC file formats
- Five headband-style stereo headsets

## ACQUISITION OF A PROTOTYPE BIOFEEDBACK ARTWORK

*Distillery: Waveforming* was the winning entry in the 2012 invitational National New Media Award and subsequently entered the QAG collection via compulsory acquisition. The award was worth A\$75,000 and Khut expressed an interest in using the funds to further his work on the BrightHearts app, to make it available as an iTunes download for use with separate specialised, pulse-sensing hardware (personal communication, 26 November 2012).

The curator of Contemporary Australian Art, Peter McKay felt strongly that the artwork should be acquired into the collection as a prototype, capturing in perpetuity the artwork as an increment in Khut's biofeedback project. *Distillery: Waveforming* 2012 is both an installation artwork and a model demonstration of the BrightHearts application for touch screen devices. Therefore, it was considered important that the acquisition process ensured the integrity of the work as a prototype.

## THE ARCHIVING STRATEGY

An archiving strategy was developed in consultation with the conservator, the curator, and the artist who was also in contact with the software developer. Taking into consideration the curatorial imperative to maintain the work as a prototype, archiving discussions focused on ways of gaining control of the application and operating system to lock the work down as a snapshot in time. The two options that presented as possible archiving strategies were relicensing the application or jailbreaking the hardware. In addition to this, the Gallery has chosen to retain a number of Apple iPad 3rd generation devices as replacements for the five that have been acquired as individual parts of the total installation.

## RELICENSING THE APPLICATION

The possibility of relicensing the application prior to the expiration of the developer's license was considered. Apple offers an Enterprise License for Apple approved applications. This license is a renewable 12 month agreement and would require ongoing reinstallation and updating of the BrightHearts app onto the iPads. Concerns with this licensing arrangement included the need to upgrade and reinstall the application on a regular basis and the possible need to make alterations to the source code to make the app launch following reinstallation. Relicensing also did not address the potential problem of future iPad upgrades (from iPad 5th generation and iOS 6 onwards). It is not possible to downgrade the operating system on an iPad to a previous version, so there was a reasonable risk of losing access to the iOS 5 operating system, which is essential to launch the application as the 2012 prototype. Therefore the best course of action for the long term preservation of the artwork appeared to be jailbreaking.

## THE JAILBREAK RATIONALE

Jailbreaking could be described as a legitimate form of hacking that allows a user to gain access to file and operating systems. The process, otherwise known as 'privilege escalation', disables the proprietary restrictions imposed on devices and opens them up for greater functionality and control. For the purpose of this artwork, the jailbreak allows access to load unlicensed or unapproved applications to the device.

The act of jailbreaking raises the issues of copyright infringement and voiding warranty protection. The legality of jailbreaking a device under Australian law has yet to be tested as no case has been brought to court (Chown 2012; Page 2010). Sections 132APC and 51A of the Australian Copyright Act 1968 are both relevant to the acquisition of *Distillery: Waveforming* 2012. 132APC applies to circumvention of access and security measures for technologies and 51A is a special provision for collecting intuitions that allows for copies to be made of original materials and artworks for the purpose of preservation (Commonwealth Consolidated Act). Under this legislation it seemed reasonable that the Gallery could acquire and ensure the long term preservation of an artwork that incorporated jailbroken technologies.

In the case of *Distillery: Waveforming* the decision to jailbreak the five iPad 3rd generation devices was based on the need to be able to manage the permanently installed, non-expiring copies of the app on the devices. During development the prototype iOS application was available for provisioning on a 12 month license, after which the application would no longer launch. The BrightHearts app for *Distillery: Waveforming* was designed to run on the iOS 5 operating system and can not run on upgraded or new iOS versions without revision to the original source code. It was also important to have the capability to reinstall the application software onto the iPads should it be necessary to overcome malfunctions that may occur throughout the life of the artwork. Therefore, in order to gain the required level of control over the management of the artwork it was deemed necessary to increase the end user control through jailbreaking.

## THE JAILBREAK PROCEDURE

The jailbreak of five iPad 3rd generation devices was undertaken by Khut's software developer, Jason McDermott, and once completed were returned to the Gallery. An untethered jailbreak procedure was performed on the devices to circumvent the iOS security and protection controls. An untethered jailbreak is a permanent alteration to the device and ensures that the jailbreak is active each time the iPad is turned on. The jailbreak ensures that the BrightHearts app is able to launch in its prototype state. The iPads are loaded with three core jailbreak applications (Figure 5) including:

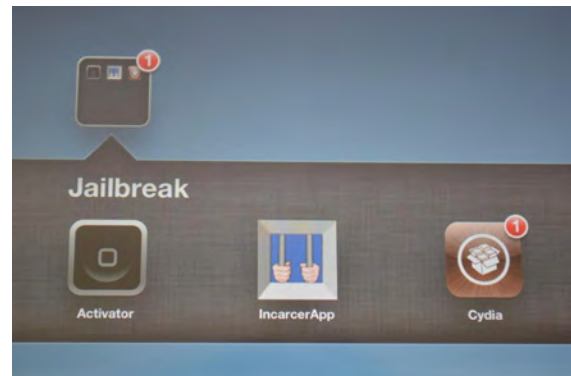


Figure 5. Image of jailbreak package on an iPad 4 device

- Activator – a jailbreak application launcher for mobile devices
- IncarcerApp – an application that disables the home button and effectively locks on the BrightHearts app when in use, preventing the user from inadvertently exiting the app
- Cydia – a software application that enables the user to search for and install applications on jailbroken iOS devices

## THE DIGITAL FILE ARCHIVE

Khut supplied the digital files for the artwork on a portable hard disk drive, the contents of which were directly transferred to the Gallery's Audiovisual Collection Archive on the storage area network, managed by the Information Technology department. The digital archive contains a multitude of files stored in distinct file containers for the backup of the artwork. The containers include:

- The BrightHearts application with Max6 patches
- Lion and Mountain Lion operating systems for reinstallation onto the Mac minis
- Source code for compiling the BrightHearts application with Xcode
- Source code for compiling the pulse-sensing Arduino microcontrollers
- Supporting video documentation of the animated visuals
- *Distillery Waveforming* video portraits in ProRes and H264 formats

## THE IPAD DEVICES

Notwithstanding inherent hardware malfunction, the most likely cause of iPad failure is thought to be the end of the battery lifespan. iPad devices use built-in, but replaceable, rechargeable lithium-ion battery technology. Apple (n.d.) reports that the lifespan of an iPad lithium-ion battery should extend to 1000 full charge and discharge cycles.

When on display *Distillery: Waveforming* iPads are permanently plugged into an external power source for the duration of the exhibition and therefore do not rely on battery operation. It is possible to connect iPad devices to external power sources for long periods of time without harming the battery function because the charging circuit has been designed to shut down when the battery is at full charge, placing it in a latent mode while external power remains in use (Hollington 2012). However, it is essential that the battery system is managed properly for the long term preservation of the artwork and scheduled discharge and recharge cycles have been incorporated into the maintenance program for this artwork. Apple advises the lithium-ion batteries require use in order to maintain good device performance and recommend that the battery should complete one full charge/discharge cycle at least once a month (Apple n.d.).

## CONCLUSION

Digital artworks are inclined to be superseded within a short space of time and as such can be complicated acquisitions for collecting institutions to manage, particularly as institutions plan on long term preservation strategies. In the acquisition of *Distillery: Waveforming 2012*, the consultation and implementation process has been thorough and protracted with discussions commencing in September 2012 and aspects of the archiving yet to be completed more than one year later. The prolonged nature of this acquisition and archiving project reflects the range of complex issues that needed to be addressed and the technological modifications that have been performed. Khut has written an extensive user's manual for the artwork that is currently in draft form and has yet to be completed. It is an essential component of the acquisition and even in its incomplete state, it is a bible for this artwork.

The decision to proceed with the recommendation to jailbreak the iPad devices was based on discussions with the artist and an understanding of his artistic practice, within which *Distillery: Waveforming 2012* is an increment in the ongoing biofeedback project. To capture the artwork as a prototype iPad interactive, jailbreak modifications presented as the most reliable means of managing the artwork in the long term.

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