# Creative Applications of Interactive Mobile Music

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### Abstract and Keywords

This chapter examines the foundational research concerning the applications of interactive mobile music conducted at Sony Computer Science Laboratory Paris and at Culture Lab Newcastle. It analyzes the forms and formats that music can take on when deployed on mobile devices and wireless infrastructures and looks at the development of conceptual thinking of mobile music creation outside the sphere of consumer markets and commercial applications. The chapter also discusses efforts to leverage the possibilities of contextual sensing coupled with dynamic media delivery systems to create new musical experiences that can be shared by groups of performers and listeners.

Keywords: interactive mobile music, mobile devices, music creation, conceptual thinking, contextual sensing, musical experiences

past decade has seen enormous development in the portability and mobility of musical content, aided by advances in mobile wireless networks and the miniaturization of data storage. This chapter reviews foundational research conducted in this period at Sony Computer Science Laboratory Paris (CSL), a noncommercial industry laboratory for fundamental research, and at Culture Lab Newcastle. The work draws upon methods from creative practice and reexamines the forms and formats that music can taken on when deployed on mobile devices and wireless infrastructures. It takes as a fundamental point of departure the notion of music as an emergent, fluid form that is expressive and contextual rather than a fixed media industry commodity. With this, the chapter covers a range of contexts, including domestic environments, scenarios of socializing, locative media, and interactive music performance. Taken together, the body of work presented here provides insight into the development of conceptual thinking of mobile music creation that is outside the sphere of commercial applications and consumer markets.

## Convergence and Integration: From Walkman to iPhone

It is natural today to imagine, and utilize, advanced portable devices that are at once mobile telephone, personal music player, and digital camera. These devices, symbolized by the Apple iPhone and a range of smartphones built on the Android and other operating systems, are for the most part also connected to mobile broadband networks, and provide location sensing by means of the Global Positioning System (GPS). It is interesting to note that these products are almost all referred to as mobile *phones*. This implies that their communications functions take primacy and that their musical and imaging (p. 471) functions are secondary. As a composer, I was interested in turning around this relationship to conceive of advanced musical scenarios that could be supported by wireless content streaming, gesture detection, and location awareness.

Whether music takes the fore or not, the coexistence of such functionality on a single device represents not only a high level of technology integration but also forms of conceptual convergence. While the technology exists in an integrated manner on a single piece of hardware, less attention has been paid to the actual integration of usage. Music playing, telephoning, messaging, photo taking, location mapping are separate applications that change the mode the device is in. To date, there have been no forward-looking apps that might, for example, pipe one’s current MP3 playlist as background music to a telephone conversation, or allow associations of music and photographic image. Raskin’s notion of modelessness in screen-based interface design allows users to more productively manage multiple tasks. Moving from modal interfaces to modeless interaction is less trivial on portable devices, given their limited screen size and in-the-while use contexts, but tackling these challenges might contribute to more imaginative use integration of the different media functions on mobile devices.

Jenkins extends the mechanics of simple feature integration to propose the concept of *technological convergence*. Beyond the functionalities of sound, image, location, and communications is a higher level convergence of consumer electronics hardware, media content, network data and other services. Convergence products have seen enormous development in recent years, most notably by Apple’s iTunes system that couples entertainment content and application software catalogues to their hardware line up. This convergence, however, has taken place at a commercial level and has not resulted in a fundamental change in the actual content, its form and format, to otherwise exploit the new possibilities afforded by personalized, context aware network distribution. In online music distribution, a single is still a single, and an album is still an album. In the work described here, we adapt existing music into new, malleable formats specific to the infrastructures on which they reside, and imagine entirely new forms of music created specially for these systems.

The idea to combine a personal music player with a mobile telephone seems a natural fit. Besides the challenge of technology integration and conceptual convergence, there are underlying differences in the cultural contexts of music listening and communications that render this combination nontrivial. Bull notes the isolating experience of headphone listening, while Ito and Matsuda report on the constant contact that mobiles provide. While MP3 players and cell phones share many qualities—they are portable devices, they are audio devices, they are highly personal devices—in the end they each serve very different social functions. The work presented here seeks out ways in which to bridge these differences to imagine what a true convergence device might be like. We shall call upon notions of social computing to see how music can serve the new social dynamics that mobile networks allow. We will see from an audio processing perspective how participative, flexible content forms can be supported. Finally, we will look at real world issues of deploying such systems on off-the-shelf mobile phones and commercial cellular telecommunications networks.

## (p. 472) Location Sensing

Dynamic geographic location is one of the fundamental characteristics of a user in a mobile environment. Mobile use implies that the user can access the same universe of information wherever he might be—*anytime, anywhere*. Designing information systems for mobile use, however, entails more than just porting a web page meant to be viewed on a desktop computer to display on a mobile phone screen. Not only do the screen dimensions and device form-factor change, but the usage dynamic. Here, we focus less on providing a single information stream when in movement but rather on shifting needs when location changes. Commercial location based services exist in many flavors—from the simplicity of geo-tagging Twitter photo uploads to broadcasting location updates to “check in” on Foursquare, to GPS city tours guided by movie stars, but the killer location-aware app has yet to arrive. Much in the way that the challenges of creating information spaces for mobile environments is distinct from those meant to serve stationary settings, I argue that imagining music for mobile environments should go beyond the act of putting one’s whole album collection in the shirt pocket. Here we look at ways in which location sensing can be used in a musical way to create new, contextual musical experiences.

Artists in the field of *locative media art* have seized on the creative potential of geographic information. This includes the visualization of movement across geographic space in the form of drawings, to tagging of physical space by sound as in Mark Shepherd's Tactical Sound Garden. Theatrical choreography linked to displacements of participants is seen in the seminal work of Blast Theory. In sound based projects, the city can become interface to a generative electronic music system in systems like Sonic City. Yolande Harris's projects meanwhile undo assumptions of multi-user connectedness typically associated with systems to focus on the data jitter of stasis.

The Global Positioning System is the technology most commonly associated with location tracking but is not the only solution. The projects described there have used motion capture techniques, Bluetooth signal reception, GSM antenna strength, as well as GPS to sense user location. Each technology has its advantages and disadvantages with each approach having distinct characteristics, such as accuracy and response time, that have an effect on the musicality when used as an input to sound processes. In this way, we take a view that geographic localization is not one thing, but a form of information that can be captured in different musical ways.

## Domestic Environments

While GPS location tracking assumes, and operates only in, outdoor environments, indoor location sensing continues to be a highly relevant task and nontrivial technical (p. 473) challenge. Starting in 2002 with the *SoundLiving* project, we used low power Bluetooth base stations to arm a domestic environment in order to create personalized spheres of sound that could follow a user throughout the home (Figure 19.1). It resulted in a working prototype designed to augment a home stereo system where, in place of the traditional remote control for the hi-fi system, the user had a Bluetooth probe that could communicate with receivers in each room. The listener would use the touchscreen on the device to select what music to play. Once the music was playing, if the listener moved to another room in the house, for example from the living room to the kitchen, the probe announced his presence to the room he just entered, and caused the system to re-route the network data stream carrying the music, in a seamless manner, from the living room to the kitchen. From the listener's vantage point, the music simply continued uninterrupted, and just naturally started coming out of the speaker system in the kitchen and stopped playing in the living room stereo. It was as if the music he was listening to constituted his personal audio sphere that followed him around the house.

*Click to view larger*

*Figure 19.1* Example in SoundLiving of sound following user from selection made in bedroom from the stereo next to the bed down the stairs to the stereo in the kitchen.

The design of this first system separated the mobile device (in this case the personal location probe) from sound production (the speakers of the stereo systems). Hidden behind what otherwise looked like a common hi-fi system were localization (p. 474) and network routing services that integrated the different speaker systems throughout the house.

Products for wireless broadcast of audio throughout the home have since been introduced, including Apple's AirPlay. However they are for the most part cable replacements, and at best based on a broadcast model where a single source can broadcast to multiple wireless speakers. Technically they do not perform location sensing, and more important, conceptually, they do not broach the personal nature of music that can take on embodied qualities as it is co-located around, and relocates according to the listener's movements. The SoundLiving system was unique in providing a continuity of music delivery, creating the sense of a location-aware personal audio bubble.

## Malleable Content

In moving from an indoor, domestic space to imagining how music might be deployed across a multi-user, geographic space, we conceived a music remix software engine to generate continuous variations on well known popular music based on location. The idea was that each participant in a group would be represented by a part, or an instrument, in the music, and that their relative proximity would be mapped to the amplitude of that part in the total mix. The user's gestures and actions on the mobile device (the personal context) would modulate effects on his own part, and give the others in the group an idea of his behavior—whether he was running, dancing, or just sitting still. Meanwhile the mix of parts would reflect the social context reflected in the location data. The resulting mix was streamed from the server side engine back over wireless broadband networks to each of the mobile devices. All members of the group heard the same stream, thus creating a shared experience. The notion that the remix of a song could reflect the behavior of each participant as well as the global state of the group, creates what we term a *social remix*.

We implemented the Malleable Mobile Music system using a familiar pop song by the artist, Björk. We detected the global tempo of the recording, and used it to build a temporal map of the song. In this map we identified large scale structure (such as verse and chorus), and the appearance of different musical parts in each section (voice, percussion, horn section). The Malleable Music engine then used the song map as an index into the original recording, instantly seeking to any measure in the song, and looping on a certain loop length for a certain number of iterations. The server instantiated multiple voices of this engine (as many voices as there were participants in the system), and was able to synchronize them. In a three user system for example, three voices were independently playing on arbitrary sections of the original song, were synchronized in rhythm, and mixed to an output streamed to all the mobile devices. In this way, with the map and the original recording, a kind of live cut/paste remixing took place.


*Click to view larger*

*Figure 19.2* Malleable Mobile Music—with client device displaying 3 visual avatars (right) and a location service simulator (left) interface for testing location-dependent social music remixes.

In this example, music became a direct carrier of social information. The part in the music that represented each user became their *musical avatar* (Figure 19.2). The remix (p. 475) unfolded following the movements of the participants. One user could hear the proximity of another by noticing the volume of their part in the mix. One could guess at their activity through the filtering and delay effects that were heard on their part. This points to the use of music in the area of ambient information displays where the user does not need to take any explicit action (such as making a phone call or sending a text message) to gain relevant information on their friends' relative proximity and activity. This social information is embedded into the musical content itself, and perceived through the otherwise normal activity of music listening.

This work builds on a long tradition of rendering existing music interactive. Early examples included Peter Gabriel's CD-ROM, *Xplora 1* originally published in 1995. Since the original malleable music research was conducted in 2004, the technology company MXP4 has introduced a new file format in 2006 separating component tracks of a musical composition for playback in a synchronized interactive manner to facilitate listener remixing. Artists like Trent Reznor have published web-based remix systems in 2007. While all these systems and formats are similar in that they permit music to be deconstructed and reconstituted, the commercial products cited here focus on a single user actively engaging in the remix process. With Malleable Mobile Music, we were interested not just in deploying such an interactive music system in geographic space, but (p. 476) to re-contextualize music following Erickson's notion of *social translucence* to become a location-aware and responsive media form that could reflect back to the listener the state of her immediate social group.

## Sensing the Self within a Group

A perceptual challenge exists in decoding fluid changes in abstract forms such as music when they are meant to represent concrete phenomena such as physical proximity. Social translucence describes the representation of social dynamic in information displays and is a term used in social computing to describe the use of social information to support collective action. A key element in the decoding process is the task of situating oneself within the whole. In a location based remix, the instrument that represents the listener may stay at a constant volume with respect to other, dynamic voices. Giving local context to the listener's own part may provide reflexive understanding of the situation that may aid that listener to decode the wider context of other users. We extended Erickson's original term to coin the term *reflexive translucence* to include the user's own sense of agency and place in a group situation.

In order to heighten the listener's sense of agency, we implemented two ways in which the system responded to local context. One was through a sensor subsystem on the handheld device that detected grip pressure, rotation, and shaking, and the second was a localized audio display. This research took place in 2005, two years before the release of the iPhone popularized the integration of accelerometers in mobile devices to detect rotation for user interface features. In our system the local sensors (Figure 19.3) detected gestures that the listener performed, consciously or subconsciously, while listening to music. The gesture as captured by pressure and accelerometer sensors in turn affected the music being listened to, creating a feedback loop of perception, reaction, and enaction. In a multiuser musical environment such as a social remix, the sensors local to one listener gave that listener interactive feedback on his own part, creating a different and identifiable immediacy relative to the more slowly modulated mix of part representing the other users.

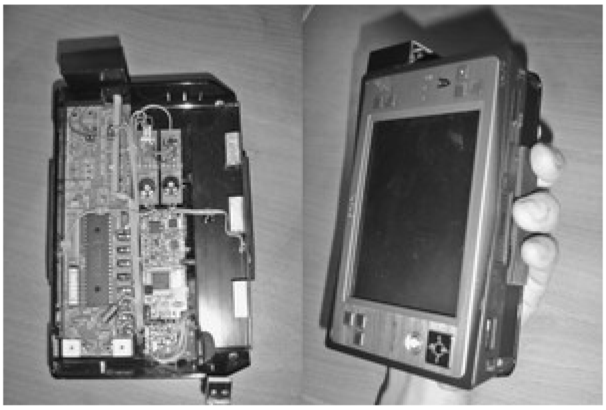

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*Figure 19.3* Visceral Mobile Music device—a palmtop PC with custom sensor acquisition card capable of sending two pressure sensors, two tilt sensors, and a gyroscope to pick up the personal context of the listener.

The local sound output of the mobile devices could be directed to a built-in speaker on the device, or to its headphone output creating a separate audio stream from the whole mix that might be playing in a room. This helped to situate the device and its listener in a physical space and himself in the midst of a music that projected multiple users' states. This acoustically placed a sound source in the space and differed markedly in effect compared to the virtual surround sound panning representing the group. The use of local outputs or network as audio destinations and the possibility to render audio in the public space or locally to headphones constitutes a multifaceted, hybrid audio space. This hybrid model supports the two social contexts, personal and community. (p. 477)

## Into the Wild—The Real World and Real Mobiles

In the social remix example, we were concentrating on how generative music content and delivery could respond to personal and community contexts. Community context was derived from geographic data generated by a location simulator module that placed three visual avatars on a city map. By dragging the avatars across the screen, the simulator generated geographic data. With this the Malleable Mobile Music engine was set up to receive geographic data as control input from the network. It helped us conceive of ways in which the music would evolve as community members moved around. The next step was to move beyond the simulator and look at location tracking techniques that would work out on the streets. This work, originally conducted in 2003, was done in anticipation of the broad mass-market deployment of 3G/UMTS mobile broadband in Europe around that time. With the arrival of 3G and handsets supporting these infrastructures, these early experiments led to real world implementations.

First generation 3G mobile phones in 2005 were beginning to be multimedia capable. They had high resolution color screens, built-in mega-pixel digital cameras, and could (p. 478) be programmed using Flash and Java J2ME. If the mobile's capabilities were limited, the 3G networks were even more so. The Malleable engine works over live MP3 streaming over the network. Signal coverage was and continues to be a problem for persistent connections such as audio streaming. Moreover, advanced control over ports and network protocols such as RTSP remained in the hands of the telecommunications network operators. While the internet is governed by an international series of committees and standards defending openness, 3G networks are governed by private entities who decide what parts of the network are accessible based on their own commercial interests.

The reality of implementing a streaming mobile system is non-trivial. The mass market mobile internet applications available today are for the most part based on web services, and reduce the scope of network communications mostly to the HTTP protocol. To this day, fixed line streaming music services, like Spotify, operate on a download-based model for their mobile version. Meanwhile in our research, conceptual development of possibilities of locative media interaction continued to develop. Despite the technical limitations of 3G networks, GPS, and the capabilities of mobile phones, the goal of these projects was to create a community-based, location aware music system. While the initial prototypes ran on various non-telephone devices, it was imperative to make the system run on mobile phones—to bring to a logical end the initial concepts, to validate them on the true target device, one that is already charged with cultural associations and common usage patterns. How could we implement a new music listening experience on mobile phones, and what were the requirements to create an engaging experience within the practical constraints of contemporary infrastructure and technology?

Conceptually we accompanied movements of the time in the area of locative media arts that drew upon radical ideas of the Situationist International movement in the 1960s. Festivals like Conflux in New York were dedicated to the notion of *psychogeography*. Many mobile media projects drew upon the related concept of the dérive. *Net_Dérive* was a collaborative work with Petra Gemeinboeck and Ali Momeni that sought to create a mobile audiovisual derive through a work of locative music.

While we wished to utilize commonly available mobile telephone technology, we were interested to push beyond the typical cultural associations and musical contexts linked to those associations. We created a hollow scarf-like structure out of neoprene fabric that housed two phones and a then necessary external GPS device. There was one phone on each end of the scarf, and the GPS mobile in the middle, behind the neck. The result was an object inspired by research in wearable computing, where computing functionality is integrated into clothing (Figure 19.4). The user donned the scarf, and wore the headphones that came out of one of the ends. On the other end was the second phone whose display was visible. Only the buttons relevant to use in the project (the 5-way button) was accessible. Other controls on the phones (the numeric keypad in particular) were covered by the scarf to prevent unintentional button pushes.

*Click to view larger*

*Figure 19.4* Net_Dérive wearable device—two Symbia S60 devices and Bluetooth GPS module enclosed in a scarf-like garment.

GPS coordinates were reported to a location server automatically every five seconds. A photo was taken by one of the phones every 20 seconds and uploaded to the server, tagged with GPS coordinates, thus leaving a visual trace. The server logged all this data in (p. 479) XML files, keeping a separate record for each user, the path they took, and the images that were taken during their walk. Meanwhile one of the phones captured audio and streamed it up to the server, as a live input feed to the media content engine. The server-side content engine had several modes of visualizing the users' walks based on the GPS data and the photos taken along the way. The walks were *sonified*, generating rhythmic sounds based on the relative proximity of the users, and mixing that with live processing on the audio feeds coming from each phone. The resulting graphics and soundscape were streamed back down to each mobile device, heard on its headphones and seen on its color display.

The content in this case was not based on existing music as had been the case in the previous example. Instead here we were interested in looking at whether sound and image could work together to sonify/visualize the state of the community to each of the users while on the move. The goal was to create a satisfactory experience for the user within the technical constraints described earlier.

## Aggregation and Meta-data Tagging

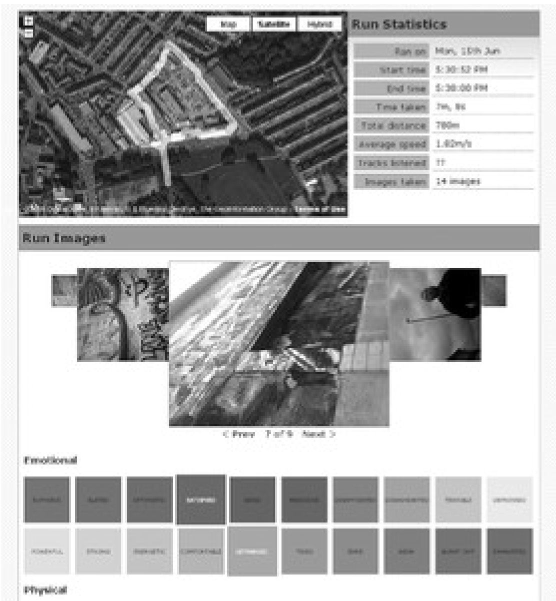


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*Figure 19.5* Dry Run—tagging interface following a run showing GPS trace, statistics, and photo trace for tagging by emotional and physical descriptors.

In 2008 a major sporting event provided us the opportunity to explore the effects of mass numbers. The Great North Run half-marathon commissioned the artist group, NAME, (p. 480) using technology from Culture Lab for a mobile, to create an online project tracing the emotional trajectory of a long distance run. The result was *Dry Run*, a prototype that tracked ten runners over one month of training for the event. Using the logging functionality from Net_Dérive, the run was automatically documented in geo-tagged photographs, generating an image bank that re-traced each training session. Photos from each run were additionally tagged post-facto by meta-data from the runner. This geographically and emotionally tagged visual trace of the run was designed to be correlated to the playlists of music that had been listened to by the athlete during the training. While unfinished, the project brought a different perspective to mobile music than the continuous, (p. 481) personal creative streams that had been explored in the previous projects. The sequence of events, outlined here, included capture, tagging, aggregation, and visualization.

During the run, a mobile device running custom Symbian software was used to replace the MP3 player commonly used by runners to listen to music during training. On this device, the runner had, in the classic manner, loaded a playlist of music to accompany this run. Upon starting the run, she initiates software on the mobile which plays the playlist, and activates the GPS module, built-in camera, and 3G broadband network. Similar to Net_Dérive, the journey is documented by an automatic series of photographs taken once per minute that are geo-tagged with the latitude and longitude data, and uploaded live over 3G mobile broadband to a fixed line server. Additional functionality not found in Net_Dérive include associating the current music with the photo. In essence, each photo was time-stamped, geo-tagged, and music-tagged.

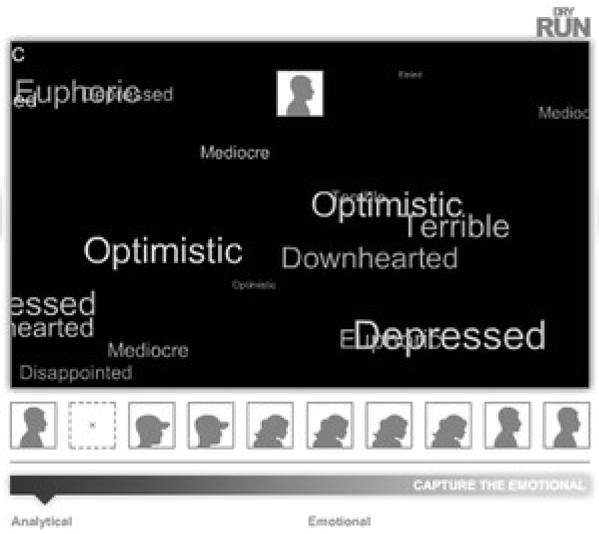


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*Figure 19.6* Dry Run—tag cloud visualization of emotional and physical descriptors.

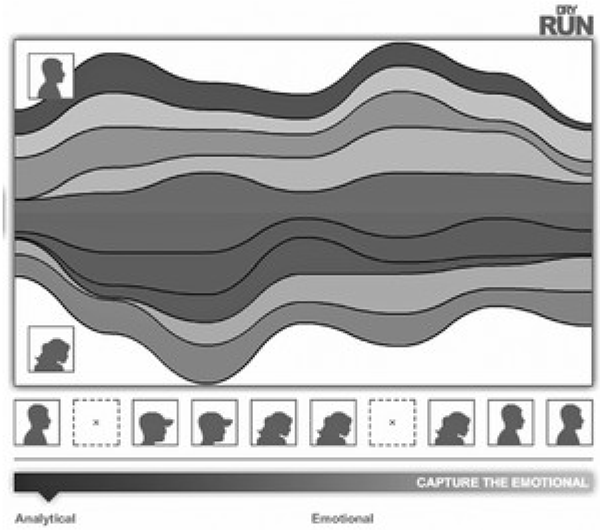


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*Figure 19.7* Dry Run—exertion curve visualization of emotional and physical descriptors.

Following the run, the runner completed the process by meta-data tagging photos from the run using a post-training interface (Figure 19.5). A series of descriptors drawn from sports science studies that describe physical and emotional exertion during sport were proposed in drop-down menus as possible meta-data tags for the runner to select and associate with each photograph retracing the run. This created a topologically correlated physical and emotional trajectory characterizing a run which could then be visualized in different ways (Figures 19.6 and 19.7). **(p. 482)**

The aggregation of multiple runs by any single runner, then of multiple runners, created an accumulation of statistically significant data across time and across a number of participants. With the association of the playlist track being played at each data point, it becomes possible to begin to understand the role of music in the training process. While products like Nike + iPod connect music listening to sports training, Dry Run situates music in both the geographic and emotional trajectories of a training session. By aggregating across training sessions and runners, the idea, to be completed in a future version of the project, would be to extract from the data set the "ideal playlist."

## The Mobile Musical Instrument

In our most recent mobile music project, we adopt the by now ubiquitous iPhone and focus on creative practice and live concert performance. Throughout the time that the research described here was conducted, technologies from the laboratory have steadily found their way into the mainstream, embedded in consumer products. The iPhone represented the arrival of advanced multimedia, embodied, mobile computing. This has triggered the publishing of numerous music apps, some of which are discussed elsewhere in this volume. One of these music apps for iPhone and Android mobile (p. 483) phones to emerge from the open source community is the free software RJDJ, standing for *Reality DJ*. RJDJ is a mobile interactive music playback engine based on Pure Data (PD), the open source branch of the family of graphical music programming environments that also includes Max MSP, originally developed at IRCAM by Miller Puckette. RJDJ deploys a simplified version of PD on mobile processors, and facilitates interactivity through microphone input, and the accelerometers and touch screens found on advanced smartphones. The developers of RJDJ publish a catalogue of what they term “reactive music”—different forms of generative and interactive music that extend traditional Walkman-style music listening from one of fixed music assets to one that is continuously context aware. With this, some of the vision originally articulated in research projects such as Gaye’s Sonic City have arrived in the marketplace.

It is noteworthy that the dissemination of these technologies and concepts to broader audiences are built on the same software platforms that have been at the root of interactive computer music composition and performance since the 1980s. Beginning with the Patcher at IRCAM, the graphical programming paradigm of programmatic function represented onscreen as objects interconnected by virtual wires, started as a way to control computer music synthesis on mainframe computers. With Max/MSP and PD, real time computer music on personal computers and laptops became pervasive. The port of PD to iPhone and Android in many ways has put the IRCAM studio of the 1980s in one’s pocket. Along with this transposition from mainframe to mobile comes a fundamental shift of the social contexts in which computer music can take place.

My own musical output has paralleled this development, with the formation of different music ensembles that reflect the musical and technological contexts in live concert performance. This included Sensorband, formed in 1993 and Sensors_Sonics_Sights formed in 2003. With the move to RJDJ on iPhone, the duo of Adam Parkinson and this author, 4 Hands iPhone, continues the live computer music tradition with the use of mobile music technology.

*Click to view larger*

*Figure 19.8* Adam Parkinson and Atau Tanaka: 4 Hands iPhone in concert.

In the duo, we exploit the iPhone, a commonly available consumer electronics device, as an expressive, gestural musical instrument (Figure 19.8). The device is well known an iconic object of desire in our society of consumption. While the iPhone can play music as a commodity, we re-appropriate the device and exploit its advanced technical capabilities to transform the consumer object into an expressive musical instrument for concert performance. In a duo, with one device in each hand, we create a chamber music, four hands for iPhone. The accelerometers which typically serve as tilt sensors to rotate photos are reutilized for high precision capture of the performer's free space gestures. The multitouch screen, otherwise used for scrolling and pinch-zooming text, becomes a reconfigurable graphic user interface akin to the JazzMutant Lemur, with programmable faders, buttons, and 2D controllers that control synthesis parameters in real time. We have ported Nobuyasu Sakonda's advanced granular synthesis implementation of from MaxMSP to RJDJ and use it as the single process by which a battery of sounds are stretched, frozen, scattered, and restitched. Source sounds include, among other things, excerpts and loops from popular music—the very music that is commodified and typically listened to in fixed form on iPods, as well as natural sounds—artificially processing (p. 484) and re-contextualizing the kinds of experience associated with standard, ambulatory personal music player use. The fact that all system components—sensor input, signal processing and sound synthesis, and audio output, are embodied in a single device make the RJDJ enabled iPhone very different than the controller + laptop setup typically seen in contemporary digital music performance. The encapsulation of all instrumental qualities from gestural input to expressive sound output in a self-contained, manipulable object take the mobile phone beyond consumer icon to become a powerful musical instrument.

## Conclusion

The goal of the systems described here were to leverage the possibilities of contextual sensing, from location tracking to gestural capture, coupled with dynamic media delivery systems to create new musical experiences that could be shared by groups of performers and listeners. Each of these topics—localization, musical expression, content delivery, association, and community dynamic—were developed step by step over a number of technology iterations. Content delivery began with SoundLiving as a single user experience, with a fixed piece of music seamlessly being redirected on the fly. This developed into a group experience with Malleable Mobile Music where we looked at (p. 485) how each respective participant could maintain a sense of agency for their contribution to the musical whole and used the term reflexive translucence to describe this effect. Net_Dérive focused more closely on the music and ways music could be a carrier of social information. Moving from questions of how music could convey information on human presence, we concentrated on a tight association between the sonification and visualization of community dynamic. This was extended to a broader group dynamic in a non-musical context with Dry Run. Finally, 4 Hands iPhone brings contextual sensing back to a pure musical performance, exploring the potential of the mobile phone as expressive, holistic musical instrument.

Throughout these projects is a working method that considers music an emergent form to be sculpted rather than a fixed media commodity to be consumed. While this position may be natural for musical performance seen in 4 Hands iPhone, we apply this notion of the malleability of music to the very consumer formats of popular song in SoundLiving and Malleable Mobile Music to demonstrate how music otherwise recorded and produced to be a commodity can be rendered interactive and context sensitive, to define personal spatial spheres and signal human presence. Small’s notion of *musicking* describes forms of engagement with music that overcome traditional boundaries between the playing and listening of music. Here we have created musical systems built on mobile technologies that perhaps represent musicking machines.

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