# Developments and Challenges turning Mobile Phones into Generic Music Performance Platforms


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## ABSTRACT

There has been an ongoing effort to turn mobile phones into generic platforms or musical expression. By *generic* we mean useable in a wide range of expressive settings, where the enabling technology has minimal influence on the core artistic expression itself. We describe what has been achieved so far and outline a number of open challenges.



## Keywords

Mobile phone performance, technology, generic musical platform, infrastructure.


## 1. INTRODUCTION

Mobile devices have long been recognized as having potential for musical expression. There has been a rapid development over the last few years and first performances using mobile phones as primary musical instruments have emerged. For example Greg Schiemer's PocketGamelan project has served as the foundation for *Mandala*, a series of mobile-phone based works that have been performed recently [16]. Earlier this year, *MoPhO* – the Mobile Phone Orchestra of CCRMA – was founded [21], performing its first public concert on January 11, 2008 (Figure 1). However, the effort to provide a broad platform for designing and facilitating interactive musical expression on these devices is still very much in its infancy. The ongoing effort described in this paper is part of a larger field of mobile and locative music performance that involved not only mobile phones but also other mobile technologies such as PDAs, GPS and custom made sensing devices [7, 18, 6, 19, 20].

The purpose of this paper is to describe the progress of creating such platforms in the last few years. As so often, the development is mediated by what is technically possible and recent advances in technology of high-end programmable mobile phones have in no small part helped the development of the field. Using the developments so far we want to highlight a number of what we believe to be important open challenges in the field.

### 1.1 What is a generic music platform?

Before starting the discussion it is important to define the goal explicitly: What is "generic"?

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**Figure 1. The Mobile Phone Orchestra of CCRMA playing the piece DroneIn/DroneOut by Ge Wang (2008)**

By *generic* we mean a platform that is not designed with a specific performance in mind (a negative definition) or alternately, a design that is open to flexible, varied use without trying to prefigure artistic intent (a positive definition).

For example a laptop running general-purpose real-time synthesis software is a generic music platform. A laptop running a script written to accommodate a specific piece (e.g. special purpose software to control a motor that moves a speaker), is not generic.

Desktop and laptop computers have a wide range of software available that make them generic music making platforms. A range of sequencing software exist that can control general sound generation engines over MIDI or OSC. In addition to software sequencers and synthesizers, a number of programming languages and environments are available, including Csound, RTCMix, CMusic, CLM, Nyquist, SuperCollider, Max/MSP, Pure Data, and ChucK. While some commercial products may have a musical style in mind (like FruityLoops or Ableton Live) they still are generic within a very broad range and do not intrinsicly try to dictate a specific style.

The goal is to have a similar and appropriate level of *genericity* for mobile phones. In other words, a platform should exist that is simultaneously adequately high-level, i.e. abstracting the more mundane and repetitive development tasks, especially those close to a specific system hardware, and simultaneously universal enough to allow a wide variety of artistic possibilites.

## 2. CURRENT DEVELOPMENTS

Mobile devices come in many different forms and funtions: They can be portable games, PDAs, mobile phones, portable media players and so forth. For many of these there have been developments to make them useful for musical performance. The attempt to turn portable gaming platforms into rather generic sounding devices is in fact rather old. Already the original GameBoy inspired a fairly generic music performance platform called nanoloop developed by Wittchow [1].

This example showed already a characteristic of different mobile devices. Often their input is geared to more specific use, like phone dialing on mobile phones, or track selection for digital music players. In the case of gaming platforms, like the Gameboy, joypads and buttons are the primary means of input. It is a regular 16-beat sequencer that can be manipulated on the fly by the game joystick and controller button.

### 2.1 Input Modalities

Here we want to review further examples of technologies that have either been directly proposed for musical use or are related. Again we will attempt at a rough classification of these technologies by type. A detailed review of sensor technologies for mobile music performance can be found in [5].

#### *2.1.1 Hand gesture sensing*

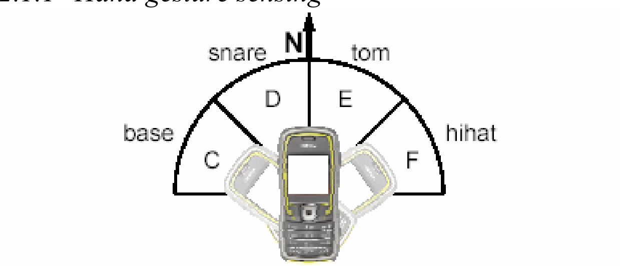


**Figure 2. The accelerometer/magnetometer based interaction of ShaMus.**

The hand is a major site of human motor control and most musical instruments rely at least in parts on hand and arm actions. There are a number of technologies that allow sensing of gestures, usually using accelerometers. These platforms include the Mobile Terminal [17], Mesh [11] and XSens [13, see for a review] for iPaqs. The Shake [10] which is platform independent and connects via Bluetooth.

The ShaMus project (see Figure 2) incorporates Shake sensors or uses built-in sensors of mobile devices if available (such as the Nokia 5500) [5] to manipulate interactive sound synthesis on the mobile device itself.

An alternative approach to get to hand gestures is the use of the optical system of the camera to track motion. The CaMus system [15] uses both tracking of 2-D markers or optical flow to enable this kind of hand motion sensing.

#### *2.1.2 Gait sensing*

Bodily motion has played an important part in some of the mentioned performances. Usually accelerometers are used to sense the gait, from which the pace can then be derived. A possible musical use for gait has been proposed by Elliott in a concept called PersonalSoundtrack [2]. Here the idea is to vary the playback speed of a current sound track to match variation in the pace of a listener. If the pace varies significantly, the system may decide that a different song may be a better match and switch. Gait and pace detection can also be found in commercial products, though usually in the context of sport application such as giving the user feedback on their performance while jogging. Two examples are the Nokia 5500 sport phone (nds1.nokia.com/phones/files/guides/Nokia_5500_Sport_UG_en.pdf) which includes accelerometers for this purpose and the Nike+iPod system embedding a sensor in the running shoe and communicating to the iPod device (www.apple.com/ipod/nike/).

#### *2.1.3 Touch sensing*

Most mobile devices have some number of buttons. These either are part of the standard numeric dialing keypad or are track selection buttons of music players. These can be mapped freely to synthesis algorithms. Some mobile devices, typically PDAs are equipped with a touch-sensitive screen for input. Often these are accompanied by a stylus. Geiger designed a number of interaction patters on touch screens using a stylus, including 3-string guitar strumming and a 4-pad drum-kit [9]. Recently a commercial product appeared with a similar idea, the software JamSessions by UbiSoft (www.ubi.com/US/Games/Info.aspx?pId=5560) was developed for the Nintendo DS platform allows a single-string strumming interaction with a stylus. The joypad selects from a bank of pre-recorded guitar coords allowing for guitar-chord progressions to be played with a touch-pad strumming gesture.

#### *2.1.4 Using input audio for control*

Finally the microphone is an important sensor for mobile devices. It can be used for literal recording as has for example happened in the MoPhive piece by Adnan Marquez-Borbon [21]. It can also be used as a generic sensor [12] where blowing into the microphone is used to excite a wind instrument or police whistle. The great advantage of microphones is its true ubiquity in mobile phones and the good dynamic range and fidelity.

### 2.2 Output Technologies

The main modalities for output on mobile devices are: visual output mainly through a screen, auditory output through speakers, and vibrotactile output via vibrotactile motor display. Often these modalities are used together. A synthesis engine using the speaker output usually also overs visual feedback. Vibrotactile display often relate to visual or auditory cues.

Generic sound synthesis engines that completely run on the mobile itself are only recently emerging. For devices running the ARM port of Linux, a ported version of PD called PDa [8] is available. The open source sound synthesis library STK (Synthesis ToolKit) by Cook and Scavone has been ported to Symbian based mobile devices [4].

An array of sound editing and sequencing programs exist which got recently reviewed by Elsdon [3]. The CaMus system, which uses optical tracing in the plane uses a graphical display in the plane, where sound sources can be placed in a virtual spot and the distance, height and rotation relative to sound sources allow for interactive manipulation [15]. Visual output also can be an important part of feedback to the performer or the audience during a piece.

There is very limited use of vibrotactile display so far. An interesting recent specific example is Shoogle [22] where vibrotactile combined with auditory display inform the user of the presence of instant messages on a mobile device.

## 3. CHALLANGES

Many questions concerning the generic use of mobile phones as musical instruments remain open. We believe that the most pressing ones are the availability of generic synthesis software, the design of appropriate GUI and editing methaphors for mobile devices, design for the limitation of mobile devices and finally simple yet flexible ad hoc networking.

### 3.1 More synthesis options

For one we do lack a palette of synthesis and sound rendering architecture. Currently only MobileSTK for Symbian OS [4] and pdA for Linux on mobile devices [8] are available. MobileSTK comes with a basic Symbian-based interface, while pdA retains visual elements from original PD, though these elements are very often only used for event display and not for online authoring.

### 3.2 Special purpose editing, mapping and manipulation

Generic flexible authoring paradigms are missing. The editing system of CaMus may be the only broadly concepted graphical editing paradigm we have so far, and it is very worthwhile to envision more. CaMus's setup is very camera-centric and hence does not translate easily to gesture-based setups (see Figure 3).

The goal in designing a mobile phone musical instrument involves: 1) Decide which input modalities to use, 2) manipulate them to be good control for synthesis, 3) pick a matching synthesis algorithm. Ideally the composer should have to spend as little energy of any other cursory requirements.

### 3.3 Limitations set by the nature of the devices

What limits this is specific to mobile devices:

1. Limit and nature of the input capacities – the standard editing interfaces for today's computers are keyboards and mouse/touchpads. Keyboards can transport a lot of texual information quickly and mouses allow to navigate graphical elements. The problem with translating these ideas to mobile devices is that there is no space for a full keyboard and that the screen-space is smaller to warrant other navigation elements than the mouse-bound typical windows-GUI.
2. Limit and nature of visual real estate – the limit of visual real estate is that there is limited space to present information which it may make sense to show graphical patches of Max/MSP or PD as a whole on a standard computer, zooming the total display down to mobile size makes them hard to follow. If one zooms in one loses visual context which leads to excessive scrolling and tedious editing of large structures. A visualization for mobile devices needs to be much more sensitive to display only what is really crucial and hide was is not important.

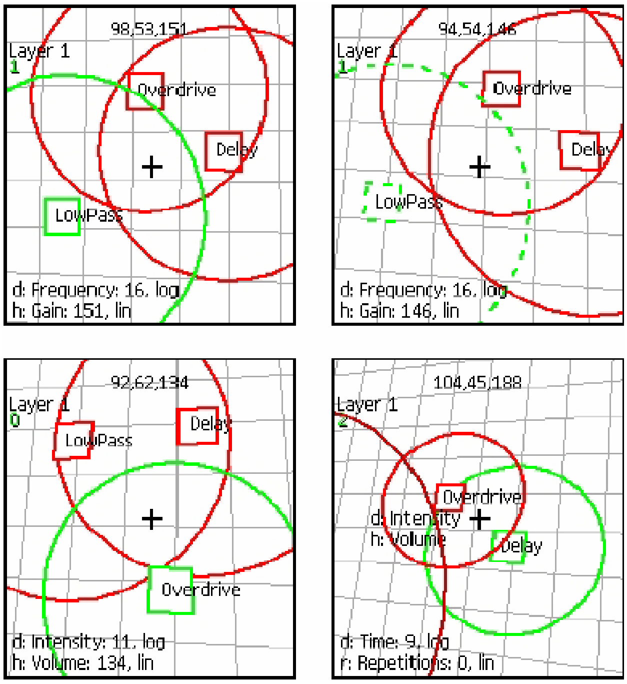


**Figure 3. A view of the graphical editing platform of CaMus.**

### 3.4 Flexible ad-hoc networking

This is a very complex topic so we will but mention two basic areas. One is local ad hoc networking for localized performances, others are remote networking for remote performances. Both share that they need to be easy to administer, but certainly there are differences. Local ad hoc networking can hope for sensibly low latencies and may allow non-addressed handshaking, for example handshaking by proximity. Remote networking requires addressed hand-shaking of connections to build.

Ideally we want to be able to exchange broad performance data over these networks, specifically exchange via OSC or other common standards that are performance-centric would be useful.

This area is very much in its infancy. To the best of our knowledge the kinds of networking solutions are so far all special purpose to specific performance and installations. Proposals like the ad hoc networking of the CaMus[2] system is not yet generic either and uses a custom protocol of limited scope [14] (see Figure 4).

## 4. CONCLUSIONS

Mobile phones have reached a point where they have enough interesting sensory capabilities and computational power to serve as generic devices for musical expression. Yet the amount of available software infrastructure is still rather limited. In this paper we discussed a number of early steps in this direction and outlined a few open problems. Mobile phones are very attractive platforms to become generic mobile music instruments.

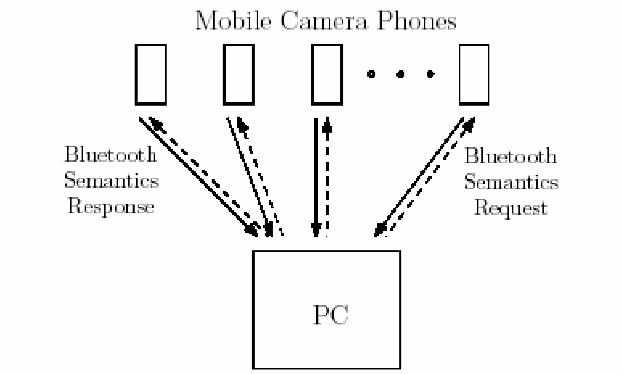


**Figure 4. Bluetooth wireless network of the CaMus2 system.**

Hence, we plan to continue developing toward that goal and simultaneously encourage our colleagues in academia and industry to explore and develop similar, alternative or joint platforms in order to mature this exciting area.

## 5. ACKNOWLEDGMENTS

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