

# The BeatHealth Project: Application to a Ubiquitous Computing and Music Framework

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## ABSTRACT

*This work will elaborate on the new EU Beathealth project: an initiative to create an intelligent technical architecture capable of delivering embodied, flexible, and efficient rhythmical stimulation adapted to individuals' motor performance and skills for the purpose of enhancing/recovering movement activity. It will then explain how it can exemplify the principles of Ubiquitous Music and how knowledge from this field can suggest creativity-driven social enhancements. Case Studies will be presented to illustrate potential applications and additionally a short discussion on suitable theoretical guidelines will be made.*

*Keywords: Biomedical Mobile Technology, Entrainment, Music Synchronisation, Music Technology Applications, Wearable Sensors*

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## INTRODUCTION

In recent times scientists have begun to seriously investigate how rhythm and music can be harnessed as a drug-free way of stimulating health (Pollack, 2014). Music affects our autonomic nervous system activity, stimulating sensations of wellbeing at a subconscious level (Ellis & Thayer, 2010). This has naturally led behavioural scientists to posit that this could be a source of inspiration for a whole new set of therapeutic tools. Innovations in mobile technology in the last 10 years offer a very promising means by which such therapies can be delivered whenever the user or patient is free to practice them, and wherever they happen to be.

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The collaborative research project 'BeatHealth' has been conceived to be at the forefront of these technological developments (BeatHealth Consortium, 2014). The objective of the project is to create a new method for improving health and wellness based on rhythmic stimulation. The system under development is an age-friendly, portable system that has the capability to invigorate the user through musical playlists and then simultaneously record their physiological activity (i.e., during walking or running) via advanced sensors. Currently, the music playlists are built using commercial audio tracks; these are employed so that users can increase their motivation by using music selections that they enjoy. The sensors have been custom-built to capture the individual's motor performance and physiological response. Additionally, as the kinematic data and stimulation parameters are collected on the fly they are to be recorded via a dedicated network-based e-Health application for storage on a cloud service. This will facilitate the visualization of information on movement performance for the individuals themselves and for sharing among family members, doctors and coaches. Such access to this information will empower the user to have greater awareness of her/his motor condition, whether healthy or deficient, and encourage them to adopt a more active lifestyle to either enhance their performance or compensate for a motor disorder they might have.

An essential component to this application is the delivery of the music used to stimulate the kinematic activity. It is not simply a playback mechanism; instead it takes a significant role in the process. The belief is that by encouraging an entrainment, or synchronization, between the music and the movement then the maximum benefits should be obtained for the user. This can be realized at both a coarse and fine degree; from simply choosing music whose tempo is close to the rhythm of movement up to using special audio processing techniques to dynamically adapt the beat pattern of the music to align itself exactly with specific landmarks in the user's movement.

The idea of synchronizing music for sports training has been around for some time. (Terry & Karageorghis, 2006) reported that anecdotally it is known that synchronous music can be applied to aerobic and anaerobic endurance performance among non-elite athletes and exercise participants with considerable effect. As well as running, it has also been considered for application to cycling, rowing and cross-country skiing (Karageorghis & Priest, 2008). However, the severe limitation of a standard commercial portable music player is that the onus is on the person to adapt to the music under all circumstances. Significant recent developments in mobile computing power have ushered in new ideas for applications where the music can interact dynamically with the user's activities leading to a more stimulating interaction. Earlier systems adopting this concept for running have been described in the research literature by (Elliot & Tomlinson, 2006), and by (Hockman, Wanderley & Fujinaga, 2009). The BeatHealth project itself is an evolution of the D-jogger application (Moens et al., 2010). Rowing was shown too to benefit from technological assistance (Schaffert 2009). Commercially, the first product that could adjust its music playback in response to movement was first introduced by Yamaha as the BODiBeat (2007), followed by Philips Aactiva (2010). Both devices use a traditional interface and are focused on simply selecting tempo-appropriate music to optimize workout performance. A number of mobile phone apps such as Nike+ (Nike+, 2015) and Runkeeper (Runkeeper, 2015) have been released more recently. However, in all cases unfortunately the relationship between the runner and the music is not one of a seamless synchronous interaction throughout the activity. It is worth noting too that only very recently has a similar commercial application appeared for people with Parkinson's disease (BeatsMedical, 2015), but its solution is unsophisticated in comparison to what BeatHealth can offer. Thus, there has been a strong case for developing the BeatHealth approach that will provide a stronger and more personal interactivity between the music and movement, resulting in improvements in both the user performance and enjoyment.

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