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TIYU
A location based music player for sports

Georg Schneider, Henning Voss

Computer Science Department, University of Applied Science Trier, Trier, Germany

g.schneider@.fh-trier.de, h.voss@fh-trier.de

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Abstract: This paper describes a mobile location based music player for outdoor sports like running, cycling or hiking. Athletes can boost their performance while listening to the right songs. The TIYU system augments trails with appropriate music for the athletes, either automatically using an intelligent selection mechanism or manually via a web based authoring tool. These so created trails can be shared with other users on a web based sports community platform.

1 INTRODUCTION

Many activities seem to be easier when we listen to our favorite music. This is true for sports as well. Findings from medical research have lately proved the positive effect of music on the performance of athletes (i.e. Karageorghis and Terry 1997, Karageorghis et al. 2008). One consequence of these findings is that portable music players have been banned from official races in the USA 2007 (New York Times 2007). On the other hand this is the reason why the 2009 London Half Marathon (Run to the Beat 2009) consequently adjoined music to the race for everybody. At this event, bands were playing along the racetrack. However it is not always obvious to choose the right tune for a workout. Some runners are faster than others and when it comes to inclination or descents the pace also changes (the same is true for other sports like cycling or hiking equivalently). One way to deal with these issues is that a runner would plan his workout at home. Ideally she would select the trail she wants to run on a map and select the appropriate songs for the different sections of the run depending on the profile of the trail. Using a mobile music player with GPS she can automatically play the before selected music according to her position on the trail. The device could easily detect a pause in the running and would stop the music accordingly. However another approach would be that she could simply run a trail and choose the songs manually. Once she has finished her workout she could save the settings for the future.

An even smarter solution would be that the mobile device automatically selects appropriate songs depending on the speed of a runner or alternatively in a way that she would accomplish to attain a certain training goal, e.g. run a certain velocity.

Once the different playlists for the trails are set up the runner possibly wants to exchange either playlists or trails with other runners or even meet other athletes with similar preferences. She would possibly be interested in what music other people listen to at the same trail or if there are runners that have similar characteristics concerning velocity, duration of the workout, time of the day of the training etc. like her.

Another idea could be to see what playlist would be appropriate in order to improve the running time for a certain trail.

In order to realize such an application we will describe in this paper a mobile application together with a web based community website where users can exchange the type of information mentioned above. The name TIYU is derived from the Chinese

language (体育) and means “sports“ or “making sport”.
First we will describe systems with similar goals in the related work section. Afterwards we will illustrate the concepts used in order to build such a system. Then the concept is refined in the realization section. We will show an example of the system and give a short overview of the implementation. We will finish the paper with a conclusion.

2 RELATED WORK

Several approaches to combine music and sports exist already. The MiCoach system (MiCoach 2009) from the companies Adidas and Samsung uses sensors for heart rate and pace, which are transmitted to a mobile phone. The phone uses this information to select appropriate songs once the user has selected the sport she wants to perform, e.g. running or cycling and the desired speed. The user has to copy songs to her mobile phone and set up a playlist, which she listens to during her workout. MiCoach offers so called motivational songs, which can be selected manually during the workout. Songs can also be selected automatically depending on the type of sports the user has selected. A GPS sensor is not a part of the system. A belonging website is used to personalize the system, to set up training plans and to visualize data acquired during the workout.
Nike+ (Nike 2009) is a cooperation between the companies Nike and Apple. It consists of a mobile music player, the iPod and a sensor that counts the steps of a user. The user can define playlists or download playlists that are supportive for a certain type of sports e.g. running or cycling. A community website is used to define workout goals and to visualize and exchange information concerning the training, like consumed calories. Furthermore running trails can be defined and shared on the website using a map. Since the iPod has no GPS receiver these data cannot be used directly for a workout.
The Nokia Sports Tracker (Nokia 2009) is an application that runs on Nokia cell phones with GPS receiver. Sportsmen can save GPS data of their trails. These data can be transmitted to a website and visualized on a map. Additionally this information can be shared with other users. The so called “Live Sharing” functionality transmits automatically the data to the web server and other users can see the location of this specific user. In the case of the Nokia Sports Tracker, there is no support integrated for music as part of the training.
Active Outdoor (Wayfinder 2009) is a website where users can upload GPS tracks in order to visualize these data on a map. The system can be used for navigation and sharing of the GPS tracks with other users. The system mainly supports blogs, bulletin boards and the creation of groups. Similar as the Nokia Sports Tracker, there is no support for music.
Especially for runners more specialized websites and communities have emerged lately, like Jogmap. In general they differ only slightly compared to the two foregoing systems concerning the functionality in regard to storing, visualizing and sharing GPS information. Jogmap offers a greater variety of possibilities in order to create personalized workout plans and analyze data for runners.
In contrast to the systems and services illustrated above the service Run2rythm (Blake 2009) produces music especially targeted for running. Users of the service can select tunes based on the velocity they want to run. Figure 1 illustrates the connection between BPM (beats per minute) of the music and time and distance that a runner will cover running in the beat of the music.

BPM Steps per minute	Time per km (minutes)	Steps per km	Stride length metres	Time per 100m (sec)	Steps per 100m
150	10	1500	0.67	60	147 to 150
153	9	1380	0.73	54	135 to 138
156	8	1250	0.80	48	122 to 127
160	7	1120	0.89	42	109 to 112
163	6	980	1.02	36	98 to 102
166	5	830	1.20	30	83 to 86
171	4	680	1.47	24	64 to 68

Figure 1: Dependency between music and running pace (Run3rythm 2009).

However this service does not include functionalities like tracking the trail a user runs.
None of the systems above offers functionalities like we have motivated in the first section. Either a GPS device is integrated in order to visualize and track the trails or music is used to support a training goal. Using both, music and GPS data together to annotate trails, to automatically select suited songs and to share this information among users of a web community has not been realized so far.
In the following we will describe the ideas of the TIYU system, which combines the different approaches of music selection in dependency with the kind of sports and velocity of a user together with the trail she moves along. A mapping and

visualization of this information using GPS and maps is also part of the system.

3 CONCEPTS OF THE TIYU SYSTEM

The goal of the TIYU system is to integrate the different ideas of music selection, mapping and exchanging of GPS data and sharing this information between users into one system. First of all we will describe different ideas of music selection for outdoor sports.

3.1 Music selection

In the preceding section we have already illustrated the different influences in regard to music selection for sports. Moving along an outdoor trail, not only the kind of sports and the targeted speed have an impact in the music selection but also the profile of a specific route, especially the altitude profile. If a user moves along a river the trails is normally flat and the speed is relatively constant as well. Compared to a trail in the mountains the situation is different. The athlete will most certainly move slower uphill than downhill.

Additionally the situation may arise where the user wants to listen to a certain tune at a specific section of the track but the tune may be to short or too long.

In the following we will sketch our ideas to select music for a certain outdoor trail. In the following, we will refer to a playlist, where the songs are related to a certain GPS position as *Location Playlist*. We will concentrate in our demonstration on running but the same ideas apply for other sports equivalently:

- Manually, on the fly
  While running, the user selects manually one song after another. The playlist is recorded together with the GPS data as a location playlist.
- Manually, prepared earlier
  A user has already set up a location playlist for her trail. This may be the case either using one of the playlists created using the former procedure or choosing a playlist, which has been created by another person.
- Automatically, user centered
  Automatic selection of songs can be achieved using the findings illustrated in figure 1. Using GPS, the mobile device can compute the velocity of a user and likewise can choose an appropriate song for the current situation.
- Automatically, trail centered
  If the trail is known in advance or if the mobile device uses the GPS data in order to find out the profile of a trail, the system can figure out, which song might be appropriate for the current situation. However this mode strongly benefits from a tagged music library. These tags may be specified manually or calculated after a run (e.g. songs that a user or different users often play while running uphill)

As we mentioned earlier situations may arise, where a song is too short or too long for a certain section of the trail. In the case, where songs are too long, they may be skipped or blended into the next song. For songs that are too short the situation is more complicated. Different approaches may be possible:

- The song is simply repeated until to the next position, which is identified with a different song.
- Sections of a trail are not identified with a single song but with a group of different songs. In this case songs from this group are played until the user reaches the next section of the trail.
- The song is artificially slowed down or sped up in regard to the current speed of the user (e.g. Bieber and Diener 2005).

3.2 Audio feedback

Audio feedback is a way to give information about certain aspects of a workout or trail to a user. In the TIYU system we regard aspects of the workout e.g. if a users moves too fast or too slow or if she moves away from the selected GPS trail. In order to inform the user about these facts we do not want to interrupt the music displaying a voice message. This could bother the user and interrupt the rhythm of the music.

Our approach is to inform the user by turning the music up or down. Thus the user can quickly identify that she is no more within the intended frame of the workout and she can check the trail or the speed.

3.3 Workout Information

In order to share workout information between users and possibly find training partners information like day, time of the day, sport (e.g. running, cycling), distance, duration and favorite trail and music are stored in the system as well. This information can be used to find users with the same training behavior. This information is crucial for a community with numerous users because it enables searching and filtering of relevant potential training partners or suited trails or location playlists.

4 REALIZATION

In the following sections we will describe the realization of the system. We will start with illustrating our approach of the calculation of an automatic song selection process.
Afterwards we will illustrate the procedure of selecting users with a similar training profile.
Finally we will describe the architecture of our system.

4.1 Calculation of suitable songs

Selecting the right song for the actual setting of an athlete is crucial for our system. In order to make an automatic selection for the best song that can be played in a specific situation we use the following approach:

```
BEGIN
bpmBest = 2.22 * geschwindigkeit + 140
bpmDiff = bpmBest – bpm(lied)
IF bpmDiff < 0 THEN
bpmDiff = bpmDiff * -1
bpmPoints = 255 - 1.0 / 10.0 *
                    bpmDiff * 255
IF bpmPoints < 0 THEN
bpmPoints = 0
RETURN bpmPoints
END
```

First we calculate the optimal beats per minute (bpmBest) for the current velocity using the findings illustrated in figure 1.
Afterwards we calculate the bpmPoints, which has a highest value of 255. If the beats per minute do not fit exactly to the speed of the user, the bpmPoints for this song will be lower, e.g. if the bpmDiff is 5, the value will be 127. If the difference bpmDiff is 10 the value is 0. Basically the function shows a linear decline. The different values are based on experiences from several tests we have carried out.

4.2 Display of training partners

The system supports the user in order to find suitable training partners or location playlists. Thus not only the music tastes of the different users but also their training schedule and profile has to be taken into account.
Because it concerns finding users with the same preferences for music the Lastfm platform (Lastfm 2009) already offers a web service to find out similar music given a certain music profile.
Additionally, the training schedule and profile have to be taken into account. We have used the following formula in order to calculate the similarity of users:

$$\text{Similarity} = \text{SameSports}/4 + \text{SameDay}/4 + \text{SameTime}/4 + \text{TrainingIntensity}/4 \quad (1)$$

$$\text{SameDay} = \text{SameDayMonday} + \text{SameDayTuesday} + \ldots \quad (2)$$

$$\text{SameDayMonday} = \min(\text{SameDayMondayUser1}/\text{TotalUser1}, \text{SameDayMondayUser2}/\text{TotalUser2} \ldots) \quad (3)$$

In (1) we calculate the overall similarity between users, summing up the different similarities of the factors we take into account. Formula (2) shows the calculation of the similarity concerning the days different users workout, whereas for each day (3) the different users are compared in regard to their training behavior on that day in relation to their overall training.
The remaining similarities are calculated accordingly.

4.3 System Architecture

The architecture of the TIYU system is a client server architecture as illustrated in Figure 2.
The mobile user (User1) communicates with a web server after a training or even during a training, when a mobile connection is possible and allowed by the user. Information about GPS position, playlist and further application relevant information (e.g. if the song has been played on an incline or a decline) is transmitted to the server using the HTTP protocol for communication and the XML format for the content description.
Later the user can visualize or edit the data using a web interface (e.g. User2).

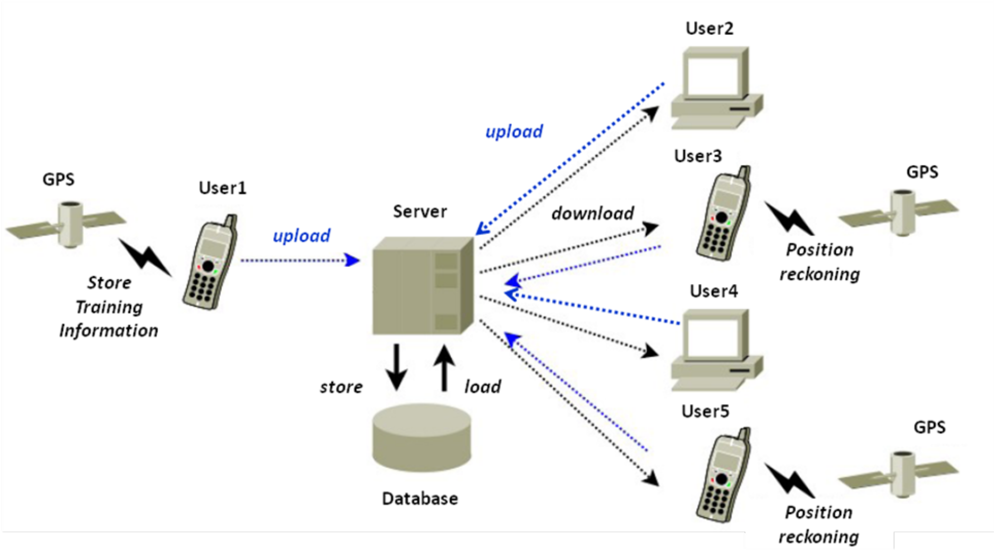

Figure 2: Architecture of the TIYU system.

Other users may download already existing location playlist form the website, for example User3 and start the training using these data.
User4 may set up her training using a web interface before the training and associate songs or groups of songs to certain sections of the trail. Later on she uses the location Playlist for her workout (e.g. User5).

5 EXAMPLE

The following example shows different views of the system. The TIYU website as shown in figure 3 consists mainly of a map displaying the different trails the user has (or friends of the user have) created in this belonging section. By clicking on the different numbers on the map, information about length of the trail, velocity and time the trail has

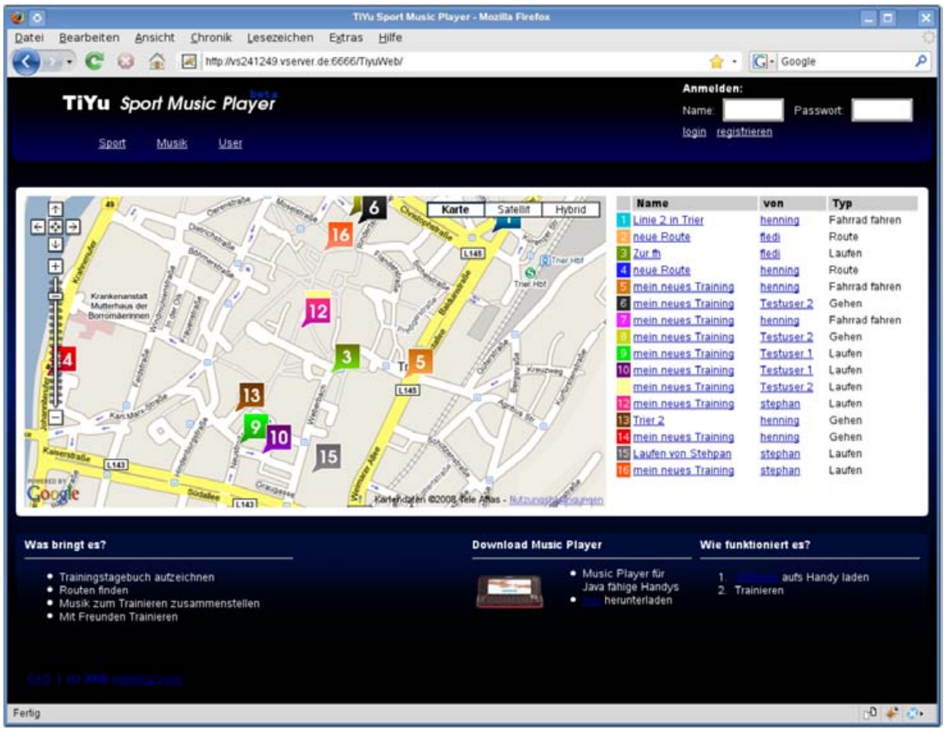

Figure 3: TIYU website.

been used for the last time will be displayed. Furthermore the system tries to detect automatically the kind of sports, e.g. running, hiking or cycling depending on the velocity of the user.

In a different view the users of TIYU who upload continuously their GPS coordinates to the server (and who allow to access these data) will be visualized similarly on the map.

The website can also be used to exchange comments to a specific trail or visualize training data. The user can see on which days she usually works out. Furthermore she can see the total amount of time and distance she has covered in this week and she can also look at the altitude profile for a certain trail and the belonging velocity. Finally she can search for similar users concerning training behavior and music taste.

The user interface on the mobile device can cover only a very limited space. Figure 4 shows one view of the mobile client running on the cell phone. In this case the training data is displayed showing the velocity for a certain trail in the first minute.

Further views can display the dependency of distance and velocity. Another graph display shows the altitude profile together with time an athlete has covered. Altitude profile and distance is a further alternative.

Additionally the current song and a table with statistics for the training so far are possible screens.

A map view showing the position of the user and also the selected trail if desired, can be displayed on the mobile phone as well if a mobile data connection is available.

Figure 4: Screenshot from the mobile client.

6 IMPLEMENTATION

The TIYU system has been implemented using JavaMe on the Nokia cell phone E90 Communicator (MIDP 2.0) with 128 MByte memory, a 330 MHz TI OMAP2420 processor (ARM11 architecture) and a Symbian S60 operating system. The songs are played using the media player installed on the phone. In the current version of the system music streaming is not yet available and the songs have to be copied on the phone.

The server application is realized in Java as Servlets hosted on a Tomcat web server. As database MySQL is used together with the Hibernate framework. The web application makes use of the Google Web Toolkit. Furthermore the Google Maps web service is used in order to display the map data. The Lastfm web service provides the data for the similarities of different songs.

7 CONCLUSIONS

In this paper we have presented a concept for athletes who are interested in working out with music. The system offers different modalities.

A user has different possibilities to generate a location playlist, like generating one using a web application, generating a location playlist on the fly, downloading a playlist or let the system decide automatically.

Furthermore information of the trainings are recorded and displayed on a community website in order to exchange trails or location playlists. The discovery of new music, new trails and possibly also future training partners can also be stimulated using the system.

We have made a first test with three different users that are regular runners. The feedback was in general positive. The users characterized the system as beneficial. Although these opinions are promising a more detailed and profound user study has to be carried through in the future in order to gain a valid insight in the usefulness and the behavior of the system.

REFERENCES

Bieber, G., Diener, H.; StepMan - A New Kind of Music Interaction, in: HCI International 2005, Lawrence Erlbaum Associates, Inc., Mahwah, New Jersey, 2005

Blake, G.; Run2Rhythm Productions Pty Ltd, How Run2Rhythm started, http://www.run2r.com/about-run2rhythm+about-run2rhyth-music.aspx, [4.11.2009]
Jogmap media GmbH, http://www.jogmap.de/ [4.11.2009]
Karageorghis, C., Jones, L., Stuart, D.; Effects of Music Tempi on Music Preference, Intrinsic Motivation, and Flow during Long-duration Exercise, International Journal of Sports Medicine, Georg Thieme Verlag 2008.
Karageorghis, C., Terry, P; The psychophysical effects of music, in: Sport and exercise, United States Sports Academy, 1997
Last.FM Ltd., API Spezifikation, tasteometer.compare Web Service, http://www.lastfm.de/api/show?service=258, [4.11.2009]
MiCoach, www.adidas.com/miCoach/ [4.11.2009]
New York Times, 2007, http://www.nytimes.com/2007/11/01/sports/othersports/01marathon.html, [4.11.2009]
Nike, Inc., Nike+: Hear How You Run, http://www.nike.com/nikeplus, [4.11.2009]
Nokia Oyi, Nokia Sports Tracker, http://sportstracker.nokia.com/nts/main/index.do, [4.11.2009]
Run2Rythm, http://www.run2r.com/Technical+linking-bpm-to-running-speed.aspx, [4.11.2009]
Run to The Beat, http://runtothebeat.co.uk/ [4.11.2009]
Wayfinder Systems, Inc., Active Outdoor, http://www.activeoutdoor.com/Activeoutdoor/loginform.js [4.11.2009]