Adaptive Tuner for Workouts

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***Abstract*—It is important for runners to exercise at an appropriate running cadence. As music tempo has an impact on the exercise and the endurance activities, it might also serve as a means to shape running cadence. We are planning to design a smart runner's music player. The player will dynamically detect the cadence of the user in real-time, and play the music whose tempo most matches the runner's cadence. Our primary design incorporates the use of builtin Accelerometer in modern smartphones to detect the cadence (steps) of the user. When the user is running or walking, there would be cyclical changes in X-axis, Y-axis and Z-axis data output by the Accelerometer. Based on this pattern, we will use existing algorithms to design a pedometer that detects the user's cadence and cadence changes in real time. When the user's cadence changes, the player will automatically adapt and switch to the most matching music from the music library. To obtain the tempo of the music, our app also includes the tempo detection function, which allows the user to detect the tempo of the music through a sequence of simple taps on the screen. This can be done at the time when each music clip is first imported into the library. This results in an immense personalised listening experience based on the runner's speed.**

***Index Terms*—Step rate, Personalisation, Adaptive track technology**

I. Introduction

In the fast busy life people have found music to be relaxing their brain and a method to rejuvenate the mind from a heavy workday or other mental stress. When you have a tough day at office and heading gym or going for a job and you forgot to make your playlist. This app would suggest the songs based on your mood and the pace you are working out. Some of us like to hearing soothing music while we meditate or fast music while we do heavy workouts and it depends on the individual. The app would learn the mood of the person and play the songs which they would like to hear. It will compute the person cadence based on the heart rate , respiratory rate and other gestures which would determine the person's physical activity. It requires a lot of data to train and make an algorithm which would be a best fit to predict the mood of the person and suggest the music he would hear based on the mood.

II. Significance

Have you ever found yourself reflexively tapping your toes or drumming your fingers to a catchy tune on the radio? This is because the human brain and body is hardwired to respond to rhythm. It's not just that the tunes get our body moving, it has also been proven that it helps it move in the most powerful and efficient way possible, especially when it comes to exercise. Moreover, it is said that music gives your brain a workout too by improving your mental alertness and memory. On top of this music pushes the athletes to their limits by distracting them from the pain and fatigue, this in the end increases their endurance. Another way to explain this is to understand that our brain tells us we are tired as a way to prevent us from damaging our bodies. Hence if we are highly motivated to achieve a certain goal, the brain is willing to push us a little closer to our limits. Music alters our perception of effort and fatigue, allowing us to trick our brain into pushing a bit harder to achieve the goal.

With so many pros on the line, putting together a good and effective workout music is not as easy as it might come across. It can't be just about queuing together high paced, high energy songs. Different songs evoke different memories and emotions in different individuals. It should be also taken into consideration that fast-paced songs are good for beginning the workout but towards the end slower paced songs are preferred. A lot of people prefer to match their stride to the kind of music/beats they are listening to, this helps them regulate the slight nuances in their stride to make them a more efficient runner. It might not be needed for the human body to make a lot of adjustments to coordinate movements when moving rhythmically as compared to when no regular external cues are given. Thus having a playlist that matches each and every activity during your workout is essential for a productive session. This is where our app comes into play. We are planning to design a system that tracks your speed (via pedometer) and selects the best songs for you. But as mentioned before speed is not everything, the system will also monitor the users heart-rate to further customize the song selection to give a seamless workout experience. It will try to integrate the two most important elements of workout music :- Tempo and Rhythm Response.

III. Solution Overview

Our application develops context and emotion-aware music based mobile application for physically active users. The business objective of the application matches the running speed of the users with the tune. It also recommends the next song to the user based on the current speed, GPS data and emotions. The proposed design provides an enriched workout experience for the users. This combination of contextual factors is our contribution with respect to existing next-song recommendation proposals.

IV. Relevance

Mobile computing is a generic term describing the ability to use the technology to wirelessly connect to and use centrally located information and application software through the application of small, portable, and wireless computing and communication devices. Mobile computing is human–computer interaction by which a computer is expected to be transported during normal usage. In the Adaptive tuner for Workouts app, we will be using the pedometer and the heart rate sensing functionality which can be computed. Respiratory rate: For respiratory rate sensing we will utilize the accelerometer or orientation sensor of the smartphone. The respiratory rate will be computed from the accelerometer or orientation data. After which there are different deep learning methods which could compute the cadence of the person which could map his current physical activity and could predict the rhythm which he would likely to listen next. So, this process involves a lot of machine learning and deep learning computation along with the mobile sensors data. The machine learning and deep learning methods would give us the predicted physical state which can be related to his mental state to determine the rhythm a person would likely be listening to when he is performing different kinds of activities like running, yoga and other exercises. As exercises involves a lot of changes in breathing pace which can be computed by the accelerometer or other sensors embedded in mobile phones.

V. Related Works

A. Emotion Based Music Recommendation System Using Wearable Physiological Sensors

This paper talks about how the music choice or selection of a user depends on the emotion that the user is feeling. It says how the existing music recommendation softwares use not only the historical preferences or music choices but also depend on the mood of the user [1]. The paper suggests a wearable physiological sensor that senses the emotions/mood of the user via signals. The data is further fed into a music recommendation system as supplementary data, thus increasing the performance of the system by helping it further customise the music selected for the user. Looking at this paper gives us a good insight into how we can go about our application as it hopes to achieve similar results. We wish to use the data collected from the pedometer as supplementary data for the recommendation system to further improve the music selection for the user based on the intensity of the workout session.

B. The BASES Expert Statement on the Use of Music in Exercise

This paper was published on behalf of the British Association of Sports and Exercise Sciences and talks about the present circumstances of music research when it comes to exercise and sports. It gives us an insight into the key factors that influence responsiveness to music in exercise and sport as well as the underlying factors that one might miss. Factors like rhythm, harmony and melody are paramount when researching music selection for exercise, as they help determine the pace and intensity at which the user is conducting the session[2]. Some things that are often missed while looking into music are the factors such as the cultural impact a particular song has, along with the memories or emotions that the music might carry for the user[2]. It also tells us that there is a large influence by the gender and personality of the user as well. All of the above mentioned factors play a vital role in deciding the music preferences and responses that a user has within an exercise setting. It talks about the advantages of (when the user moves with the beats of the song) music used during exercise. It provides factual information regarding the improvements in the rate at which the body gets exhausted as compared to the data collected when music is not used. It also suggests that synchronous/harmonized music may increase cadence of the user's movements, which further lowers the oxygen uptake to a visible amount. The paper also sheds light on how different kinds of musical beats can be used in different workout settings to achieve results.

VI. Proposed Solution

In the solution the architecture has been divided into four layers: the application layer which is the main application window, the business layer where the decision of song suggestions is done and personalisation systems are integrated, processed data layer and data provider layer which does the job of calculation of the user's mood, his running speed and responsible for getting access and processing the system's data.

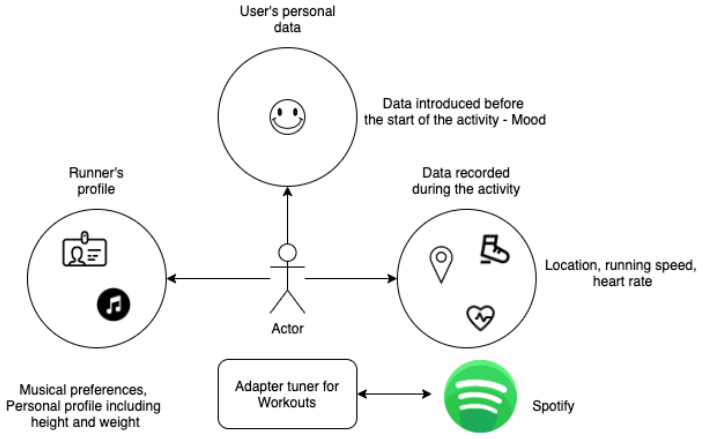

Fig. 1. Basic overview[8]

When the application is opened, the application registers the mood of the user in the system. From that point ahead the cooperation with the business layer starts to figure out which song is to be played. To work on the association convention between application layer and business layer, the application stores the current information identified with the instructional course in process (the Session information), explicitly, the client identifier, the running track of the user, the listening history, the skipped tunes and the user's emotional changes.

Internally, the mobile application integrates a music player-Spotify to play the recommended songs. This playlist is used to store the songs based on various tempo, beats and

rhythms. When the song is over, the application sends a new request to the recommendation service, specifying the runner's current location, emotional state and running speed which will determine the next song to be played. These parameters are determined from the phone's GPS and the Accelerometer and heart beat Sensor.

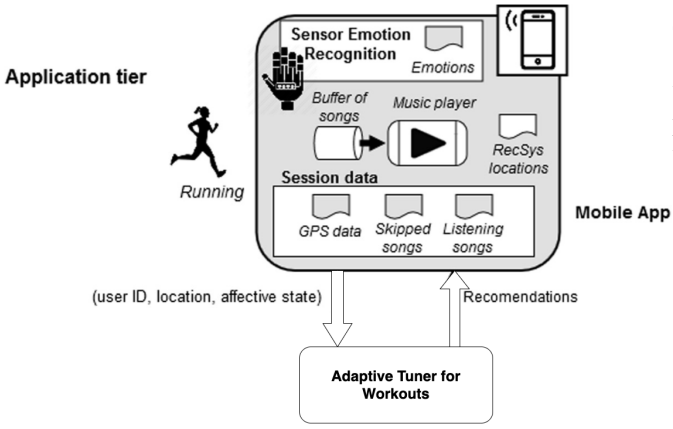

Fig. 2. Application layer[8]

The emotions recognition system is associated with the gadget that the client has and recognizes the compelling changes during the active work which includes variances for the pulse and the running speed. The recognition begins with the handling of the user's personal information and the extraction of elements of interest. Then, a bunch of AI models are applied for breaking down the users response and deciding feelings. These models depend on the examples characterized from sensor information. The decision of integrating the recognition system into the mobile application guarantees the privacy of user's data and avoids the unnecessary transfer of low-level physiological data by reducing the network traffic flow.

Supposedly, when the user is running slowly and his mood is a bit low, a energetic song will be played which will boost his morale and encourage him to run fast. When the user is feeling a bit low but his running speed is quite high, the song which will be suggested to him will be of a high tempo. Similarly there will be many use cases which will be created as a part of this solution.

VII. Feasibility

Data collection is an integral part of machine learning and predictive algorithms. As our application highly revolves around these two aspects we need ample amounts of data to create the perfect training set and design the perfect predictive algorithm. The data furthermore requires inputs such as age, gender, data extracted from the pedometer and the heart-rate sensor and other relevant factors that could influence the result obtained. To collect and train such huge amounts of data, we require a good amount of time to reach perfection as we will have to test them with multiple groups of people from different backgrounds, genders and ages. Furthermore, based on the data collected we can personalize the application to create playlists that can be used by the user based on the history of intensity of the workout sessions as recorded by the pedometer and heart-rate sensors built in the application. On top of this, we can work on integrating the system with the leading music recommendations applications such as Spotify and Apple Music to help the user experience a seamless experience with the app instead of them having to load their songs individually in the application. We can also provide the application with a few default songs based on worldwide popularity to help the user get started. All of these factors will take time and research to achieve refinement in the application.

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