Sweat-Atoms: Turning Physical Exercise into Physical Objects

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Figure 1: A 3D printed object using the heart rate pattern can be used as a souvenir of the effort invested in performing the physical activity.

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Abstract
In this paper, we introduce a novel idea of crafting a physical object in tandem with the physical exercise using the heart rate patterns. Our aim is provide a new way of visualizing the exercise intensity. We present Sweat-Atoms, a 3D modeling and printing system, which generates abstract 3D designs using the heart rate patterns of individuals engaged in a physical activity. The crafted physical objects can act as souvenirs and be testimony to the human efforts invested in performing the physical activity. We believe the creative experience of crafting will help to change the monotonous nature of physical exercise.

Author Keywords
Physical exercise; 3D printing; crafting; exertion.

ACM Classification Keywords
H.5.2. [Information Interfaces and Presentation]: User Interfaces - Miscellaneous.

General Terms
Design, Human Factors

Introduction
With the rapid advancements in the sensing technology, we are witnessing a growing interest in using technology to foster healthy lifestyle in people.

For example, devices such as pedometers [4], motion tracking systems [8] and heart rate monitors [5] that provide accurate and real time feedback on the exercise activity are also becoming popular as an accessory to physical exercise. Heart rate monitors measure and inform the exercise intensity in terms of the variations in the heart rates during the exercise. However, heart rate patterns are currently used to show accurate statistics on individual's exercise performance and to prompt the user to aim for the next achievable health goal. We believe there is an opportunity of using the measured heart rate patterns as a source for self-expression and creativity.

Our idea is to craft a physical object in tandem with the physical exercise using the heart rate patterns. Crafting physical objects that resemble the heart rate patterns can not only be a new way of visualizing the exercise intensity, but the crafted physical object can also serve as a souvenir or a testimony to the efforts invested in performing physical exercise. Moreover, crafting is one of the supreme examples of an autonomous activity where actions are often guided with self-motivated outputs. Therefore, we also believe that the coexistence of crafting activity with physical exercise can inspire the user to be more creative with her exercise activities. This can possibly help to change the monotonous nature of the physical activity, thereby leading to more engaging exercise experience. Motivated by this idea, we present Sweat-Atoms, a 3D modeling and printing system, which generates abstract 3D designs using heartbeats of the individual engaged in a physical exercise. The proposed research also aims to explore a "physical-to-digital-to-physical" mode of interaction, where physical energy is invested in creating a digital output, which is then converted back into physical form, re-entering the physical world. The 3D printing process requires considerable time and so is the process of achieving health goals. Therefore, we believe the final 3D printed output is a good match for the temporal and longitudinal nature of health outcomes of regular physical activity.

Related work

Majority of the existing works on improving health with interactive technologies have focused on providing immediate and accurate feedback on the physical activities. Health however, is often a long-term goal, and it takes time to see the improved effect of exercise on the body. Secondly, most of the designed systems [3, 4, 7, 8] sketch the exercise experience in advance for the user and the user is rewarded most often only when she follows the preset exercise instructions correctly. For example, in most exertion-based games [3], there is a predefined mapping between bodily movements and actions inside a game. This instilled vicarious nature of exercise experience limits options for self-expression and creativity. We believe there is also an opportunity to use the measured data as a source of self-expression and possibly creativity.

We, therefore, propose the idea to capture and utilize the heart rate patterns to fabricate a physical object in response to the physical activity. Previous research suggests that physical objects are more cherishable and meaningful than virtual objects because of their higher visibility in the surrounding and low replication value [1]. Hence, we believe a crafted physical object would represent a meaningful souvenir to the efforts invested in performing physical activity.

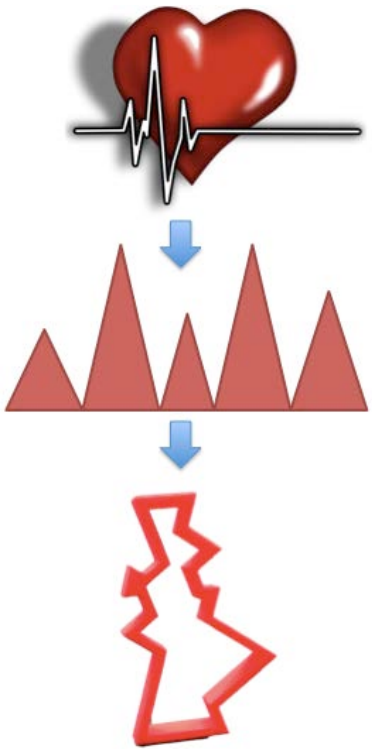

Figure 3: The 3D modeling process inserts a triangular prism of different volume for each significant (+- 10bpm) variation in the heart rate. Then all inserted prisms are assembled together to represent an abstract 3D shape.

Sweat-Atoms

Sweat-Atoms is 3D modeling and printing system where the heart rate patterns of individual engaged in a physical exercise are utilized in the modeling process of 3D printed object. The working of the system is explained below (Figure 2).

Step 1: Exercise: While performing a physical exercise, the user wears a heart rate monitor which records her heart beats per minute. In the current prototype, we have utilized the Zephyr heart rate monitor.

Step 2: Measure: While the user is performing the physical activity, the heart rate monitor attached to her body, records the exercise intensity levels in the form of increase in the heart beats. This recorded data is then sent over Bluetooth to the Sweat-Atoms application, installed on the computer. Sweat-Atoms is a 3D modeling application developed in Processing.

Step 3: Model: After receiving the heart rate data, the Sweat-Atoms software starts the 3D modeling process. In the current prototype, the constructed 3D design consists of triangular prisms of varied volume joined together to create an abstract shape. For every large increment in the heart rate (± 10 beats per minute), a new triangular prism is added to the model. The size of the triangular prism depends upon the reading of the heart rate. For example, for a higher reading of the heart rate, we insert triangular prisms of higher volumes (Figure 3). The modeling process continues as long as the user is exercising (or as long as the heart rate monitor is sending the data). The process stops when the user stops the heart rate monitor manually. The user can also manually stop the process in between the exercise if required.

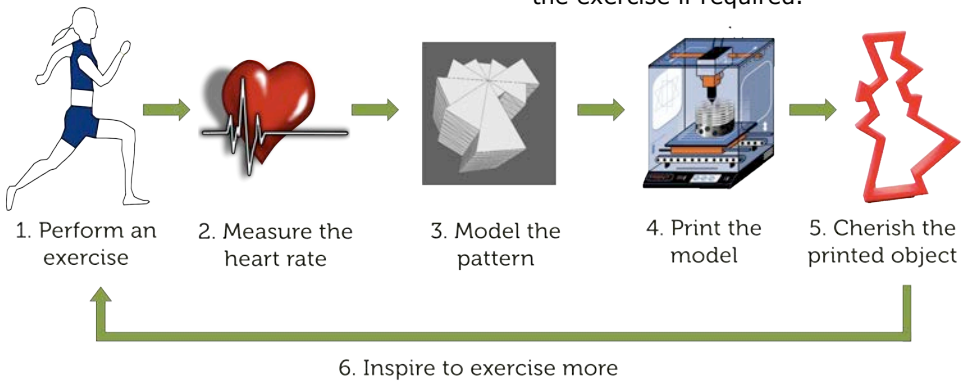

Figure 2: The SweatAtoms loop in actions: 1) user performs a physical activity. 2) The heart rate is measured 3) A 3D model is created based on the pattern 4) The 3D model is printed 5) The user cherishes the printed object 6) The cherishing and ability to create new, novel patterns hopefully inspires the user to exercise again and in different ways.

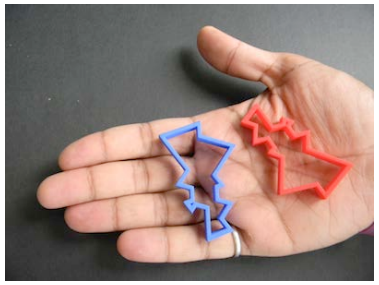

Figure 4: Some of the objects printed using the heart rate pattern of the participants are shown.

Step 4: Print: When the user has finished her physical exercise, she stops the Sweat-Atoms application. The resultant 3D model is then saved into a STL file and the file is fed to the 3D printer for printing. Users can choose the printing material of their choice as well as alter the dimensions before printing.

Step 5: Cherish: The printed object not only acts as a souvenir to the efforts invested in performing the physical activity but it can also be used for a utility purpose such as sending it to someone as a gift.

Step 6: Inspire: The design of the physical object is based on the exercise patterns. In order to get different physical object as an output, the user might get inspired to do exercise differently and to try out new forms of exercise [6]. For example, user might be interested in figuring out how the pushup exercise would reflect in the design compared to jogging or what if I increase the speed of my running, would it have any impact on the constructed 3D model? We believe questions like these would inspire the user to exercise more and be creative with her exercise. As a result, we envision that it would lead to an engaging experience.

Interactive Experience at CHI

When entering the exhibition hall, interested attendees will be asked to wear a heart rate monitor around their chest. After wearing the heart rate monitor, attendees will start or resume their exploration of presented exhibits. As they walk, the attached heart rate monitor will record and send the changes in the heartbeats to the SweatAtoms application. The received heart rate data will be projected in three different visualization forms on a large screen for everyone to see the different effects it might have on their understanding of and engagement with the activity: audiences might try to cheer the wearer on to do push-ups or get excited about some of the other demos to see it reflected on the big screen. The three visualization forms are: 1) numerical representation 2) graph based representation 3) 3D modeling based representation. When the attendees stop the heart rate monitor, the modeling process stops and the resultant 3D model is sent to the 3D printer for printing. Once the printing is over, the constructed 3D objects similar to the ones in Figure 4 will be given to the attendee as a souvenir.

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