Proper Breathing Helmet

A portable device helps your breath training when jogging

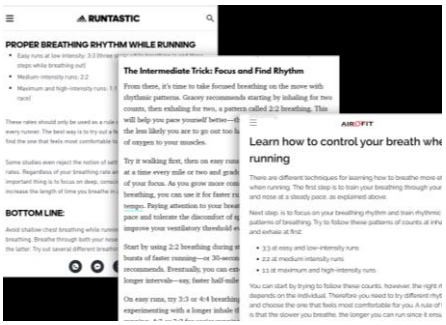
Overview

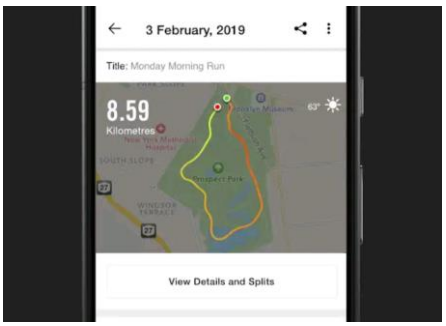
Now, people are very concerned about their health, and many people have regular jogging habits.

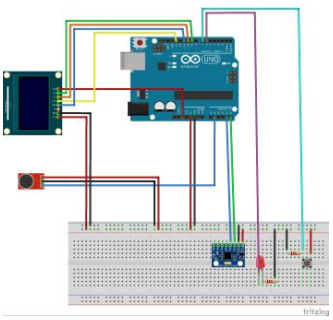
Some people have also begun to try to use wearable devices and smartphones to help record their exercise results. For example, bracelets used to record heart rate and GPS to record jogging distance and time, providing speed and calorie consumption apps, such as *Running Distance Tracker +, Nick Running,* etc. But these data provide only training results, without helping user to improve the process.

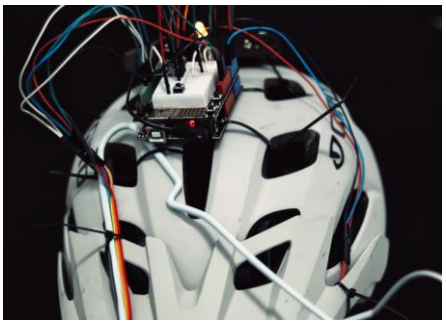
On the other hand, breath training has been recognized by academics and joggers. O'Brien et al. (2002) pointed out that using regular breathing to drive the rhythm of running can achieve better training results. Many training websites for joggers (Airofit, 2019; Kuzma, 2019; Natmessnig, 2018) also point out that regular breathing, such as 2: 2 breathing, has a positive effect on joggers' running exercises.

But for beginners, because of the lack of guidance, it takes more time and energy to complete the breath training exercises. User research shows that if someone instructs them to perform breathing training, they can enter this state more quickly. Therefore, it will be meaningful to design a wearable device to guide jogging beginners to perform breathing training for running.









Relationship to Team Concept

This group is dedicated to exploring ways to use breathing as a means of interaction to help people become better. Breathing is not only a subconscious activity. People's conscious control of breathing can often bring unexpected positive effects, such as reducing stress and improving sports effects. As a non-traditional interaction mode, breathing may also bring new possibilities for human-computer interaction. Among them, I chose to explore the breathing training wearable device with the jogging crowd as the target user, hoping to use breathing interaction to bring them better sports effects.

Video Link

https://www.youtube.com/watch?v=p4M5mV0Roww

Airofit. (2019). *How to breathe when running and strengthen your performance*. Airofit. https://www.airofit.com/blogs/all-blog-posts/how-to-breathe-when-running-and-strengthen-your-performance

Kuzma, C. (2019). *Breathing Techniques—How to Breathe While Running*. Runner's World. https://www.runnersworld.com/training/a20822091/running-on-air-breathing-technique/

Natmessnig, H. (2018, March 6). *How To Breathe Properly While Running*. Runtastic Blog. https://www.runtastic.com/blog/en/how-to-breathe-properly-while-running/

O'Brien, J. (2002). *Running and Breathing*. Yes International Publishers.

Design Process

User research

A total of 5 online interviews were conducted. 4 of the participants are people with experience in jogging, and 1 with no experience in jogging regularly. All interviews received verbal informed consent.

All 4 participants with jogging experience stated that they had learned a certain breathing training method at a certain stage, and all believed that breathing training improved their jogging efficiency.

One participant learned to use the nose to inhale and the mouth to exhale. Two other participants said they learned the 2: 2 breathing method, which means 2 step with one breath. Also, they will change to 1:1 breathing when speed up.

3 participants said they encountered some challenges when they started practicing breath control, such as forgetting to control in the second half of jogging. One participant stated that they was unable to adapt to the intensity of running in the early stages and was therefore unable to take care of breathing training. But they once had a coach to remind them to control breathing. They thought that the coach's reminder helped them learning faster.

One participants with no jogging experience indicated that they had no knowledge of breathing training. According to them, they recalled their occasional running activities, for example, running for classes. there was no regular breathing rhythm, and they always feel exhausted after running.

When asked about the experience of using existing sports apps. One participant talked about the achievement system and leader board in the app was one of the reasons that attracted them to use the app. Another participant said they was more concerned about the performance recorded by app. Two participants indicated that they had the habit of listening to music during jogging.

Changes

Based on data from user research and results of hardware possibilities exploration. This project has made some modifications based on proposal. Originally, the design envisioned a necklace-like device used to collect breathing information on the chest and use sound feedback to provide feedback for breathing training. However, considering that some users have the habit of listening to music, frequent use of sound feedback may affect the user experience. Inspired by Google Glass(n.d.), this project changed the design to a glasses-like device, used a small screen to provide visual feedback in front of the eyes, and connected a headset to detect breathing.

Finally, considering the size of the components and the comfort of wearing, this prototype finally chose to fix the device on the helmet, use the helmet as a medium to suspend the microphone and display, and place the core components of the device above the helmet.

In proposal, it was considered to make a device to help users perform abdominal breathing training. But on the one hand, abdominal breathing in sports is difficult to sense, and on the other hand, there is no direct user data support the learning motivation of abdominal breathing. Finally, based on the new research results, this project decided to make a breathing training wearable interactive device based on the 2: 2 breathing method. Therefore, taking the number of steps as driver of training will become the key. After testing several different sensors, the accelerometer was used as a pedometer to drive breathing training. The specific process will be presented in the next section.

The portability and microphone usability that had become a concern in the proposal were resolved at this stage. So this part remains the same from proposal.

Google. (n.d.). *Google Glass*. Glass. Retrieved May 10, 2020, from https://www.google.com/glass/start/

Design Process

Constructing

The prototype used a microphone as an input sensor for breathing. Finally, the XC-4438 type microphone with adjustable threshold function was selected. In the early stage of the design, this project considered to collect and analyse the user's breath audio to provide users with more information to enhance the training effect. But because only the analogue signal is provided from Arduino and the microphone, it will bring great difficulties to convert it into an audio signal and then analyse it. So this idea was abandoned. Finally, after using median filtering to gain stable reading, the signal that exceeds the threshold is considered to be the user's exhaled breath as data input. One disadvantage of the microphone is that it is impossible to detect the user's inhalation process but considering that the user would not hold breath during exercise, this project assumes that the user is inhaling at the stage of no exhalation.

After confirming the use of 2: 2 breathing method, this project began to explore the possibility of step counting. In the early stage of exploration, this project tried to use the compass to obtain the user's when running and shaking for step counting, but in fact, the shaking is not obvious, and the value hardly changes during the movement. Later we tried to use the tilt switch. The switch responded well when it was rocked up and down in the handheld test. When it was placed vertically, it was triggered every time it was shaken. But in fact, after testing on the human body, we found that the shaking of the running is not enough to trigger the tilt switch.

In the end we used an accelerometer. We use the change in reading caused by shaking up and down, that is, the change in z-axis as the basis for step counting. Similarly, after obtaining a stable reading using median filtering, the user is considered to have taken a new step when the reading exceeds the threshold, and the step is completed when the reading returns to the baseline. But one problem that has existed so far is that sometimes, the accelerometer will plus 2 steps after the user takes a step. In fact, the readings brought by the accelerometer are far more complicated than expected and may require further improving.

As mentioned above, the output method of the device is finally determined to be a display suspended at the upper right of the user's field of view.

The final design is presented in figure 1.

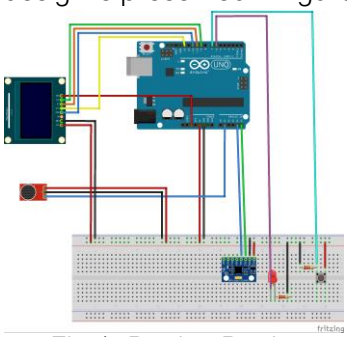


Fig 1. Device Design

The content presented on the display is considered can be difficult to read the text during running and the attention needs to be distracted on the route. The form of feedback is determined to be mainly based on images and can provide the user with the next breathing mode prediction, so that the user can be prepared.

Finally, we designed a line chart to make it easier for users to notice the next breathing direction. And let it disappear as the feedback of unstable breathing rhythm(Fig 2).

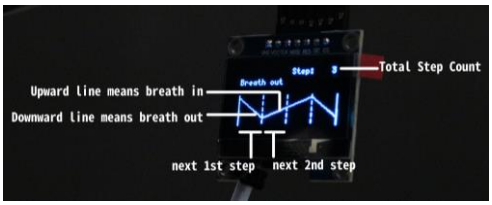


Fig 2. Device Output

Device shape considered the sense of wearing and placement of components, using a helmet as a carrier. Eventually showed good presentation.

Interaction Plan

Interaction Paradigm

The figure 3 on the right side presents an example of interaction between the user and the system in a single use.

When the user presses the button, they can enter the training mode of using breath for interaction.

Because the helmet uses 2: 2 breathing method, the breathing frequency needs to be matched with the step. Therefore, the data input includes the user's step frequency and breathing. After each input is received, the helmet will determine whether the exercise conforms to the breathing method in the background. If the breathing matches, the display will show breathing guide diagram of the next 4 steps is presented; if it does not match, the text requiring the user to adjust the breathing is presented on display.

The user maintains the breathing rhythm of his running through the guide map of breathing training to achieve the better training effect. The visualisation of the line chart allows users to predict their breathing phase in advance. At the same time, users can get feedback when their breathing becomes chaotic to reduce their attention pressure on their own breathing.

Breathing is divided into two stages: exhalation and inhalation. Because the microphone can only detect exhalation, the helmet always taking first exhales as start point after user adjustment for display guidance to achieve the best presentation effect.

After the user uses the button again after the end, the device ends the training mode and presents the statistical results of this training. By comparing the result, users can understand if they have made improvement on jogging breathing training.

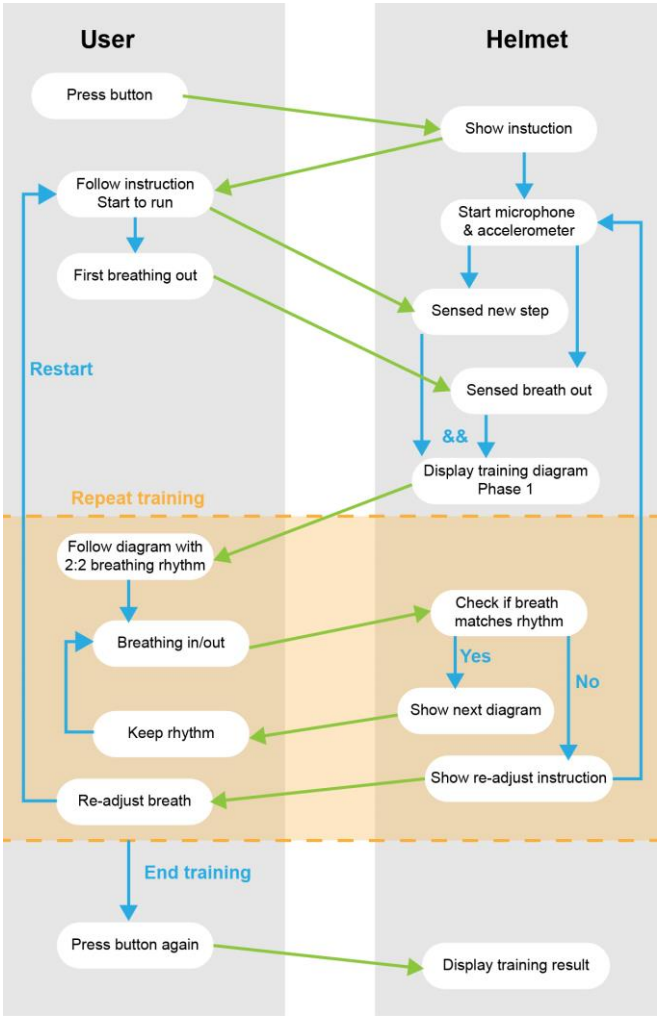


Fig 3. Interaction paradigm

Interaction Plan

Interaction Journey

The figure 4 is a typical user interaction journey.

Steve is a university student who has just started to learn to jog. He heard online about the significance of breathing training for jogging and he also practiced while running. But he always had a hard time keeping his attention on breathing. A few minutes after he started running, he forgot about breath training. Therefore, his training effect is always unsatisfactory.

He also tried to use some sports recording apps to improve his training effect. But that was more of a statistical result, and he could not get real-time interactive guidance during jogging.

Then he discovered Proper Breathing Helmet, a portable wearable device. Wearing a helmet, he will not feel too much burden, but can give him feedback guidance for breathing. When he first started using it, he forgot to control his breath again. But this time the helmet gave him feedback asking him to adjust breathing. After several times he felt that his became fluent and with good rhythm.

Finally, after a long period of use, Steve can naturally maintain a 2: 2 breathing rate. He no longer needs the assistance of the helmet, because he has become a master of jogging breathing.

Project Objectives and Success Criteria

This prototype aims to provide users with 2: 2 breathing training guidance during jogging. After considering the integrated outcome and the expected functions, I proposed 5 dimensions of measurement indicators and plotted them into Table 1.

Training and its effect are the most important parts. We quantified it into Providing clear training guidance and Training Effect and gave the highest weight.

As a wearable device, wearing sense is also one of the important indicators. The feedback of the original information is also a factor, which is one of the keys to guarantee the training effect. Also, this device hopes to reduce the user's cost of use and training costs, so ease of use is also one of the keys.

The details of measurement and successful criterial can be found in table.

Table 1. Successful criterial

Goal	Weight	Measurement	Successful Criterial
Wearable	1	• User's general wearing feeling • If device remain solid and functional during training	• User feels comfortable when wearing • User feels comfortable when moving • Device remain functional during whole process
Reflecting user behavior on device	2	• Accuracy of displaying user movement and breath feedback	• The input data (breath & step) is showing accurate on screen
Providing clear training guidance	4	• If the training guiding graph can be understood • If the training guiding can be saw clear during running	• The graph is easy to understand when moving • The graph can be saw clear when moving • Error feedback can be saw clear when moving
Ease of use	3	• If the content on display is understandable by user • If user know how to start device and training by themselves	• Users can finish one single training by themselves • General content (except graph) is understandable by user
Training Effect	4	• The user's understanding of 2:2 breathing before and after use	• Users (with no 2:2 breath knowledge) learned the pattern of 2:2 training better after use