Automatic Belt Fan for Cooling and Drying Sweaty Hands During Climbs

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Abstract

Rock climbing has few assistive devices on the market designed specifically for climbers and various needs rock climbers have such as retaining their skin while climbing, keeping hands dry and cool, optimizing hand conditions for climbs and reducing pain afterwards. The condition we examined was excessive sweating of the hands while rock climbing. The most common tool climbers utilize today to dry out the hands is chalk, but it can also do more harm than good (e.g. cracked skin). To address that issue we proposed a belt fan that would accommodate the need to cool and dry hands during the climb while simulating a breeze climbers find helpful during their climbs. We interviewed a competitive rock climber, and based on that we gathered enough data to confirm the need of our proposed cooling device. Additionally, to test the overall efficacy of the device, we propose several criteria such as effectiveness, bulkiness, and ease of access/use of the device. Finally, although our device is proposed specifically for the interviewee themselves, it can expand to the whole population of rock climbers.

I. Introduction

This project is centered around the topic of rock climbing; rock climbing is a popular sport that has been growing in the last decade along with its introduction into the Olympics in 2020 [4], but it does not have a lot of assistive equipment designed specifically for it. Part of the enjoyment of rock climbing comes from the difficulty, and equipment designed to give a mechanical advantage is often frowned upon in climbing culture. Still, there is a subset of equipment that optimize conditions for climbing which is considered acceptable and used by even the most skilled rock climbers. Some examples include tools drying hands for more friction, shoes that provide more contact to the surface being climbed, or safety equipment. This proposal investigates gaps in available tools used for rock climbing with regard to drying hands during a climb.

Fig. 1. Rock climber.

A. Background

Based on our research, we found out that climbers use a variety of tools to dry their hands. Two primary tools are towels and chalk (dry or liquid). While these tools can be effective, there are some gaps in their ability to thoroughly dry hands and keep them healthy. Dry chalk is one popular tool to keep the hands dry, and it increases grip by absorbing the liquid and drying out the hands. However, sometimes it can be hard to keep re-applying chalk and also it can have negative consequences of making the hands too

dry which can cause cracking in the skin. ”Human sweat pore patterns located along the friction ridge are unique,” [2] meaning that sweat will generate at different pores for each individual. Chalk will get all over one’s hand, drying out not only the sweat but consequently even the areas already dry which leads to cracking. On the other hand, liquid chalk can also be applied to hands to help absorb moisture and increase grip, but it requires time to dry and can be messy to use. Another common tool is a towel. Towels can remove surface moisture, but it can be challenging to utilize the towel during the climb and it can also get very saturated with sweat and useless after a certain period of time. We wanted to create something that helps climbers keep their hands dry while climbing, but also not cause issues during or after the climb is done. Our inspiration came from widely used bathroom fans, since they’re very effective at drying out hands in a short period of time, one paper even stating that ”with 15 seconds of drying, the residual water was reduced to 1 percent.” [5]. However, there isn’t a need to dry out both parts of the hand since the majority of the sweating occurs on the ”glabrous skin of the palm and sole” [6] therefore our devices only focuses on the palmar side of the hand.

B. Overview

In *Section II* we will be summarizing the results of an interview we had with a professional rock climber, pointing out the critical data collected which led us to our proposed device. Then, in *Section III* we will talk about how our proposed device looks and operates and how we will test it for efficacy. In *Section IV* and *Section V* we will describe how our proposal can be used in other areas or carried on if the concept gains popularity.

II. Interview case study

We conducted a 90-minute interview with a young adult male competitive rock climber who had been climbing since the age of 13. It was conducted in person at a rock climbing gym with video, audio, and transcript recording. As of now, our interviewee has climbed Half Dome (a 15-hour climb) with other professional climbers. During this climb, they all decided to abstain from using climber’s tape - climber’s tape is often wrapped around cuts to prevent them from propagating at the cost of some sensitivity on the hands. Our interviewee’s reason for this was that a skilled climber does not need tape as long as their technique is solid, and it adds a fun additional challenge to their climb. He also mentioned that he struggled with hand sensitivity after climbs, specifically their hands being too dry and because of it having a higher heat sensitivity (not being able to grab hot objects). That insight provided us with guidance for our final project prototype.

After interviewing, we also found that injuries are more common on the dorsal side of the hand and fingers/nails [3]. The main takeaway from our interview was that maintaining sensitivity in the fingers is important to climbing for friction and grip. However, sweat on hands can impede that sensitivity. There are lots of tools used in climbing to help dry out hands such as antihydral cream and chalk. Climbing tape is another common tool used in climbing, but sensitivity is lost in the fingers along with friction and the feeling of how you’re holding.

According to our interviewee with the primary findings documented in Table I, climbers use chalk to get rid of any sweat. The less sweat that accumulates on the hands and fingers, the easier the climbs. Rock climbers have also brought fans to use before attempting to climb outside in order to dry their hands. Our interviewee has also used a fan to cool and dry his hands before climbing outside. The peak friction for hands happens at cooler temperatures [1], so the ideal hand condition for bouldering would allow for maximum gripping of rocks. Having a cool breeze was mentioned to have helped climbers on their climbs, hence using a portable fan beforehand.

III. Proposed Device & Test Methods

A. Proposed Device

In order to cool and dry the hands and simulate the breeze that rock climbers feel, we have proposed to create an automatic belt fan that the user could use while climbing. The fan would have a clip that

Prompt/Theme	Interview statement	Interpreted need
Equipment Used	1) “That’s why climbers use chalk. That’s to get rid of any sweat.”	1) Sweat can impede climbing, so chalk is used to prevent that.
	2) “There’s climbing tape but even a perfect tape job still loses sensitivity on the fingers, you can’t feel how you’re holding, and friction is lost.“	2) Climbing tape is used to help climb but finger sensitivity is needed to feel how you’re holding and for friction
	3) “My hands are a bit more on the wet side, so I usually try to remove some moisture from hands while climbing.“	3) desires methods to dry hands while climbing
	4) “[A fan that can dry your hands during a climb], that intrigues me.“	4) desires methods to dry hands while climbing

TABLE I
PRIMARY FINDINGS AFTER INTERVIEWING A COMPETITIVE ROCK CLIMBER

would latch onto the belt and be activated by an IR sensor - when the hand is placed over the sensor within a distance of 2.5 cm, the fan would turn on and blow cool air, and when the hand is out of range and not detected, the fan would turn off.

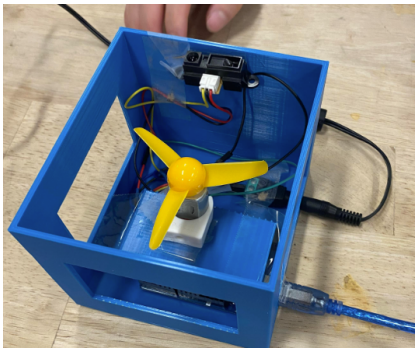

Fig. 2. Prototype 2 of the automatic belt fan showing the placement of the parts inside and the holes around the box for airflow.

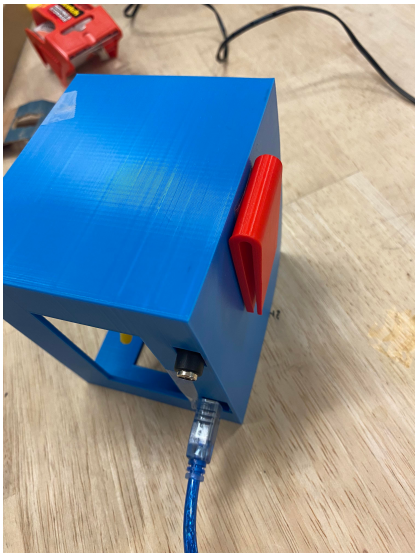

Fig. 3. Prototype 2 of the automatic belt fan showing the back where the belt clip is and the plugs for current power source.

The fan would be powered on by a battery source that would ideally last long enough for the duration of a few climbs. Because the climber would only use the device in times of need for approximately 5 to 10 seconds, the life of a 12V battery powering the motor, sensor, and microcontroller would last for a few

days. The device would be small enough so that it doesn't hinder the climbers during their climb. The casing would be big enough to enclose the fan, the motor, the sensor, and the microcontroller with the wiring but be small and thin enough so that it doesn't get in the way of climbs, minimizing the bulkiness factor. There would be multiple holes around the box to provide for airflow. The edges and corners of the box would also be rounded out so that it would not poke the climber, especially if a fall were to occur.

B. Test Methods

Our device's purpose is to allow the user to cool and dry their hands during their climbs and to also simulate the breeze they might feel on their climbs. To make sure our device serves its purpose, we would test it based on the criteria important to climbing.

The most important needs are how strong the device would be able to simulate the feeling of the breeze and if it would keep the hands cool and dry. To test these, we would test different fan blades and speeds to see which would give a more realistic feel of the breeze while also removing as much sweat as possible quickly. A successful device would create a sensation of cool air while drying it within 5 to 10 seconds. The longer it would take to dry hands would be tedious for the climber during their climb.

The second most important need is the bulkiness of the device. It should not add as extra dead weight for the climber and it should not feel as a hindrance during climbs. To test its bulkiness, the device would be clipped onto the belt in different areas (on the front, on the back, and on the sides of the belts). This criteria would need to be tested during a climb to make sure that the weight and size of the device does not impede the climber's ability to perform different holds, no matter where on the belt the fan is placed.

Another important need is determining its ease of access and use. The device should be able to turn on by waving the hand in front of the fan without being in an awkward position. Because the device is IR sensor activated, the sensors would be tested to determine the distance between how far the hand is from the device in order for it to turn on. Ideally the device should turn on within 3 cm or less away from the hand. This would also be tested during a climb to see how the hand would reach for the fan.

One of the main considerations of building a fan was its ability to cool and dry hands without overly drying it. Because the use of too much chalk could lead to cracking and damaging of the skin, the belt fan was proposed as an additive. The sensitivity and the injuries on the hand post-climbing will be monitored to see if the fan could lessen any damage compared to the chalk. This would be monitored over different climbs conducted via surveys.

All of these studies would be done with 10 climbers who would perform a climb first without the device and then with the device. Each climber would also be given a chalk bag to use on their climb. A survey would be given out to the 10 climbers to see if each need was met and how well the device performed with respect to each need. The survey would also cover how often the chalk was used versus the belt fan. Through these results, different prototypes will be built out.

Because we plan to perform human subject testing on our device, we have completed our CITI training Group 1: Biomedical Research Investigators as of April 17th, and we plan to submit a protocol for review through the Internal Review Board for the Protection of Human Subjects. We would make sure our subject is respected and comfortable during the testing procedure just as we had done during the interview.

IV. Intellectual Merit

Our study can be generalized as a method to keep hands cool and dry while also minimizing damage to the skin. When the IR sensor detects something within 2.5cm, the motor connected to the fan is then prompted to spin, generating airflow. The housing for the system has holes on all sides to allow for more airflow, optimizing the breeze felt by the user. The belt clip as seen in Fig. 3 could be placed anywhere around the waist, but holds tight enough to prevent it from sliding during a climb. In the current study, we are not testing the longevity of the battery of our fan. We also did not gather qualitative survey data on preferences of a fan, towel, chalk, or mixture of more than one method. If the desire for the belt fan was high, it would be worth investigating ways to optimize the housing to be significantly smaller and

much less susceptible to breaking. This would improve the quality of the product and make it safer for users.

V. Broader Impact

We plan on making our findings open source since there are a couple of interesting facts that might influence future designs. For e.g., initially we thought about how we can construct devices to make it easier to climb, but then we realized that professional climbers often look down on any such devices. That influenced us to move away from creating assistive devices, and move towards something that is giving you the best conditions before or during the climb.

We've realize that sweaty hands is a big problem for climbers and that current solutions have negative side effects such as causing wounds on hands and increasing the sensitivity to heath. We also learned that the best climbs usually happen when there is a light breeze in the air, which gives a mental confidence and a physical advantage (that however needs to be tested). Those leanings will hopefully help navigate future designs in the world of rock climbing.

References

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