Mech 320

Digital Manufacturing Challenge Proposal

3D-Printed Water Filter

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Abstract

The goal of our product is to provide quick and easy access to clean drinking water to those who are involved in natural disasters. We seek to accomplish this through the use of a 3D printed water filtration device. 3D printing the device provides numerous advantages for natural disaster scenarios such as fast and cheap production. The device will include a simple 3-stage filter in order to maximize the effectiveness of the filtration. This will be done through the use of a few simple materials such as sand and carbon. While there are other available options for water filtration that exist, they can be quite expensive when distributed widely. This is because they were made with long term reusability in mind. Our product aims to be a short-term solution until better accommodations can be made in a natural disaster scenario.

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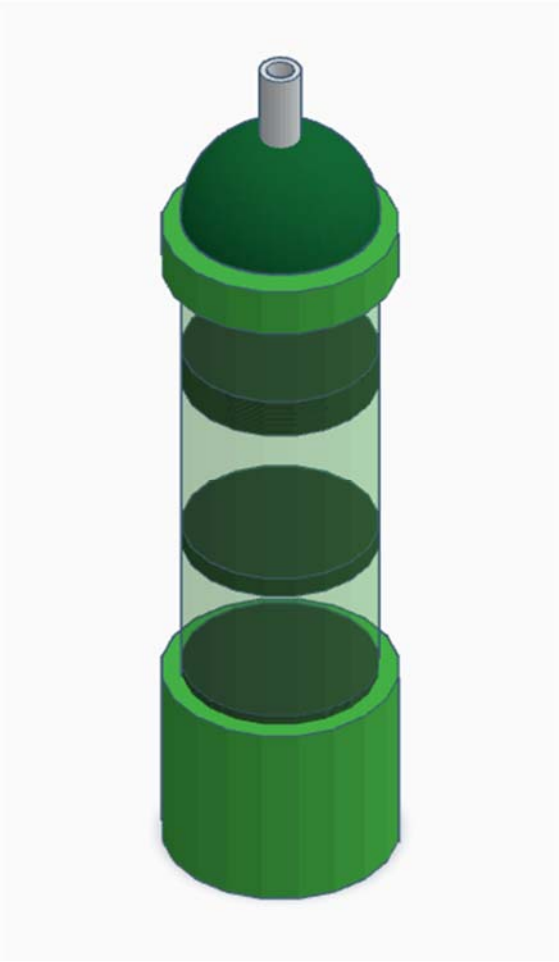
Problem Statement

A major problem that people face during natural disasters is having easy access to clean drinking water. This is a major problem because water is one of the most important things that a person needs to stay alive and a prolonged lack of water can have dire consequences. According to the world health organization 26% of people worldwide do not have access to a safely managed drinking water service [1]. There are solutions available for this problem currently, but they can be both costly and time-consuming. We aim to solve this problem in a cheaper and more effective way.

Proposed Design

Our 3D-printed water filtration device is designed to provide quick and easy access to clean drinking water in natural disaster scenarios. The device consists of a simple 3-stage filter made from readily available materials such as sand and carbon, providing a cost-effective solution to the widespread problem of a lack of clean drinking water. The 3D printing process is fast and cheap, making it possible to produce a large number of units quickly, which is critical in a natural disaster scenario. The estimated cost of the device is $1.43 per unit, with the majority of the cost coming from the choice of material (PLA) and electricity. The use of PLA, a biodegradable and easy-to-use material, is ideal for the conditions typically found in disaster zones where experienced hands may not be available. With an estimated life of 7,500 to 15,000 printing hours, the device is intended as a short-term solution to provide much-needed clean drinking water to those in need.



In addition to its primary use in natural disaster scenarios, our 3D-printed water filtration device has several alternative uses that make it a versatile and cost-effective solution for a variety of water filtration needs. For example, it could be used in developing countries where access to clean drinking water is limited. It could also be used by outdoor enthusiasts, such as hikers and campers, as a portable filtration system to ensure they have access to clean water while in the

wilderness. Additionally, the device could be used in disaster relief efforts, including providing clean drinking water in refugee camps and other temporary settlements. The affordability and fast production time of the device, combined with its ability to filter water effectively, make it a valuable tool in a variety of contexts.

The 3D printed water filtration device can also be used to fill up large quantities of water bottles in disaster relief scenarios. This can be done by setting up a system to pump water through the device and into water bottles. The 3-stage filtration process effectively removes impurities and contaminants, providing clean and safe drinking water that can be distributed to those in need. This can be especially useful in large-scale disaster relief efforts where there is a need to quickly provide clean drinking water to a large number of people. This can help to ensure that clean drinking water is available to those in need as quickly as possible, providing a crucial resource in the aftermath of a disaster.

Justification for use of Additive Manufacturing

Our main justification for the use of 3D printing is the ease of access and the cost. 3D printing is widely available in the modern day and it is relatively quick with large parts able to be constructed in a matter of hours. The material cost is also very cheap as we are using simple PLA plastic. The scale of our design is very small therefore it will not take a significant amount of time to print the plastic components.

Cost Analysis

The cost of our design will stem from the initial cost of the FDM 3D printers, electricity, and material choice. The initial cost will be in the range of $150 - $300 with an expected run time range of 7,500 printing hours to 15,000 printing hours (printing for 8 hours every day for 5 years) [2]. The lifetime of the printer will decide how many complete units can be made per printer. If the final design takes ~4 hours to print (slicer adjustments and design tweaks can improve), then the estimated units made per printer will be around 2800 units and $0.08/unit based on printer cost. Next, electricity is highly variable in disaster zones so often generators will be temporarily brought in. This variability will make it difficult to estimate its cost addition, but we feel a safe estimate is $0.025/hour and $0.10/unit based on average 100 W power demand per printer and doubling local electricity cost. Finally, material choice is the most significant cost addition. Keeping costs low means looking at the most available 3D printing filaments being ABS and PLA. Both are non-water-soluble, but PLA is our choice of material. PLA is slightly cheaper than ABS, $12.5/kg for PLA vs. $15/kg for ABS. PLA is also biodegradable but the main factor is that PLA is the easiest material to use in benchtop FDM 3D printers. ABS will often warp and is pickier than PLA over its print settings and environment. When experienced hands may not be available at disaster sites, PLA is better suited for use. The reduced cost helps our affordability efforts and for our planned weight of around 100g, the cost per unit will be $1.25. Altogether our estimated cost is $1.43/unit.

Conclusions

In conclusion, the goal of our 3D-printed water filtration device is to provide quick and easy access to clean drinking water in natural disaster scenarios. With the ability to produce the device quickly and cheaply through 3D printing, it offers a cost-effective solution to the widespread problem of a lack of clean drinking water. The device consists of a simple 3-stage filter made from readily available materials such as sand and carbon and has an estimated cost of $1.43 per unit. This device has several alternative uses, such as providing clean drinking water in developing countries, outdoor adventures, disaster relief efforts, and filling up large quantities of water bottles in disaster scenarios. 3D printing is the main justification for the use of our design due to its ease of access and low cost. The estimated cost for producing the device will come from the initial cost of the FDM 3D printers, electricity, and material choice. With its versatility and cost-effectiveness, our 3D-printed water filtration device is a valuable tool in a variety of contexts, providing crucial clean drinking water to those in need during natural disasters.

References

[1] “Drinking-water,” *World Health Organization*, 2022. [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/drinking-water. [Accessed: 21-Feb-2023].

[2] M. Dwamena, “How long does a 3D printer last? Creality Ender 3 & Others,” *3D Printerly*. [Online]. Available: https://3dprinterly.com/how-long-does-a-3d-printer-last-creality-ender-3-others/. [Accessed: 21-Feb-2023].