2025 Governor's STEM Competition

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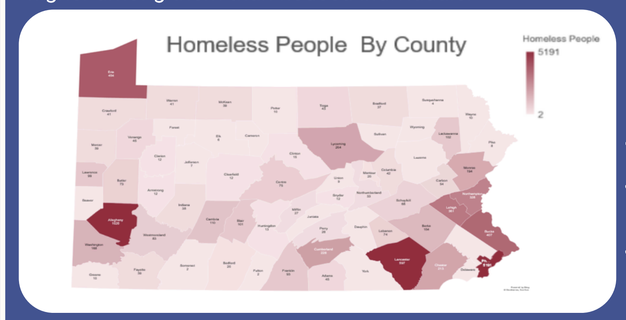
Abstract

We developed a secure tethering device for homeless individuals to prevent theft during vulnerable moments. Through partnerships with local homeless organizations, we identified that theft rates among homeless are significantly higher than those of housed individuals, with entire backpacks often stolen while sleeping in shelters or tents. Our device, StreetSafe, provides a simple, effective solution by securing the backpack to a fixed location, deterring theft and protecting personal belongings.

Understanding the Problem

In Pennsylvania, over 15,000 individuals experience homelessness daily. [1] From our work in Pittsburgh, we have seen firsthand how theft disproportionately affects the homeless, with major cities reporting theft rates 58 times higher among them than housed individuals. [2]



Homeless People By County in PA [3]

- **Cause of Theft:** Perpetrators are usually other homeless individuals seeking money, bus passes, or phones.
- **Backpacks:** Backpacks are one of the most convenient storage for valuables and are the most commonly stolen item.
- **Method of Theft:** Thieves often steal unattended backpacks, especially those that are near a sleeping owner, and then search them in private.
- **Loss of Documents:** Although thieves do not take their IDs and licenses, the owner is unable to retrieve their bag once stolen, ultimately losing their important documents.
- **Variations of Homelessness:** Homeless individuals face different circumstances, whether in shelters or on the streets. In both cases, theft is a major threat, and our device provides a solution for both scenarios.

Objectives and Challenges

Goals:

- Scalability: Affordable for widespread distribution by shelters
- Product Discretion: Blends with personal belongings
- Practicality: Easy to use for individuals of all backgrounds

Constraints:

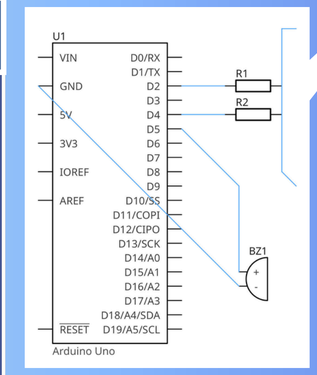
- Legal restrictions prevented direct interviews with homeless individuals
- Limited statistics hindered detailed research

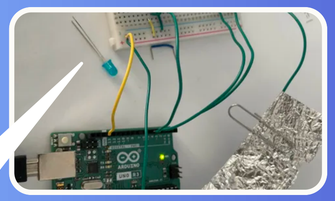
Design Consideration

Our prototype combines physical security with technology, featuring a tether equipped with an alarm.

Compatibility: The device is lightweight and compact, fitting easily in a backpack. We avoided traditional locks to prevent key loss, ensuring convenience for people on the move. The tether can attach to various structures—bedposts, walls, or even the user's leg—making it versatile for different environments.

Price: To ensure accessibility, the device is affordable for both personal purchase and distribution by shelters or organizations.



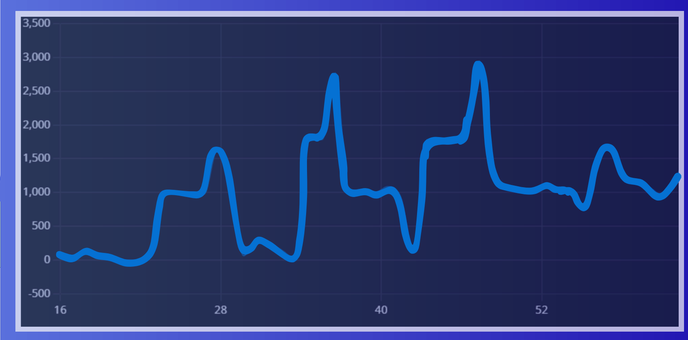


Prototype Development

- Physical Aspect: We used 1/8 inch steel cable with loops at both ends for locking. Users can secure the tether through backpack zippers and attach it to a nearby structure.
- Alarm: Initially, we tested a force sensor but switched to a capacitive sensor. The wire detects touch or proximity, triggering an Arduino to measure the change and activate a piezo buzzer if the difference is within half an inch and will stop once you tap it again.

Prototype Trial

The final prototype was tested in real-world scenarios, such as attempting to cut a steel cable or force open a combination lock. In each case, the piezo buzzer emitted a loud sound, alerting nearby individuals to the theft attempt. The capacitive sensor detects changes in voltage on a piece of foil, which is extended by the steel cable, making it touch-sensitive. The alarm triggers when the voltage difference exceeds a set threshold and stops when it drops below this threshold. Initially, a smaller, cheaper microcontroller was planned, but this had to be postponed due to a malfunction. The system is sensitive to touch or proximity, with the Arduino measuring voltage changes and activating the buzzer accordingly.



Sensor Readings using Arduino IDE

Local Organization Partnership

Our team interviewed Annie Cairns, a senior marketing manager at Light of Life which is a homeless shelter. Through her and Adam, we connected with 3 individuals experiencing homelessness to understand their struggles and needs. Both of them also guided us by providing key statistics and data for our project. The interviews deepened our understanding of what the homeless go through, and we are planning to donate our device to Light of Life.

LIGHT OF LIFE RESCUE MISSION
WHERE HOPE AND HEALING MEET

Conclusion and Future Research

The development of the anti-theft tether system demonstrates how thoughtful design can help our vulnerable populations. The system successfully balances functionality with cost, making it accessible to homeless individuals who need a secure way to protect their belongings. We still have further additions to consider because our interview with the homeless people enlightened us to think beyond something simple. In the future, our group would especially like to add a key fob and button to switch the device on or off. We would also like to create a water resistant casing. Hopefully, we will be able to mass donate working devices to shelters in the future. Not only does the backpack offer physical security, but it also offers peace of mind to the people who have one less thing to worry about when they have greater issues to face. This project not only addresses a current issue but highlights how engineering solutions can have a meaningful impact, even in small ways.

Evaluation of Prototype

Our prototype can detect when human fingers get within a half inch of the cable. It occasionally suffers from some false alarms in certain conditions, but this can be ironed out with further adjustments to the sensitivity. We also planned to use a much cheaper and smaller microcontroller but had to postpone that due to a malfunction in the microcontroller.

Design Benefits:

- **The Choice of Cable:** Since we used steel cable, it was easily hooked up to the capacitive sensor instead of having being completely wrapped up in foil or other conductive material.
- The thief does not need to explicitly touch the cable, as long as they get close enough to it, the alarm will trigger. If someone tries to avoid the wire by grabbing around it, they will still be caught.

More Innovative Devices That Are Helping the Homeless!

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Homeless Blockchain Identification App — Click
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Video | Project Report | Interview | Budget | References

Acknowledgements

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