Bend Passwords on BendyPass: A User Authentication Method for People with Vision Impairment

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ABSTRACT
People with vision impairment are concerned about entering passwords in public as accessibility features (e.g. screen readers and screen magnifiers) make their passwords more vulnerable to attackers. This project aims to use bend passwords to solve this accessibility issue, as they are harder to observe than PINs. Bend passwords are a recently proposed method for user authentication that uses a combination of predefined bend and fold gestures performed on a flexible device. Our inexpensive prototype called BendyPass is made of silicone, with flex sensors able to capture and verify bend passwords, a vibration motor for gesture input haptic feedback, and a button to delete the last gesture or confirm the password. Bend passwords entered on BendyPass provide a tactile method for user authentication, designed to reduce the vulnerability to attackers and help people with vision impairment to better protect their personal information.

INTRODUCTION
In a recent survey, more than two thirds of people with vision impairment, who are blind or have low vision, expressed concerns with typing passwords in public spaces [3]. This is mainly due to the risk of shoulder surfing attacks, because entering passwords require them to either use screen readers, which read the password characters aloud, or screen magnifiers, which make the characters easier for others to see. Prior work confirms that these users are more vulnerable to shoulder surfing and aural eavesdropping when entering PINs [6]. Additionally, they consider PINs the least secure method to unlock mobile devices, because they are easy to guess, inaccessible or inconvenient [1, 3, 4]. However, PINs are still the most common user authentication method in smartphones, required even in devices that enable biometric methods, such as fingerprints.

A truly accessible solution for passwords for people with vision impairment should not require precise manipulation of visual items, the use of one's eyes or keyboards [3], as PINs do. Therefore, to help people with vision impairment

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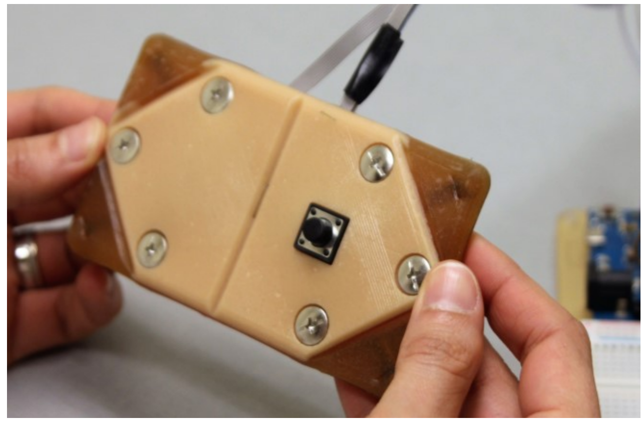

Figure 1: BendyPass prototype, where users can enter bend and fold gestures to form a password.

to better protect their smartphones from unauthorized access, this research project proposes the use of deformable user interactions (DUIs) [8–10], specifically bend passwords [7]. DUIs allow people to physically manipulate the shape of the device (e.g. bending, squeezing, folding) as input. Maqsood et al. [7] investigated the use of a sequence of deformations (bend gestures) as a user authentication method called bend password. They found bend passwords as easy to memorize as PINs, but harder to shoulder surf. Thus, we aim to explore bend passwords for people with vision impairment.

We designed BendyPass, a flexible device implementing bend passwords as a more tactile password-input method (Figure 1). We present the prototype, highlighting its novel features and fabrication, then discuss potential applications.

PROTOTYPE
BendyPass is a flexible prototype that can recognize 10 simple bend gestures (Figure 2), including bending each corner upwards or downwards (8 gestures) and folding it in half upwards or downwards (2 gestures). A series of bend gestures is called a bend password. When a user performs a gesture, BendyPass vibrates, while a computer provides audio feedback informing the name of the gesture recognized, such as "Top right corner up".

To facilitate the user's access to all four corners of the prototype while holding it with both hands, we designed it for use in horizontal position, similar in size to an iPod touch. We iterated through different prototype versions to evaluate variations of material hardness and positions of grooves that indicate bendable areas (Figure 3). We tested each prototype version with flexible devices specialists and

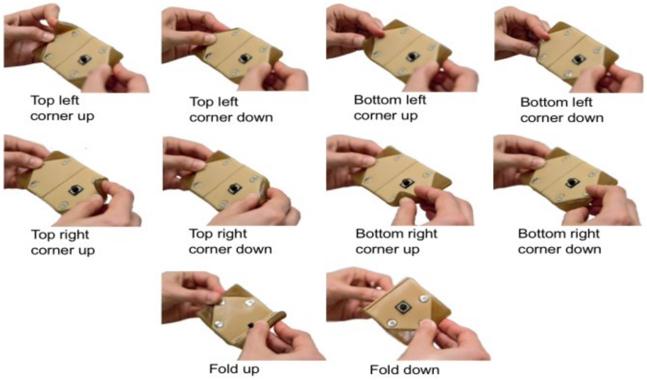

Figure 2: Set of bend gestures available on BendyPass.

experts at the Canadian Council of the Blind. The final version of BendyPass is composed of two silicone layers that enclose electronic components, including five flex sensors to capture bend gestures, a vibration motor to give feedback when a gesture is recognized, and a button to allow the user to either delete the last gesture entered or confirm the password.

Prototype Fabrication

We designed the silicone mould for BendyPass in Blender [2] with grooves to create triangular areas around each of its four corners, a vertical groove in its centre, and a lowered part to insert a push button. The grooves allow for easier bending and folding [5]. We adjusted the groove configurations from previous work to angle them, so fingers can sense them clearly but will not be pinched when the device is bent. We also lengthened the grooves to make them span from side to side for an effortless bend gesture.

In our final 3D printed mould, we used two different types of silicone to make the bendable areas more flexible than the central area, where we placed the rigid components. This emphasizes the areas that could be bent while better protecting the electronic components that should remain flat. We combined two silicone types by first pouring mixed Alumilite A80 in the central diamond-shaped area of the mould and pouring mixed Alumilite A30 in the corners and over the A80 rubber immediately after.

BendyPass has 5 1" Flexpoint bidirectional bend sensors, placed in the centre, top-left, top-right, bottom-left and bottom-right corners. It also has a vibration motor positioned inside its left side, to give haptic feedback for the user that a gesture was recognized by the system; and a push-button on its right side, to allow the user to delete the previous gesture entered or confirm the password. The user can delete the previous gesture by pressing and releasing the button in less than half a second, and confirm the password, by pressing the button and holding it pressed for at least half a second.

The prototype is connected to an Arduino Leonardo microcontroller, which transforms the gestures and button presses in keyboard entries on a connected computer. Each gesture performed in BendyPass becomes a letter on the

Figure 3: Initial prototype versions.

computer. Furthermore, deleting the previous gesture on BendyPass activates the backspace key, and confirming a password activates the Enter key on the computer. This keyboard mapping is invisible to the user, who only needs to define and replicate a sequence of bend gestures. Based on the keyboard entries received, a .php website saves each gesture entered in a mySQL database and provides audio feedback, such as "top-right corner down" or "Enter".

POTENTIAL APPLICATIONS

BendyPass is a prototype developed to run a study with people with vision impairment on the learnability and memorability of bend passwords when compared with PINs. BendyPass could be paired via Bluetooth to personal devices such as smartphones and computers to unlock them without typing traditional passwords. It could also be used to log in to various accounts in personal devices, such as email, social media and online banking. It could be connected via USB cable to public computers or to ATMs, to allow users to have a unique point of entry for passwords. Additionally, when flexible smartphones are available in the future, bend passwords could even be entered directly in the smartphones.

Although we designed BendyPass for people with vision impairment, we believe it could also be used by people with dexterity impairments, as it does not require precise selection of items. It could also be useful for people with learning disabilities because it allows users to use their "muscle memory" to remember passwords. Finally, it could be even used by people without disabilities, as an eyes-free method to unlock devices and access accounts without having to look at the device, similarly to what was previously proposed [7].

In summary, bend passwords are a more tactile alternative to PINs, and could replace them when using BendyPass, a light and small device that can help everyone to more willingly protect their personal devices with passwords.

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