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Haptic Project Proposal
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LOCKPICK SIMULATION

Introduction

"Pin tumbler locks offer the most security for their price. They have close machine tolerances and approximately 1,000,000 different key combinations for a five-pin lock." (Hampton, 1987, p. 17) Pin tumbler locks were invented by the Egyptians and are now the most commonly used lock today (Hampton, 1987, p. 1). Innovation has made these common locks more difficult to pick, with some of the preventative measures consisting of mushroom and spool pins (Hampton, 1987, p. 43-44), spring loaded cylinders (consider the Brinks circular Padlock), and even angular pins (Hampton, 1989, p. 11-13). Picking a tumbler lock is a haptic skill learned by locksmiths which is often performed with both hands and without visual feedback: "To successfully pick a pin tumbler lock, your sense of touch should be honed so that both hands feel the tools. Once the hand holding the pick has located a slight relief in tension while picking a particular tumbler, the other hand holding the tension wrench will feel a relief or breaking point. Both hands should be involved with the sense of touch, the sensing of the inner workings of the lock." (Hampton, 1987, p 18) A lock smith would need to be able to feel through a pick for the pins and properly position them. The locksmith also needs to use a wrench to feel for the relief that comes with each successful pin placement: "Push on the wrench as far away from the lock as the length of the wrench will allow. With increased leverage you get better sensitivity for movements inside the lock." (Conkel, p. 21).

The goal of this project is to create a simulation environment that would enable lock smiths to practice picking a variety of locks which they may not have access to. This simulation environment would also enable lock designers to create prototype locks in a virtual environment and test their anti-theft designs. For this project to be successful, the picking sensations will need to be imitated through the two haptic paddle and Phantom Omni. Because the actual haptic picking experience involves close tolerances and a small workspace, it is necessary to sample the user's position at a high frequency (Hayward, p. 9, & Maclean, p. 105).

For simplicity and to fit within time constraints, the simulation environment will be limited to the simplest of the locks, a pin tumbler lock with five one-degree-of-freedom pins. In creating this environment various haptic rendering techniques will be explored to design the most realistic haptic experience. If we have sufficient time we would like to implement voice-coil-recorded and -generated vibrations to help feel the pins. These vibrations would target Pacini or FA-II mechanoreceptors, (Johansson, p. 4).

Materials List & Expenses

* Phantom Omni (to simulate pick)	Available to use in lab for free	($1000 value)
* Haptic Paddle (to simulate wrench)	Available to use in lab for free	($50 value)
* Voice Coils (to simulate wrench and pick vibrations if necessary)	From a thrift store	$5.00
* New Omni stylus 3D printed (if necessary)		$15.00
* Other expenses		$20.00

References

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Timeline

March 10 – Render haptic paddle interface:

- Train Courtney on dynamics of lock picking
- Program vibrations for tripping pins as felt through the picking wrench
- Program cylinder friction as felt through the picking wrench; device friction may suffice
- Program five stopping points, one for each pin (as each pin is compromised the cylinder will allow movement to the next stopping point), and simulate effect via keystroke (i.e., without needing the Omni)

March 29 –

- Visually display wrench in lock according to current orientation
- Create a model of a cylinder lock with five spring-loaded pins
- Render graphics
- Using collision detection locate the pins relative to the stylus

April 12 –

- Program dynamics of internal parts, including pin and pick frictions
- Render Omni forces
- If time, measure, record, and play back vibrations felt during normal lock picking