

VIRTUAL LOCK

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Project Statement

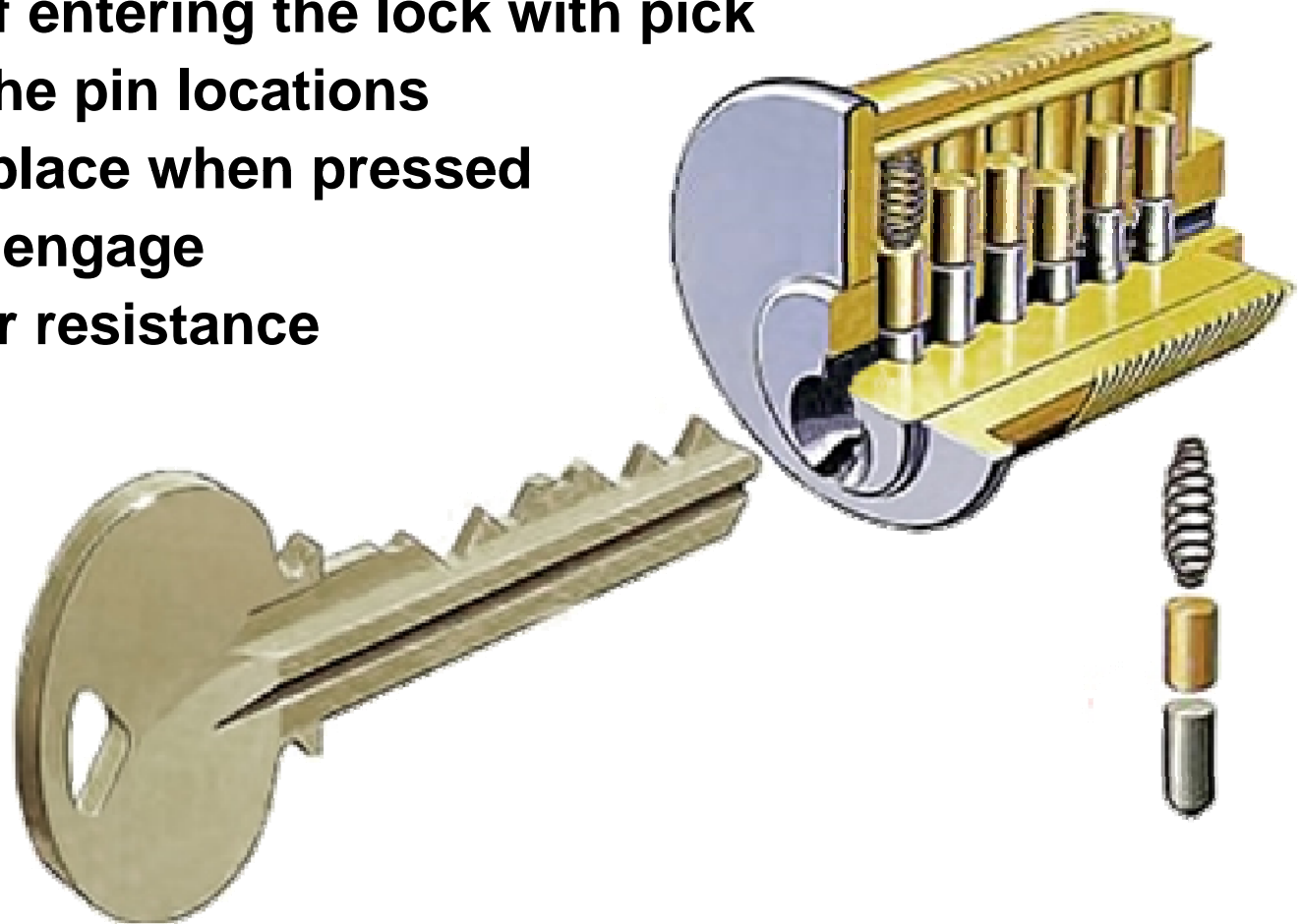
Design a lock picking simulator that provides the necessary haptic cues to mimic the experience of picking a lock.

MOTIVATION

- **To gain practical experience developing a haptic simulation**
- **To provide lock smiths with a practical simulation environment**
- **To provide lock designers with a testable simulation tool for developing more secure locks**

SIMULATION INCLUDES:

- Sensation of entering the lock with pick**
- The feel of the pin locations**
- Feel pin displace when pressed**
- Feel the pin engage**
- Feel cylinder resistance**



SUMMARY OF RELEVANT LITERATURE

[1] - Conkel, Hans. *How to open locks with improvised tools*. Level Four Publications, 1998. Print.

[2] - Hampton, Steven. *Secrets of lock picking*. Boulder, Colorado: Paladin Press, 1987. Print.

[3] - Hampton, Steven. *Advanced lock picking secrets*. Boulder, Colorado: Paladin Press, 1989. Print.



SUMMARY OF RELEVANT LITERATURE

<http://gregmiller.net/locks/mitguide/>

Reference on the internal workings of a lock, and gives tips on how to pick a lock.

http://www.stanford.edu/class/cs277/homework/assets/cs277_projects2008.pdf

“Picking a lock is one of the few activities that doesn’t use any sense other than touch.”

SUMMARY OF APPROACH AND METHODS

- **Created wrench interaction using haptic paddle**
- **Created objects using SolidWorks**
- **Used examples from Chai3D to implement 3D environments with arbitrarily shaped objects**
- **Used Chai3D collision detection to calculate forces**
- **Programed internal workings of the lock by hand.**
- **Used interaction point at pick's tip**
- **Added optional force to draw user towards plane of pins**

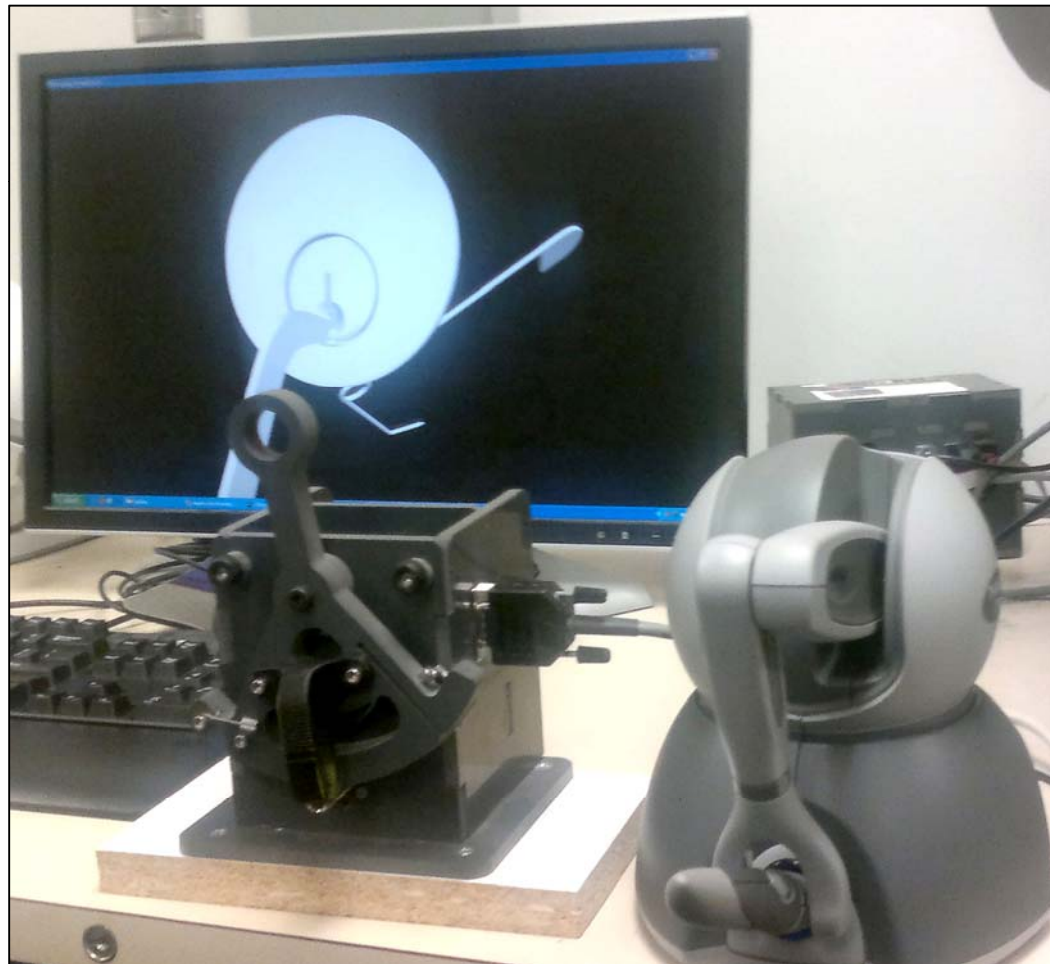
HAPTIC DEVICES USED

PHANTOM Omni

- Move within environment
- Sense pins using pick

Haptic Paddle

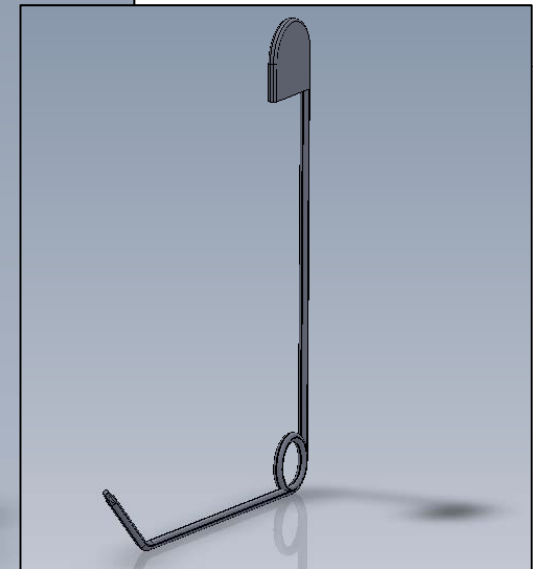
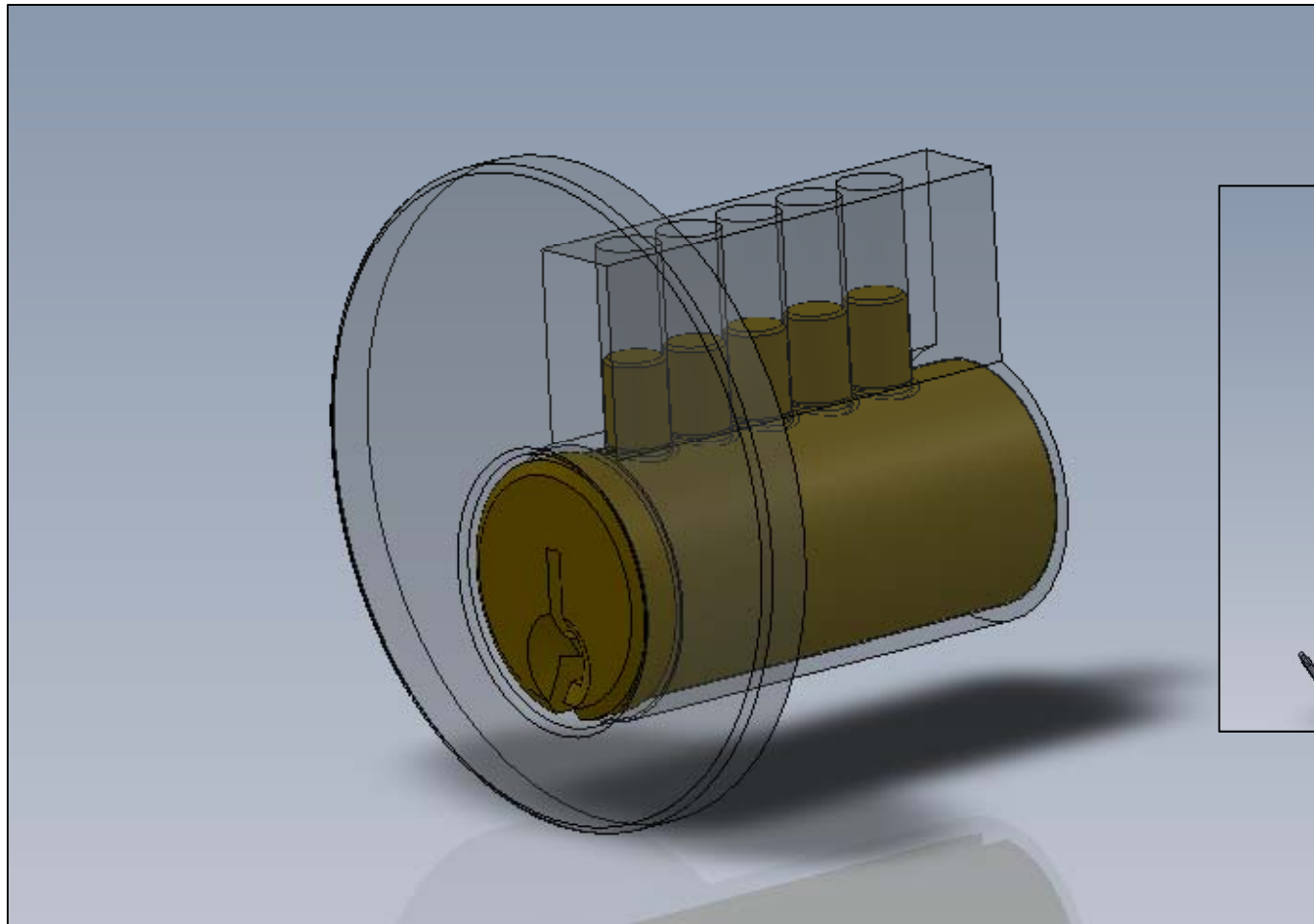
- Turn wrench
- Feel pin compromise



SOFTWARE USED

- **C++ (Microsoft Visual Studio 2008)**
- **Chai3D**
- **SolidWorks**
- **MeshConverter**
- **3D printer courtesy of U of U pro shop**

SOLID MODELS USED



RESULTS

- **Accomplishments**

- Pick environment was successfully rendered.
- User can move pins inside the lock and feel both inside and outside the lock.
- User can feel wrench using the haptic paddle
- User can change the view of the environment.
 - View objects as wire frame
 - View environment at different angles
 - View environment with pins and pick only
- Pin dynamics function accurately
 - Note: pins are extra heavy to enable sensitive forces

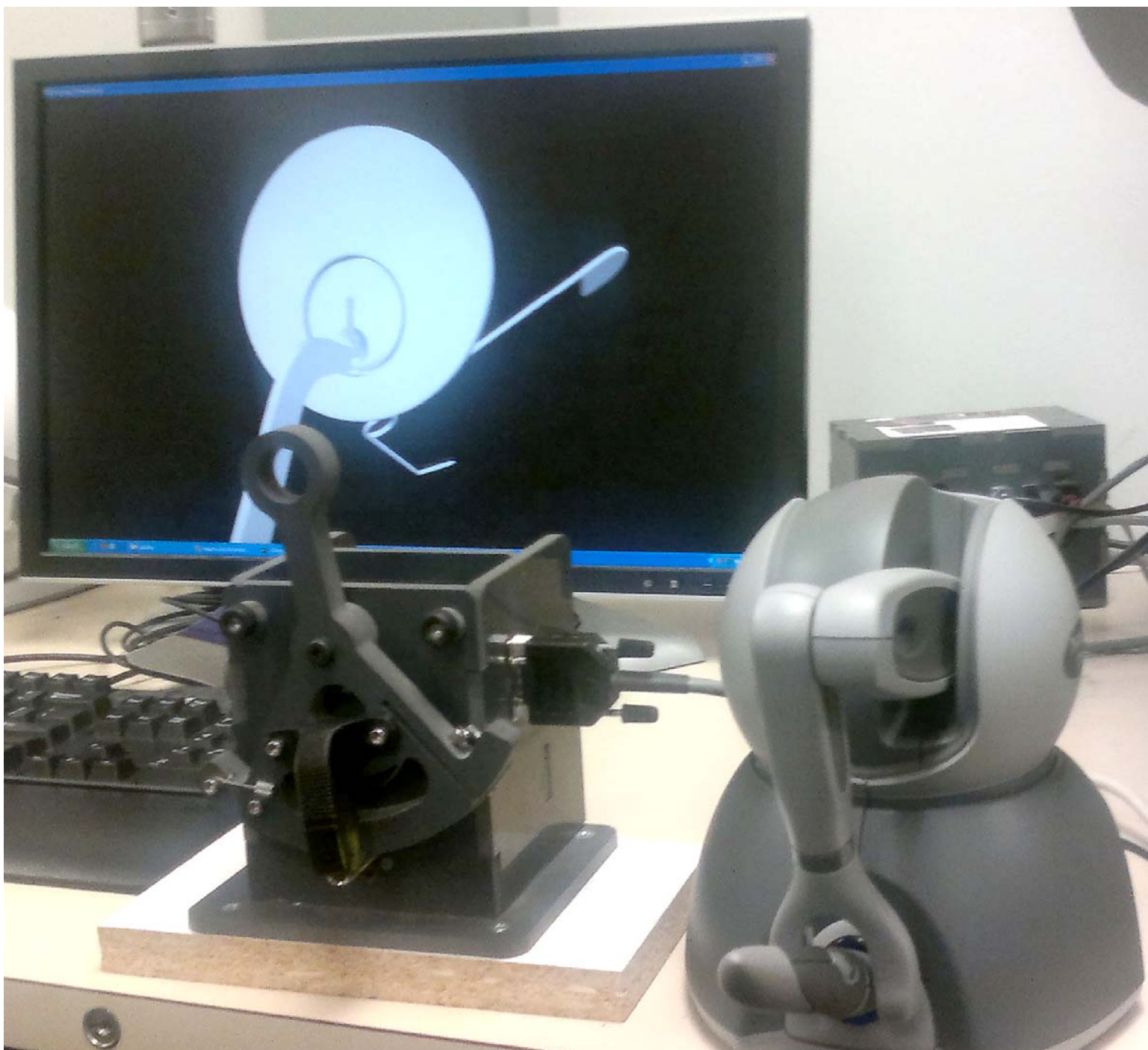
CONCLUSION

- **Lock picking depends on haptic cues**
- **These haptic cues can be mimicked using common haptic displays**
- **This program could be generalized to simulate many lock environments**

FUTURE WORK

- **Correct cylinder rotation**
- **Separate top and bottom pins to allow for independent movement**
- **Trigger the pin compromise between environments**
- **Move wrench away from lock when at non-contact angle**
- **Add more pick options, with multiple contact points**
- **Make the lock picking sensation more realistic by:**
 - Adding Vibrations
 - Using a 6 DOF device with force and torque feedback in all degrees of freedom
- **Perform experiments to test if a users ability to learn lock picking is improved with this simulation**

DEMO SUMMARY



DEMO

- Each user will be given 30 seconds to feel the environment
- PHANToM and haptic paddle will already be setup
- Users will be able to show and hide the lock assembly
- Users can toggle between free movement and pin plane only (by pressing M)
- Users will be able to feel pins move
- Users will be able to feel the wrench sensation from compromising pins (by pressing C)
- Users can hold the pins in place by applying force to the wrench

QUESTIONS?

