Living in a Glass House:
A Survey of Private Moments in the Home

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Motivation

- Sensors and recording devices are being integrated into homes.

Motivation:

- Entertainment (e.g., Kinect)
- Energy Monitoring
- Eldercare Application (e.g., Fall Detection)
- Home Security Monitor
Motivation

• Sensors and recording devices are being integrated into homes

• However,
  – Home is a private and intimate place
  – There are multiple stakeholders
  – Sensing and activity inference data captured in the home could be highly sensitive
  – Private activities can be inferred by eavesdropping
Goal

• Understand the privacy concerns around sensing and recording technologies in the home

• Focusing on
  – the *activities* that people do not want recorded
  – and *where* these activities take place

• So that we can be more mindful of the types of activities that need to remain private
Challenges

- Studying privacy concerns of in-home sensing
  - depends on householders being willing to disclose sensitive information about their private lives

- People may not want to reveal this type of information to others (e.g., researchers) in person
Our inspiration

Sunday Secrets

8/25/2007

Sunday Secrets

A homemade postcard containing secrets

when my roommates aren't around, i look through their cameras and delete the pictures i look bad in
Our approach: Anonymous survey

Recruiting Methods, Number of responses

- Online Recruiting Method
  - Mechanical Turk, 405
  - Craigslist, 24
  - Personal Network, 16
  - Postcard, 30

- Offline Recruiting Method

Total # of respondents = 475
Postcards

MY PRIVATE MOMENTS RESEARCH SURVEY

You are invited to anonymously contribute your private moments to a group of researchers.

What To Do
1. Take a postcard.
2. Complete the survey.
3. Seal the pre-paid postcard and put it in a mailbox.

Imagine a future where you live in a smart home in which security cameras and microphones are used to protect you, the other members of your household, and your household itself. These devices would be integrated into every room in your home except for the bathroom(s).

Note that no one other than the members of your household would have access to the recordings unless you give them permission (e.g., in the event of a fire or break in).

PLEASE FOLD

Please describe at least three regular habits that you do in your home that you would not want to have recorded by these devices (e.g., putting clothes that I'm currently wearing in the washing machine and then walking from the laundry room to the shower, late night snacking in the kitchen).

Please include WHERE in your home that you do the activities.

1. 

2. 

3. 

4. (optional)

5. (optional)
Scenario & Questions

• “Imagine a future where you live in a home with \textit{security cameras} and \textit{microphones} that are used to protect you”

• Describe at least \textit{three habits} that you do in your home that you would not want to have recorded by these devices.

• Include \textbf{WHERE} in your home that you do the activities.

\begin{itemize}
\item Specific, less emotionally loaded, and generally understandable
\item Conducted 7 iterations with 114 pilot respondents using Mechanical Turk
\end{itemize}
Analysis

• Developed a category scheme using affinity diagramming
• Activity type: 19 high-level and 75 sub-categories
• The coded activities were also analyzed based on the location

1433 activity descriptions from 475 respondents
# Breakdown of activity types

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-appearance</strong></td>
<td>Nudity, walking in underwear, no makeup</td>
</tr>
<tr>
<td><strong>Intimacy</strong></td>
<td>Sex, masturbating, kissing</td>
</tr>
<tr>
<td><strong>Cooking &amp; Eating</strong></td>
<td>Eating, snacking, binging, cooking</td>
</tr>
<tr>
<td><strong>Media Use</strong></td>
<td>Watching TV/movies/porn, computer use</td>
</tr>
<tr>
<td><strong>Oral Expression</strong></td>
<td>Singing, conversation, phone calls, crying</td>
</tr>
<tr>
<td><strong>Socially Awkward Acts</strong></td>
<td>Nose picking, scratching</td>
</tr>
<tr>
<td><strong>Personal Hygiene</strong></td>
<td>Grooming, toileting, showering, weighing</td>
</tr>
<tr>
<td><strong>Physical Activity</strong></td>
<td>Dancing, exercising, yoga</td>
</tr>
<tr>
<td><strong>Sleep</strong></td>
<td>Sleeping, snoring, napping, staying up late</td>
</tr>
<tr>
<td><strong>Home Keeping</strong></td>
<td>Being messy, cleaning, sniffing clothes</td>
</tr>
<tr>
<td><strong>Contentious Acts</strong></td>
<td>Arguing, swearing, yelling, disciplining</td>
</tr>
<tr>
<td><strong>Bodily Functions</strong></td>
<td>Passing gas, blowing nose, belching</td>
</tr>
<tr>
<td><strong>Alcohol &amp; Tobacco Use</strong></td>
<td>Drinking alcohol, smoking</td>
</tr>
<tr>
<td><strong>Unwinding</strong></td>
<td>Lounging, relaxing, killing time</td>
</tr>
<tr>
<td><strong>Working</strong></td>
<td>Working, writing, creating artwork</td>
</tr>
<tr>
<td><strong>Intentional Sneaky Acts</strong></td>
<td>Sneaking into the kitchen, hiding, stealing</td>
</tr>
<tr>
<td><strong>Illegal Behavior</strong></td>
<td>Illegal drug use</td>
</tr>
<tr>
<td><strong>Spirituality</strong></td>
<td>Praying, reading bible</td>
</tr>
</tbody>
</table>
Example—Self-appearance

“I take off my clothes in the bathroom, but then really quick nip out around the corner and toss them in the washer. It is only a foot and a half to step around the corner to the washer in the hallway. Still, I don't want anybody looking at me.” —62, F, homemaker, lives with spouse & child(ren)

→ **Self-appearance** category, 22.5%
   (Nudity, walking in underwear, makeup-less face, getting dressed & undressed, etc.)

→ **A specific path or sequence** category, 5.2%
   (bathroom to laundry)
"If I am cooking in the kitchen and something falls on the floor, sometimes I will still use the food (though I rinse it off)." —53, F, faculty, lives with a spouse

Cooking & Eating category, 9.3%
(Eating, snacking, binging, cooking)

Kitchen and/or Dining area category, 11.1%

Sensitivity of an activity depends on subtle changes in context
Example—Media Use

“Watching bad TV. I generally watch at least a couple hours a day of TV that I don’t want people to know about because they’ll mock me.” —21, F, student, lives with parents

Media Use category, 8.3%  
(Watching TV/movies/porn, computer use)

Male respondents were more likely to report activities in the Media Use category than female respondents (16.7% vs. 10.7%)
Summary

- Anonymous survey is effective for collecting private data

- Many of these concerns are not being accounted for in current systems

- Seemingly ‘innocuous’ activities could suddenly become sensitive activities by subtle changes in context

- Designers of UbiComp systems need to be more mindful of the types of activities that need to remain private
Acknowledgments

Co-authors

Sunny Consolvo  Jaeyeon Jung  Beverly Harrison  Julie Kientz  David Cho

Postcard distribution

Questions: eunky@uw.edu
Appendix
Imagine a future where you live in a smart home in which security cameras and microphones are used to protect you, the other members of your household, and your household itself. These devices would be integrated into every room in your home except for the bathroom(s). Note that no one other than the members of your household would have access to the recordings unless you give them permission (for example, in the event of a fire or break in).

Please describe at least three regular habits that you do in your home that you would not want to have recorded by these devices (e.g., putting clothes that I'm currently wearing in the washing machine and walking from the laundry room to the shower, late night snacking in the kitchen). Please include WHERE in your home that you do the activities.

Your description #1:

Your description #2

Your description #3
Postcards

Postcard with a dropbox

Prepaid

- Distributed 300
  Received 30 (10%)
My Private Moments

This is for research purposes only

Mail to: Eun Kyoung Choe
University of Washington
Sieg Hall Room 313
Box 352315
Seattle WA 98195-2315

PLEASE DON'T TELL US WHO YOU ARE. DON'T INCLUDE YOUR REAL NAME OR CONTACT INFORMATION

My country of residence is: ______________________

- city / state: ______________________

- My age is: ______________________

- My gender is: ______________________

- My occupation is: ______________________

I live in (select one):

- Single Family Home
- Apartment / Condo
- Dormitory
- Townhouse
- Duplex
- Other (Which?): ______________________

I am: (select one):

- Renter
- Owner
- Other (Which?): ______________________

I live with: (select all that apply)

- Spouse / Partner
- Child(ren)
- Parent(s)
- Sibling(s)
- Roommate(s)
- I live by myself
- Dog(s)
- Cat(s)
- Housemate(s)
- Other(s) (Who?): ______________________

PLEASE FILL OUT THE QUESTIONNAIRE ON THE BACK

Eun Kyoung Choe
University of Washington
Sieg Hall Room 313
Box 352315
Seattle WA 98195-2315

Thank you!

Upon completion, seal the pre-paid postcard and put it in a mailbox.

This is for research purposes only
RESEARCH SURVEY
MY PRIVATE MOMENTS

YOU ARE INVITED TO ANONYMOUSLY CONTRIBUTE YOUR PRIVATE MOMENTS IN YOUR HOME TO A GROUP OF RESEARCHERS

1. TAKE A POSTCARD
2. COMPLETE THE SURVEY ON THE POSTCARD
3. PUT THE POSTCARD IN THE PURPLE DROPBOX
Distributing Postcards
## Recruitment

<table>
<thead>
<tr>
<th>Methods</th>
<th># of Responses</th>
<th>Cost</th>
</tr>
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<tbody>
<tr>
<td><strong>Offline</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postcard + drop box</td>
<td>Distributed—150</td>
<td>Printing, enormous manual effort</td>
</tr>
<tr>
<td></td>
<td>Received—15</td>
<td></td>
</tr>
<tr>
<td>Pre-paid postcard</td>
<td>Distributed—150</td>
<td>Printing, enormous manual effort, $66</td>
</tr>
<tr>
<td></td>
<td>Received—15</td>
<td></td>
</tr>
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<td><strong>Online</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical Turk</td>
<td>405</td>
<td>$44</td>
</tr>
<tr>
<td>Craigslist</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>Personal network</td>
<td>16</td>
<td>0</td>
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<tr>
<td><strong>Total</strong></td>
<td>475</td>
<td>$110 + α</td>
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Anonymous survey

- **Offline**
  - Prepaid postcards (15)
  - Postcards with a drop box (15)

- **Online**
  - Mechanical Turk (405)
  - Personal network (16)
  - Craigslist (24)
Public places (e.g., Café)
## Recruitment

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<td>Pre-paid postcard</td>
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Data collected

1433 activity descriptions from 475 respondents

Response

Private moments with my husband
Changing clothes - bedroom
Writing--I don't like people watching me while I write. There are only two rooms in my house and I write in both of them.
wakl around naked
pick my nose - bedroom
If I had to choose, one would be picking my nose. It is easier to pick it out than it is to flush it with water. I do this all over my house.
having sex - bedroom
I sit and watch too much TV, in the living room.
Obviously would not want my sexual life recorded.
intimate moments with husband
I dance very badly to 80's music in my living room.
Martial relations in bedroom (usually)
Showers- Bathroom
Getting dressed in my room.
Walk around naked; living room
Having sex with my husband. We have sex in the bedroom, and since we live with children and grandchildren I would not want them to have access to recordings of that.
I would not want sex recorded by the device. I would be extremely uncomfortable having any record of my intimate life. We have sex in the bedroom. Since there would be no camera in the bathroom, I might even shift my behavior into the bathroom.
Making love to my husband which normally takes place in the bedroom.
I pleasure myself in the bathroom.
have an intimate moment with my partner in the living room.
Singing while doing dishes in the kitchen.
I sit in public and pretend to read but I eavesdrop on conversations.

I wish that just for one day, exactly what I wanted to say.

I give decaf to customers who are RUDE to me!

I wish you were as good a husband to me as you are employee to them.
I am 33 years old. I have my own house and a great job.

And everyday I dream about running away from this place.

I'm 27 years old. Two years ago I had surgery to lose 120 lbs. I felt like a beautiful man, but in my head I still feel terrified all the time. I can no longer hide behind my image and I'm scared.

While others pray at church I bow my head and think about the TV programs I plan on watching.

My 2 year old little girl imitates the sounds I make throwing up everything I eat.

I wish I knew how to fall out of love.

I'd be happy not to be your friend anymore but I don't know how to tell you.

If you love a man very much don't let him go. If you just put it out of your mind you won't have to put up with the pain.

If I just eat it I will win the battle.

I am the second richest man in my building but I still make my own collars and stays out of cereal boxes.

I want to go back to believing in everything again.

Whenever I see someone driving a hybrid car covered in arrogant bumper stickers I am filled with incredible sadness knowing that in a collision.

We met in St. Louis almost 5 years ago and we've been inseparable ever since. I can't wait to meet you face to face in January to see if our relationship could work out as well as our St. Louis one does.

I haven't told you, but I fell in love with you a long time ago. You are the main reason I broke up with my St. Louis boyfriend, because I couldn't stand doing with him and thinking of only you.

You never leave my thoughts, I dream of you. I think about you all the time. I'm trying to graduate early so that I can move to be with you.

3000 miles is a long way to be apart, but I

When people ask how I'm losing the weight, I tell them I will power walk self-scam.

Songs for the road.

I made this mix for you but you never came.