# A Child Recognition System Based on Image Selection Patterns

Work in progress

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## ABSTRACT

In recent years, a market of games and learning websites and apps for children has grown everywhere in the world. With the increasing development of online services on various devices such as PCs, smartphones and tablets, it is important to recognize kids across the web. This is not only required to provide them with more effective services e.g. for education purposes, but also to prevent them from having access to certain content e.g. violent or sexual films. This paper presents our ongoing effort in developing a child recognition system based on the patterns users produce when clicking a set of pictures. We propose a system where users are presented with a set of images chosen from two different pre-prepared categories: children and non-children (adults). The users can click on any of these pictures without any specific rules for this selection process. We implement a web-based prototype of our system and test it with 120 different users (60 adults, and 60 children). The initial results show that children have different image selection patterns compared to adults which enable us to tell them apart from each other.

## KEYWORDS

Recognition system, Image selection patterns, Children users, Children online protection, Online services

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## 1 INTRODUCTION

Millions of children are connected, mobile and social, and millions more are going online each year. According to the Guardian [6] in 2016, children (5 to 15) were spending three hours a day using the internet. This was, for the first time, longer than watching TV hours. Accordingly, the time spent reading books for pleasure, has declined from an hour a day on average in 2012 to just over half an hour in 2016. Children are now seeking out the content of their choice by switching to online services in their spare time.

Replacing conventional extra activities such as watching TV and reading books with online services puts the kinds in the risk of exposure to adult content since they lose solid parental supervision. According to a recent research [19], the analysis of the Google Play Store apps shows that apps explicitly targeted at children are sending private information to third-party services and advertisers. This is, however, violating the rules set for children privacy by e.g. Children's Online Privacy Protection Act (COPPA) in USA. As reported by the Guardian [3], half of children (8 to 11) signed up to mainstream social media terms and conditions agreeing their posted data to be sold to third parties without reading and understanding the implications.

Many websites and mobile apps specifically target children with educational or entertainment content [14], and some vendors often have specific strategic plans either as a public service or to build brand loyalty from an early age [5]. Despite this growth in younger users, little is known about how children actually use websites and apps [9, 11]. Most of usability studies and access control systems for online services are developed for adult users. As discussed in [2], having access to different online resources in the digital era is moving individuals toward the ideology of "you are what you can access". Hence, having access to worthy online resources plays a vital role in shaping younger users' personalities.

According to a report by the National Society for the Prevention of Cruelty to Children (NSPCC) [12], over 81% of children and young people think social media services should do more to protect them from inappropriate and harmful content. Protecting younger users in online services is not straightforward. For example, tracking online child abuse has gone beyond tracing credit card payments on commercial child abuse websites due to the rise of anonymous payments using cryptocurrencies such as Bitcoin [17]. As recently stated by Peter Wanless, the NSPCC Chief: "It is time online companies came under scrutiny from an independent regulator with bite and to face fines when they fail to keep children safe." [12]. In view of all this, we believe that telling children apart from adult users in online services is essential.

There are many differences between children and adults e.g. physiological, cognitive, and social. Researchers have benefited from these differences to develop a few children recognition systems. Examples include child face recognition


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[4], child voice recognition [16], and child writing style recognition [1]. According to [10], children experience the visual world in a different way compared to adults. As we experience every day and is supported by many research (e.g. [13]), people can remember images better than words. Over time, they build an internal database of images with labels, and this supports instantaneous recognition. As it is discussed in [15], since adults have lived longer, they have accumulated more knowledge and have build a larger internal database of images over time. Children, on the other hand, are limited in this database. In this paper, we use this cognitive difference and propose HaPo; a child recognition system based on image selection patterns. Image selection patterns have been previously suggested by researchers for other purposes such as authentication [18] and CAPTCHAs [7].

In HaPo, we prepare two image sets associated to children and adults separately. In a web-based implementation of our system, we present a series of pictures chosen from both sets to volunteer users and ask them to select those they like more. By reviewing the interactions of our participants with the proposed system, we conclude that children have different image selection patterns in comparison to adults; enabling us to tell them apart. The results support that the idea can be developed for real-world applications such as in-app or web-based scenarios.

## 2 SYSTEM DESIGN AND IMPLEMENTATION

In this section, we review our system. First, we explain the recognition feature that we use in this system. Second, we go through the preparation steps of our image sets used in the experiments. And finally, we present the details of our implementation.

### 2.1 Recognition feature

As mentioned before, in this work, we aim to use a cognitive difference between children and adults to tell them apart. According to [10], children may perceive the visual world differently from adults since they are able to keep information from their senses separate. As stated in [8], children are using the world around them and picking up cues from their environment to aid them in the psychosocial development of their values, behavior, and social circles. While this development also continues for adults, it is far more defined and stable. Therefore, picking up clues from the world surrounding the children would impact their decision making directly. For example, children tend to own items with their favorite cartoon characters, a behavior which more and less fades away through adulthood.

In this paper, we aim to benefit from this behavioral difference between children and adults. Out hypothesis is that: "in an image-based system with multiple choices, children would select those that have been appeared to them more often on a daily basis". These photos can include images from school text books, popular games, cartoons and tv shows. To examine this hypothesis, we need to build two different image sets for children and non-children users separately. In the following paragraphs, we explain how we have prepared such sets.

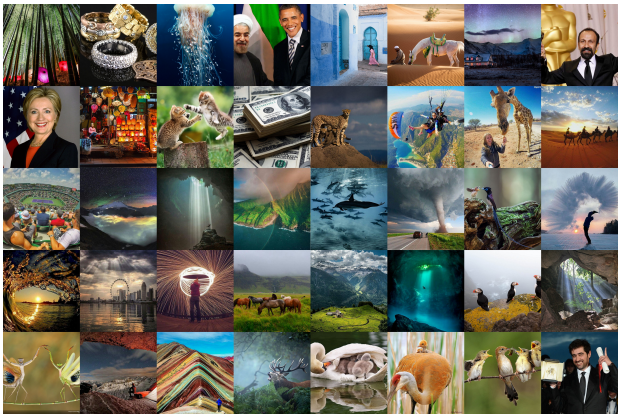

**Figure 1: HaPo's adults picture set**

### 2.2 Image sets

We prepared two image sets for children and adults separately, each included 50 pictures. We adopted a few different heuristic approaches to select the photos of each set. For the adult set, we searched a few keywords and phrases to find photos related to abstract concepts, news, nature, daily concerns, etc. We used different sources to compose this set as listed below. These selected photos are shown in Fig. 1.

- photos included in the news items by googling "world news",
- pictures shown by googling "abstract concepts",
- searching for "pictures we loved in 2015" and "50 greatest pictures" in the National Geographic website,
- using the Instagram's Explore feature using hashtag #nature, and
- photos returned by googling "most searched pictures".

For the children photo set, we tried to find photos that children are more likely to be exposed to everyday. We again adopted a few heuristic techniques to find these images as listed below:

- including pictures from popular cartoons such as Minions and Spiderman, by googling "most popular cartoons".
- including pictures from primary school textbooks in Iran (where the experiments of this paper was conducted).

For the latter pictures, we asked for advice from a few primary school teachers to pick the most popular textbooks pictures among students. We chose photos of first grade books, since all students at any stage would be familiar with them. These selected pictures used in our experiments are shown in Fig. 2. We acknowledge that there might be better ways to build the photo sets for children and non-children users. We adopted

**Figure 2: HaPo's children picture set**

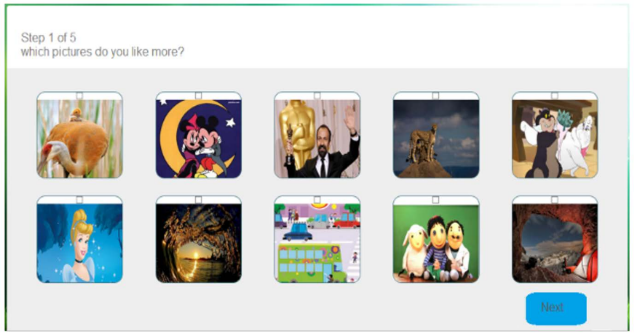


**Figure 3: Screenshot of HaPo GUI**

the suggested approaches to validate the idea in this paper, and more research is required to achieve optimal results.

### 2.3 Implementation

We used HTML and PHP for developing a proof-of-concept implementation of HaPo. All pictures were stored in a MySQL database (db) with tag '1' for children, and '2' for adults. User interactions were also logged in a MySQL db. We used XAMPP as our Webserver, and performed our experiments on a Windows machine. Our system included a page for saving demography information including gender, education level, and age.

HaPo's GUI showed a set of 10 photos (5 from children set, and 5 from adults set) to the users and asked them to click on those they liked better. The size of each picture was 150*160 pixels, and pictures from the two categories were presented randomly in the page. This process was repeated for five rounds for each participant. A screenshot of the system is shown in Fig. 3. Note that the instruction message shown on top of the window is translated from Farsi (Persian) to English to be presented in this paper. All tests were conducted using an HP ProBook 4540s, 15.6" monitor, under the supervision of the first author.

## 3 EVALUATION

In this section, we present the results of the analysis of the logged data collected from our participants. First, we explain the data collection details, and then, we analyse the interaction of our participants with the system.

### 3.1 Data collection

We collected data from 120 volunteer participants; 60 adults (aged between 18 to 55, 30 males) and 60 children (6 to 11 years old, 30 males). Our adult participants were recruited by messages via mailing lists and social messaging apps (e.g. Telegram), and by word of mouth within university and non-university communities across two cities in Iran. We explained to our participants that we wanted to evaluate a graphical system. We noticed that our adult participants were curious about the purpose of the experiment. Hence, we explained to them that this is a system to recognize children from adult users.

For our child participants, we chose four places to run the experiments: two English institutes for children, and two parks in two different cities. We informed the parents of these child participants about the experiment either directly or via the institute management. We collected the data from these children in the presence of their parents or teachers. We explained to the children that we had a graphical system and needed their help on it. We told them that this was a game and they needed to click on pictures they liked more and then click next. We also explained to the children and their parents/ teachers that if they feel not comfortable to complete this experiment, they can withdraw from it at any stage without any explanation. The same instruction was given to our adult participants. None of our users dropped out of the experiments.

We explained to all participants that there was no wrong or right answer and the purpose of the experiment was to evaluate our system. We also clarified that there was no limit on the number of the chosen pictures in each round and it could vary from none to 10, depending on their feelings about the pictures. In order to decrease the stress level of the children, we offered them gift packages (including story books and stationary items). We observed that none of our participants experienced any difficulty or stress while completing the tasks.

### 3.2 Number of clicked images

We logged the interaction of our participants with HaPo in a file for further analysis. Our expectation was that our child participants would choose photos from the children photo set with a higher possibility. In a similar way, we expected our non-child participants to choose from their own photo set with a higher chance. A summary of the number of the pictures clicked by children and adults and the number of the pictures chosen from their own categories (correct pictures) is presented in Table 1. We observed that there was not a considerable difference in these numbers across the rounds of

| Participant category | Children | | | Adults | | |
|---|---|---|---|---|---|---|
| | Female | Male | Ave | Female | Male | Ave |
| Number of clicked pics | 3.54 | 3.50 | 3.52 | 3.9 | 4.4 | 4.15 |
| Number of correct pics | 2.76 | 2.48 | 2.62 | 2.9 | 3.62 | 3.26 |
| Percentage of correct clicks | 78% | 71% | 74% | 74% | 82% | 78% |

**Table 1: Number of (correct) clicked images**

| Participant category | Children | | Adults | |
|---|---|---|---|---|
| Click no. | Success rate (%) | Time (s) | Success rate (%) | Time (s) |
| Click 1 | 83 | 8.13 | 78 | 5.94 |
| Click 2 | 81 | 6.04 | 78 | 3.69 |
| Click 3 | 66 | 5.08 | 80 | 3.49 |
| Click 4 | 58 | 4.63 | 75 | 3.22 |
| Click 5 | 54 | 3.47 | 80 | 2.81 |

**Table 2: Average success rate and completion time per click**

the experiment (1 to 5). It indicates that the system can be easily learned by users without any special education.

As it can be seen, on average, our adult participants clicked on images from their own category with a slight higher chance than children (78% vs. 74%). They also have chosen more number of pictures in contrast to children (4.15 out of 10 vs. 3.52). Although the number of the clicked photos is almost the same for male and female child participants, girls have chosen more photos from the child dataset in contrast to boys (78% vs. 71%). This pattern, however, did not appear in our adult participants. As you can see, male adult participants have clicked more photos, mostly clicked from the adult image set. While the purpose of our system was to distinguish younger users, the high success rate of the adult participants suggests the idea to be used for other purposes too. For example, identifying adults pretending to be children is an effective way to detect online grooming [1].

We noticed that in both adults and children groups, females completed the tests quicker than males. For children, it was 20.19 s for girls vs. 22.07 s for boys, and for adults, it was 17.14 s vs. 12.27 s for women and men, respectively.

### 3.3 Success rate and completion time across clicks

In Table 2, we present some detailed analysis of the interaction of our participants with the system. We show the success chance and completion time across the first five clicked images (since our participants barely clicked beyond 5 images). As you can see for success rates, there is a different pattern between children and adults throughout the image selection. While the correction rate of our child participants drops down in later clicks more dramatically (from 83% to 54%), it remains about the same with small fluctuations for the adults (between 75% and 80%). This is an interesting behavioral difference which can be fed to our identification system.

Moreover, the selection time for our non-child participants decreases very smoothly between different clicks (milliseconds), while it drops down around one second between the two clicks for the kids. In both categories, the first click takes longer since the participants are familiarizing themselves with the system. With the exception of the first clicks, we can see that our child participants showed less patience in later clicks which indeed led to lower success rates. As we explain in Subsection 3.5, we noticed that our child participants rushed to complete the test to receive the gift package, hence they lost their focus in their later selections. We believe that the gift package would have the same impact of the child's enthusiasm when using an online service. In other words, in both scenarios the children want to quickly complete the activity to reach their desirable item. Nevertheless, we aim to study our idea in a more realistic setting in the future.

### 3.4 Selection patterns motivations

While performing the experiments, we encouraged our participants to think out loud. We observed some of the reasons behind their photo selection patterns for both children and adults, as listed below:

- When children clicked the pictures from their set, some automatically started to tell stories behind the pictures e.g. "I am like the Happy character in Inside Out movie" or "I have a ruler with a Sponge Bob picture on it".
- Most of our child participants could easily remember the text book pictures and started to explain the story of the related exercise in the book when facing these pictures.
- Some of our children explained that they remember a particular picture from some movies or their text books, but since it is not their favorite movie character or subject, they would not click on it.
- Some children chose a few animal photos (sometimes from adults photo set) saying e.g. "I have a cat looking like this picture".
- Some adults clicked on children set pictures stating e.g. "my child loves this cartoon character" or "I've seen this picture in my 8-years school book".
- Some adult participants clicked the cartoon characters, explaining that they like particular children shows. This pattern appeared in our female adults more often than male adult participants.
- We noticed that in our adult participants, the level of education had a positive impact on the number of the clicked images and the success rate. We acknowledge that one of the contributing factors to this observation was our photo set, and this observation would change with the change of the dataset.

As one might expect, while children tend to have simpler reasons for picture selection, adults showed more complex

behaviors. These complicated behavioral patterns can be modelled in a system to identify other ranges of information about the users such as education level, gender, and age.

### 3.5 Further observations

**Children.** We showed a welcome page to our child participants which included a male and a female cartoon characters welcoming them with a simple written massage ("Hi, click on the photos that you like the most"). All the children could easily read this message, and as we observed, this helped them to feel more confident about the experiment. For the first few child participants, we noticed that they rushed to quickly click on the images to finish the experiment as soon as possible to receive the gift package. To avoid randomly created records by children, for the rest of our child participants, we allocated more time to clearly explain to them that we needed them to pay attention to this game by focusing on the photos and choosing the ones that they liked. We observed that a more detailed instruction helped the children to focus on the experiment better.

Furthermore, we asked the children if they preferred a mouse to click the images or using the laptop touchpad. In 63% of the cases, they chose the mouse and perfectly knew how to work with it. For the rest of them, we took extra time to explain how a laptop touchpad works. We found that in both cases, our child participants could easily complete the experiment. All the children were comfortable with the presence of the researcher when completing the tasks and most of them thought out loud voluntarily (e.g. via telling stories).

**Adults.** We asked our adult participants if they would like to think out loud with the presence of the researcher. Some of the adult participants preferred to click the images without any observation. Hence, the laptop was handed to them to complete the experiments in private. We observed that those participants who did the selection with the presence of the researcher chose fewer photos than the second group. Except 5, all our adult participants preferred the laptop touchpad over the mouse.

## 4 LIMITATIONS AND FUTURE WORK

The reported results presented in this paper are initial outcome of a pilot study. This research needs to be completed in various ways, as we explain here.

### 4.1 Photo sets optimization

Optimizing the photo sets is an important piece of this puzzle and most likely would affect the results. As explained before, there might be better ways to build these photo sets. An alternative to our approach is to simply include featured photographs of image-based social media websites such as Flicker, or pictures of daily online news websites for the adult dataset. However, we believe building the children photo set is not as straightforward as the adults set and needs further studies. The results from our initial experiments show that using popular tv shows and cartoons and pictures from school text books are promising. Other photo sources can include photos from popular children games and mobile apps, images from mainstream children toys in the market, etc.

Note that the experiments of this study have been done in Iran. The two datasets for children and adults were prepared according to the audience of our experiments. As it can be seen in Figs.1 and 2, the local context is prominent in this composition. If we repeat the experiments across countries and cultures, we might find more interesting patterns; some specific to certain cultures, geolocations, etc., and some beyond those. More research is required for building such comprehensive image sets.

### 4.2 Photo sets update

Updating the photo sets used in this system is important due to security reasons. Some users might learn which images click or not click to bypass the system. On the other hand, an automatic program should not be able to bypass the system as well. By updating the photos in our databases, we would decrease the chances of such exploits. This can be achieved by adding an automatic update package as proposed in [7]. Such an automatic update feature would constantly replace the old photos in our datasets with new ones retrieved from the web. Once it is proved to the system that the user is a child/adult, she/he can contribute to the process of adding new pictures to the database by evaluating a few new pictures downloaded from the web. We leave this as future work.

Note that while social network websites such as Instagram might raise copyright issues, free websites for public domain images such as Wikimedia will not. Hence, for a practical system, the photo sets can be prepared and updated from such websites.

### 4.3 Usage model and data collection

We conducted our experiments by designing a web-based prototype. Another way of having access to the web is via mobile apps which is very popular between children. An age identification system can be integrated within app stores or inside apps to control the installation or even the usage of certain apps for children. For example, while there exist tones of useful videos on Youtube for children, they might accidently be directed to inappropriate content. Regular age checks via an implicit graphical game would prevent children being exposed to such content. Such a feature can be ticked on or off by the admin of the system (e.g. parents) in the case of having a child as the user of the system.

We conducted our studies in a semi-controlled environment and with limited age ranges. If participants are completely left on their own to finish the tasks without any supervision, they might show different behavioral patterns. In addition, changing the usage model and mandating the users to click on certain number of pictures might create more advanced patterns leading to a better recognition. Also, if the users know about the intention of the system, they might change their behavior; some might try to deceive the system. We

will investigate these factors by conducting further studies in the future.

## 5 CONCLUSION

In this paper, we introduced HaPo, as a child recognition system which works based on image selection patterns. We presented the initial results of a prototype of our system which was tested with 120 users. These results suggest that child recognition in online services is achievable via e.g. a graphical game. We aim to extend our studies to improve our results in different ways such as improving picture sets, extracting more complex patterns, and testing the system in a more realistic setting.

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