Automatically Detecting Children Excessive Internet Use on Smartphones

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Problem Statement

As the usage of smartphones and Internet increase, the number of children who play Internet game, browse website, use app and social media on smartphones is increasing. According to Nielsen's fourth-quarter 2016 Mobile Kids Report, slightly less than half (45%) of mobile kids got a service plan at 10-12 years old, and the top mobile activities include text messaging (81%), downloading apps (59%) and playing preinstalled games and mobile internet/accessing websites (tied at 53%) [1]. Excessive Internet use in children resulted in their academic failure and health aspects of children [2].

Recent research has shown that excessive Internet use lead to children's declining verbal memory performance, anxiety, relationship difficulties, cyber-bullying, sleep abnormalities, aggressive or oppositional behavior, inattention and etc [3, 4]. Excessive Internet use on smartphones in children has becoming an important social problem that requires a solution. To minimize the harmful effects and maximize the benefits, some parents use parental control system to monitor and restrict their children' online activities. It is necessary to establish prevention efforts to target adolescents who have their first experiences with addictive substances and behaviors [5]. We need to incorporate automatic detection method into clinical process to identify when parent offer an intervention and what kind of intervention they adopt.

Related Work

For the excessive Internet use on smartphones in Children, there are some parental control solutions on the market, such as Google Family Link, Norton Family, mSpy, UnGlue, Tecent growth guidance platform and etc. Google Family Link app let parents create a Google Account for their children, and help parents set certain digital ground rules which includes managing the apps children can use, keeping an eye on screen time, and setting device bedtime [6]. Norton Family parental control software helps protect children from online predators by showing what children are doing online and identifying potential dangers before they become problems [7]. MSpy monitors and logs user activity on the client device, and can help parents as a way to monitor smartphone, tablet, and computer usage of their children [8]. UnGlue lets parents control the time children spend on their screens: social media, video, games, websites, apps and etc., and teaches children to have better screen time management and make smarter choices with their electronic devices [9]. Tencent growth guidance platform can combine the platform public account with children's QQ, wechat account to control the playing game period of children and playing game behavior [10]. These parental control system mainly control the playing game period and monitor device usage of children, but they can't classify excessive Internet usage of children and can't help parents take appropriate

intervention and control method for children who are classified heavy excessive Internet use.

On patents.google.com, we find some patents of parental control for Internet use. The patent "web-based parental controls for wireless devices" provides an enterprise-based parental control settings server that allows parents to set and control parental control restrictions on their children's mobile devices [11]. The patent "method and parental control and monitoring of usage of devices connected to home network" provides a control module grants a child access to the devices and media content via the devices based on the levels of access and a monitoring module monitors the child's usage of the devices and the child's consumption of media content via the devices [12]. The patent "supervising user interaction with online services" produces a report card which provides a parent with information about the activities of a child [13].

Recently, various projects related to excessive Internet use have been released in the area of HCI. Shin and Dey explored an automated, objective and repeatable approach for assessing problematic usage of phone and built detection models based on Adaboost with machine learning algorithms automatically detecting problematic use [14]. Wisniewski and etc. conducted a qualitative feature analysis of Android mobile apps designed for the purpose of promoting adolescent online safety and found an imbalance that favored parental control over teen self-regulation [15]. Dhaka and etc. investigated the impact of Internet usage on the level of anxiety among students and found that Internet addiction and anxiety both were positively correlated [16]. Some significant research related to Internet addition has been explored in the psychology area. Young investigated the extent of problems caused by Internet misuse and found that pathological Internet use was problematic for academic performance and relationship functioning [17]. Rho and etc. explored predictors and patterns of problematic Internet game use and found six important predictors and three patterns [3]. Lai and etc. studied the associations of Internet addiction with social anxiety, depression, and psychosocial well-being among Asian adolescents and found significant associations of Internet addiction with depression and social anxiety [18].

Previous studies have focused on the causes for excessive Internet use among children and the impact of excessive Internet usage. However, these studies are unable to automatically classify children excessive Internet usage and can't provide online alarming and predicting system for parents.

The competitive analysis table of the metrics of existing solutions to our ideal solution is as follows:

Table 1. Competitive analysis table.

Solutions / Feature	Google Family Link	Norton Family	MSPY	UnGlue	Tecent growth	Our ideal solution
Real time	√	√	√	√	√	√

Control screen time	√	√	√	√	√	√
Manage app	√	√	√	√	√	√
Price	free but Limited	49.99/year	from $29.99/month	free	free	free
Classify excessive usage	×	×	×	×	×	√
Online alarming	×	×	×	×	×	√

Proposed Solution

Since the original researches were based on passive features sampling, such as battery usage, data usage (SMS log) and so on, we're going to design active feature sampling according to the children.

1. Memory game

    IA would lead to memory decline due to long time abnormal life style. We're going to design an App in mobile phone to test how severity the memory decline for the addicted children.

    In [19], Chudler has developed a website called – Neuroscience for Kids, to help all students and teachers to learn about the nervous system. What's more, Chudler has posted lots of vivid games in the web site to help students and teachers understand what the mechanism of human brain.

    From these games, we got an idea to design a memory test game to see how severity the memory decline for the addicted children.

    The game would firstly show a picture, which contains lots of objects, to the children. Then the children have 30 seconds to remember all these objects. 30 seconds later, the picture would disappear, and the children would be given 10 multiple-choices questions. Finally, the App would calculate the correct rate, which reflects the memory decline severity of the children. In addition, the children should play the game every day. We would give an example as following.

    The Figure 1 memory test picture from Internet is an example pictures in our memory test game. While the Table 2 Sample questions in memory test game is example questions in our memory test game.

Figure 1 memory test picture from Internet

Q1: what is/are the object(s) in the picture?	a. Bike b. Airplane c. Truck d. train
Q2: what is/are the object(s) in the picture?	a. dog b. cat c. hen d. money

Table 2 Sample questions in memory test game

2. Vision test
    IA also has great harm to vision because of long time staring at the screen. The decline of vision is a significant symptom of IA. Usually, we use the E-chart (Figure 2 E-chart from Internet) to test vision. The doctor would point to different "E" signs (from up to down, from big to small), and the tester then speaks out what he/she sees. Finally, the doctor gives the result based on the smallest "E" sign that the tester could see.

    Based on this procedure, we are going to design a self-assist vision test App in mobile phone using VR Headset, like Figure 3 VR Headset from Internet. The VR technology enables us to create different viewpoints, like view angle and far and near perspective, to simulate the real E-chart vision test scenario.

    At the same time, the App would contain a voice assistant to guide the tester to finish the testing and an ASR (Automatic Speech Recognition) module to capture what the tester speaks. The procedure is as follow.

    App: generates an "E" sign marked by a transparent red box (Figure 2 E-chart from Internet), and says "what E sign do you see? Up? Down? Left, or right?"

    Tester: "Right"

    App: "OK. Next"
        then, generate another "E" sign marked by a transparent red box.
        "What E sign do you see? Up? Down? Left, or right?"

    Tester: ……

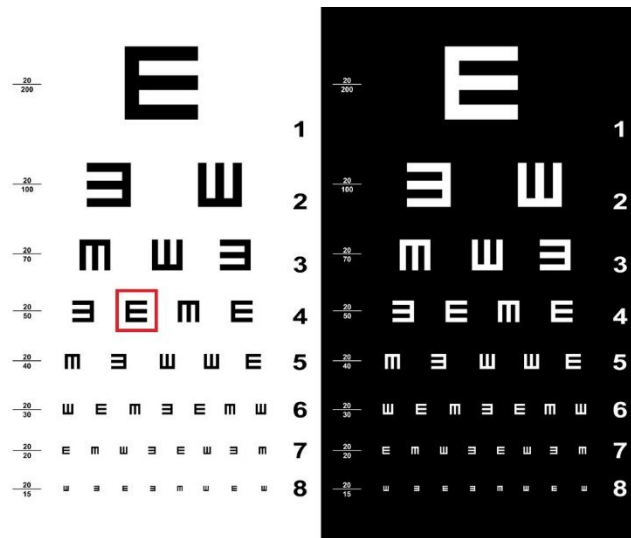   At the end, the App would get the vision test result of the tester.

Figure 2 E-chart from Internet

Figure 3 VR headset from Internet

Evaluation Methodology

For labeling the data, we are going to use the "Internet Addition Test" by Dr. Kimberly Young[20]. In spite of the active sampling features (memory test and vision test), we also include some traditional passive features, such as battery level, network data use, screen active time and so on. Finally, we use this labeled dataset

to build a decision tree regression model to predict the severity of Internet excess usage. If the prediction exceeds a preset threshold, our App would give a warning to the children and send an Email to their parents.

Our App would include two stage.

First stage is focus on data collecting and model building. The children would be required to finish the "Internet Addition Test" when they use our App at the first time. At the same time, our App would remind the children to commit the memory test game and vision test once a week.

After getting enough data, our App would come into the second stage. Based on the trained model, our App would sample the data in real time, and give the feedback to children and their parents.

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