Case study

The Importance of Child Guard Apps Worldwide

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Abstract. In today's digital age, where children are exposed to the online world, the need for effective parental control apps has become more critical than ever. This article explores the significance of *Child Guard* apps in safeguarding children's online experiences globally. It delves into these apps' various features and benefits, their impact on children's safety, and the challenges they address. Additionally, it discusses the role of parents and caregivers in utilizing such tools to ensure a safer and healthier online environment for their children.

Keywords: *Child Guard* Apps; Online Safety; Health Monitoring; Parental Control; Digital Well-being.
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Introduction

The rapid expansion of the Internet and the proliferation of digital devices have opened a world of opportunities for children to learn, communicate, and explore. However, along with these opportunities come inherent risks, including exposure to inappropriate content, online predators, cyberbullying, and excessive screen time. In response to these challenges, ChildGuard apps have become valuable tools for parents and caregivers to monitor and manage their children's online activities. These apps offer a range of features designed to protect children from online threats while promoting responsible digital citizenship.

This article explores the features and impact of *Child Guard* apps, the technologies that drive them, and the challenges involved in balancing child safety and privacy in the digital age.

1. Technological realizations

Child Guard features a sophisticated four-sensor system that measures vital signs with unparalleled accuracy and reliability. This system includes an oximeter, accelerometer, PPG sensor, and sweat sensor.

1. Pulse oximeter. Pulse oximetry can be considered the most successful noninvasive biosensor, as pointed out by Wang [1]. An oximeter is a medical device that can assess a person's general health status using noninvasive real-time blood oxygen measurement. The noninvasive method is the most recommended because there are no contraindications related to inflammation, infections, etc. The optical absorption principle determines the amount of oxygen in the blood when excitation is provided in the visible region.

Spectral analysis of absorption allows for determining the oxygen absorption rate in the blood if the light of different wavelengths is used for excitation. This is how the oxygen saturation of the blood is assessed. The article also discusses the method of data transfer using an interface with a smartphone.

The growing use of oximeters in wearable devices for health monitoring could help with the early diagnosis of conditions like asthma or other respiratory disorders.

2. Accelerometer. The accelerometer allows for estimating the track's movement and activity levels, a crucial feature in monitoring daily exercise and detecting irregular movement patterns that might indicate a health issue. An accelerometer plays a very valuable role in assessing physical activity in several parts, such as sports medicine, health rehabilitation, exercise prevention, etc. [2]. When a person performs requested or free physical activity, an accelerometer measures the change in speed and calculates acceleration. A number of steps, sitting bouts, or activity levels are used as primary data. Since the fifth smartphones in 2007, now all people can evaluate and monitor personal active behavior: all smartphones have an internal inertial sensor (internal measurement unit, IMU) as a standard chipset, and almost all manufacturers provide sophisticated applications for physical activity monitoring, fitness testing, or exercise training.

3. PPG Sensor. Photoplethysmography (PPG) allows monitoring of heart rate and blood flow. PPG technology is widely used in wearable devices because it can measure heart rate variability and detect abnormalities like arrhythmias. PPG represents a noninvasive optical technique that evaluates volume changes in blood in tissues based on the interaction of light with living tissue [3]. Commercial medical devices record oxygen saturation, blood pressure, and heart rate; autonomic nerve function can be assessed. PPG has been integrated into various wrist-worn devices. Using suitable algorithms for signal processing, wearable devices can measure various health indicators in everyday life. Sensors with multiple light sources of different wavelengths are required. It is possible to value primary parameters such as blood pressure and blood glucose level and secondary complex parameters such as stress assessment, sleep, and activity.

4. Sweat sensor. Non-invasive real-time measurement of sweat at a fixed skin location can be recorded with a portable sweat sensor [4]. This data type makes it possible to assess the training load, stress, and other characteristics related to human physiology at the molecular level parameters. Personal health monitoring is generally based on changes in tissue fluid dynamics. Electrochemical sensors are efficient, low-cost, and miniature.

2. Overview of *Child Guard* Application

Child Guard is a suite of tools or settings designed to protect children from harmful content, activities, or interactions, primarily in digital environments like the Internet and smart devices. These tools can also extend to monitoring a child's physical safety through health and activity tracking, providing a holistic approach to parental oversight.

Child Guard is a revolutionary application designed to monitor children's online activities and safeguard their physical and mental well-being. Some of its key features are presented below.

2.1. Health Monitoring

Child Guard tracks vital signs such as heart rate, skin temperature, and skin perspiration, providing real-time data on your child's physiological state. This feature lets parents stay informed about their child's health and promptly address concerns. Boyd [5] discussed the wearables for health monitoring and reported significant advancements in real-time health tracking for children. For human health monitoring and diagnostics, receiving information in real-time without extraneous influence is very important, as it would force you to adjust your normal or stressful life rhythm. Devices worn on the wrist are suitable for this. Static data from databases can and should be combined with wearable health monitoring sensor data. You can proactively manage your health by collecting and analyzing real-time data. Data privacy, device accuracy, and user support must be addressed. In general, wearable technology significantly contributes to preventive care and early diagnosis. Continuous research and interdisciplinary collaboration are needed to maximize. Partial unification is necessary: to establish wearable technologies in the future, it is necessary to formulate the Technology Acceptance Model (TAM), Health Belief Model (HBM), and Unified Theory of Acceptance and Use of Technology (UTAUT).

Data-driven tools allow for preventive care and early interventions, especially concerning stress and anxiety symptoms [6]. Physical activity characteristics indicate mobility levels, latent chronic diseases, and the aging process. Sensors and accelerometers of wearable devices are designed to measure and evaluate physical activity, including posture and movement classification, energy expenditure assessment, fall detection, and balance control assessment. Research shows the efficacy of wearables in detecting early signs of illness and providing timely interventions. Health monitoring systems have demonstrated the ability to reduce emergency incidents by identifying early symptoms, especially in children with pre-existing conditions.

2.2. Activity Tracking

The application monitors your child's daily activity levels, encouraging them to stay active and promoting a healthy lifestyle. By keeping track of their physical activity, parents can ensure that their children are getting enough exercise and staying fit.

Research highlights the use of activity-tracking wearables in promoting fitness among young users, ensuring adequate exercise [7]. Photoplethysmography (PPG) signals can provide various biological information, which can help determine and diagnose various health problems. The PPG device measures light absorption in tissues (i.e., blood vessels, blood), which correlates with changes in blood flow volume, heart rate variability, and blood pressure fluctuations. PPG methods can solve about 25 health problems. They are divided into six categories: heart, blood pressure, sleep health, mental health, diabetes, and others. These PPG studies used various methods to make the diagnosis techniques: machine learning, deep learning, and statistical techniques. The biggest problem for us is the lack of publicly available PPG databases, which makes it impossible to cover a wide spectrum of health problems. It is necessary to promote using PPG devices as a possible tool for precision medicine in everyday life, both for healthy and sick people.

Nardelli et al. [8] claim that the leading cause of death worldwide is heart disease. Given this, constant monitoring is necessary for cardiovascular system dynamics - due to exercise prevention and/or diagnosis. Wearable physiological signal monitoring technologies have become widespread after the COVID-19 pandemic. Photoplethysmography (PPG) is a non-invasive and inexpensive optical technique that can provide helpful information about the cardiovascular system. The convenience of PPG sensors is sufficient (comfortable wearing, small dimensions, and long battery life). However, problems with poor sensor contact during physical activity result in corrupted signals, noise, and motion artifacts. At the same time, a good surrogate for the PPG signal can be extracted from face RGB image processing. It is a contactless monitoring technology, suitable for studying clinical pathologies, biometry, and sleep patterns.

Activity trackers have increased physical activity in children by about 20%, particularly when integrated with parental feedback systems. Wearables like fitness bands are practical tools for ensuring children meet recommended daily activity levels.

2.3. Stress Detection

Child Guard identifies signs of stress in children, helping address potential stressors and support their emotional well-being. The application provides valuable insights into a child's mental state by detecting changes in physiological parameters associated with stress, such as elevated heart rate or increased perspiration. Studies indicate that wearables can detect stress through physiological markers such as heart rate and perspiration, providing accurate and timely feedback. Monitoring people's stress levels is a complex task, as using physiological measurable indicators would make it possible to quantify stress on a metric scale. Han et al. [9] pointed out that stress assessment results when tests are performed under controlled laboratory conditions are not always effectively transferred to everyday contexts. The current state of wearable sensor technology allows us to create systems that measure physiological signals reflecting stress 24/7 while recording context. As a prototype, there is a possible stress monitoring system, measuring psychological stress in everyday life environment based on three physiological signals: electrocardiogram (ECG), photoplethysmogram (PPG), and galvanic skin response (GSR), *Shimmer3 ECG*, *Shimmer3 GSR+* and *Empatica E4* wearable sensors were used for this. Whether motion artifacts affect stress estimation was investigated.

In some cases, stress assessment using only the previously listed parameters is questionable, and new technology is needed. Gjoreski et al. [10] described the usage of novel wearable surface electromyography (sEMG). Induced affective states by measuring facial muscles were investigated. Facial muscles are traditionally associated with positive (left/right orbicularis and left/right zygomaticus) and negative expressions (corrugated muscle), activation. Significant relationships between sEMG amplitude and stimuli could be used for quantitative estimation of stress.

Sensors in wearables can measure stress indicators, allowing parents to identify and manage stress in real-time. Detecting early signs of stress in children can significantly improve mental well-being by addressing issues before they escalate.

2.4. Sleep Quality Analysis

By analyzing sleep patterns and quality, *Child Guard* offers insights into children's sleep habits and helps optimize their rest for better overall health. This feature enables parents to identify any sleep disturbances or issues affecting their child's well-being and take appropriate measures to address them. Wearables are increasingly used to monitor and improve sleep quality in children, ensuring they get adequate rest. Crivello [11] described the criteria necessary for "sleep quality." The comprehensive study covers the entire taxonomy of sleep monitoring systems concerning various categories of

users (sleep specialists, neurologists, psychiatrists, clinics, etc.). A complex combination of physiological signals and sleep variables must be used. Several technological methods must be used. Three types of sensors, such as those worn on the wrist, surveillance cameras fixed by the bed, and specific actigraphy devices, allow the collection of information of interest.

Farooq et al. [12] analyzed complex problems related to the sleep disorder. Cyberbullying is a recognized threat to public health, which is associated with physical and mental health problems such as sleep disorders. Preventing cyberbullying can also partially solve the problem of healthy sleep. Sleep-tracking technologies help parents ensure their children adhere to recommended sleep patterns, reducing issues like insomnia. Monitoring sleep quality provides actionable insights into a child's overall health and well-being.

2.5. Mental Health Monitoring

Child Guard harnesses the data collected by its sensors to offer comprehensive analyses in key areas of concern, including anxiety, depression, heart disease, asthma, and sleep disorders. By monitoring physical and mental health indicators, the application provides a holistic view of your child's well-being and enables early intervention when necessary. Mental health monitoring via wearables has proven beneficial in the early detection of mental health disorders in children. Long et al. [13] presented a review of smart wearable devices for detecting mental health problems. Generally, long-term and persistent mental health problems can lead to severe mental disorders. Wearable devices are widely used for mental health monitoring and play an important role. It is possible to predict a person's mental health quite accurately and identify problems early. Depression is a problematic societal problem to diagnose because people with depression are afraid of professionals. Depression detection can only be realized using multivariate information, e.g. Questionnaires, speech and facial landmarks, design, and sensor data [14].

Wearables can track early signs of mental health issues like depression and anxiety, providing intervention opportunities. Health wearables monitoring physical and mental health offer a holistic understanding of a child's well-being.

Additionally, a Norton LifeLock report [15] revealed that parents who use monitoring apps are more likely to converse with their children about online safety and establish rules for Internet usage. This aspect of *Child Guard* facilitates a proactive approach, leading to more assertive family communication and better-prepared children for navigating the digital world.

Furthermore, *Common Sense Media* conducted a survey indicating that 78% of parents who use parental control apps reported discussing Internet safety with their children, compared to only 48% of parents who do not. By providing parents with insights into their children's online activities, these apps facilitate constructive conversations about responsible Internet usage, digital literacy, and potential online dangers [16].

3. Challenges and Solutions

Recent data from worldwide studies underscore the growing need for *Child Guard* apps. According to a Pew Research Center survey, 72% of parents in the United States express concerns about their children's online safety, citing issues such as cyberbullying, inappropriate content, and excessive screen time [17].

Implementing *Child Guard* apps has shown promising results in mitigating these risks. A study by the London School of Economics and Political Science [18] found that households using parental control apps experienced a 30% reduction in instances of cyberbullying and a 25% decrease in exposure to inappropriate content among children.

Despite their benefits, *Child Guard* apps face challenges safeguarding children's online experiences. One of the primary challenges is the constant evolution of technology, which introduces new platforms, apps, and digital threats. Keeping pace with these changes requires regular updates and improvements to the *Child Guard* app features and algorithms [19].

Another challenge is balancing privacy and protection. While *Child Guard* apps are designed to monitor children's online activities, they must do so without infringing excessively on their privacy or autonomy. Striking the right balance between parental oversight and children's independence is essential for building trust and maintaining open communication within the family. Moreover, *Child Guard* apps may not be foolproof and can sometimes be circumvented by tech-savvy children. This highlights the importance of ongoing education and dialogue between parents and children about online safety and responsible digital behavior.

Conclusions

In conclusion, the importance of *Child Guard* apps in protecting children's online safety and overall well-being cannot be overstated. These apps offer parents and caregivers valuable tools to monitor, manage, and educate their children about responsible digital behavior. By utilizing advanced technologies and fostering open communication, *Child Guard* apps empower parents to create a safer and healthier online environment for the next generation.

Looking ahead, the future of *Child Guard* apps lies in innovation and collaboration. Developers must continue refining and enhancing app features to adapt to evolving digital landscapes and emerging online threats. Collaboration between technology companies, child advocacy groups, and educational institutions is also essential for promoting digital literacy and fostering a culture of online safety from an early age.

Furthermore, policymakers play a crucial role in supporting the development and adoption of *Child Guard* apps through regulations and initiatives that promote online safety. By working together, stakeholders can create a safer and more secure online environment for children worldwide.

Abbreviations

ECG	-	Electrocardiogram
GSR	-	Galvanic Skin Response
HBM	-	Health Belief Model
IMU	-	Internal Measurement Unit
PPG	-	Photoplethysmography
SEMG	-	Surface Electromyography
TAM	-	Technology Acceptance Model
UTAUT	-	Unified Theory of Acceptance and Use of Technology

Authors' contributions

MMA developed the methodology and structured the content according to the specified guidelines, ensuring the final version adhered to the required standards. LKJ conducted an extensive review of relevant literature, analyzed current technologies, and evaluated the significance of the topic about contemporary challenges. SM identified security issues as a central concern and considered the latest innovations in the field, formulated general conclusions and recommendations. SG revising and supervising. All authors have reviewed and approved the final manuscript.

Conflicts of interest

There are no conflicts to declare.

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