

'Welkin' – Parenting App and Analytics Engine using an IoT Framework

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Abstract — In today's world of rapidly growing connectivity technology, everyone is busy with their tech-gadgets on social and immersive media. Lives revolve around the internet and folks are busy catching up with and following the latest trends. Due to work commitments and hectic office schedules, adults lack in giving the required attention to their off-springs. This is deeply impacting the lives of kids. Kids suffering from different mental and physical disorders are left unnoticed at the initial stages causing serious issues at later stages that completely change their personality. Even for non-working parents, it is not possible to closely monitor kids during playtime or in school. Thus, several problems are left ignored. While there are available monitoring solutions, they are either too intrusive or leave the problem solution identification to the parents. There is a need to bring in available knowledge base to parents, to both understand the problem as well as to solve them. This paper proposes a novel solution - 'Welkin' as a kid-wearable and analytical engine, which captures and analyzes events & data, recognizes patterns learnt a priori from pediatrics and physiology, to create meaningful recommendations and follow-ups for parents. Recommendations enhance kid's capabilities by helping alleviate potential behavioral and situational risks, allowing the parent to focus their time and energy on the right thing – enjoying parenting!

Keywords—IoT wearable, Cloud Computing, Data Analytics, Parenting App.

I. INTRODUCTION

A great nation is made from great young minds, and to create great young minds, a great upbringing is required. This is incomplete without proper parenting. Parents are the backbone in the development of a child's physical, emotional, cognitive and social well-being. Research has shown that the involvement of parents positively impacts children in their academic achievements as well as in their overall growth [1]. To provide a strong developmental foundation, the following aspects play a very important role:

(a) *Physical Development* – Physical development is about motivating children towards activeness and engagement with the outside environment. Parents are the ones whose influence impacts a child the most. They should spend time playing with their children. It develops resistance among children against depression and anxiety. At an early age, parents should promote children in trying different sports to discover their kid's interests. This is not only important to keep a child physically healthy but it also develops strong personality traits in a child such as discipline, leadership

through sports, team spirit, etc. Also, a basic regular hygienic routine is very important at a growing age for a child. These little efforts contribute largely towards a child's growth.

(b) *Social Development* – Social interaction for a child always begins with parents. It provides a sense of affection and emotional fulfillment. Simple gestures like talking, asking about the daily routine, hugging and sharing quality time contribute a lot to their social development. Children learn the meaning of compassion, love, gentleness and care from these childhood experiences. Several kinds of research have shown that positive interaction with parents contributes social development of a child in the long run [2]. Social development is in a way incomplete without making friends, sharing a good bond, laughing and eating together with other children. Children who are deprived of proper attention often suffer from loneliness. These things should be specially considered by parents for proper growth.

(c) *Emotional Development* – Emotional well-being is equally as important as being physically fit. In today's world, young children often suffer from stress, anxiety problems. In toddlers, separation from their parents can cause anxiety. Family problems like divorce impacts kids. Sometimes, what they hear and watch also impacts them deeply. So, parents should be very attentive to the content their child watches. Even on TV and tabs, parents should monitor and filter out the best for their child. Besides preventing these problems, it is equally important that parents should be available for their child every time irrespective of whether a child needs them or not. Children learn to deal with emotional outbursts and breakdowns only from their parents' support. Parents can only teach them how to express and feel better.

(d) *Cognitive Development* – Research shows that getting engaged in a child's learning plays a very critical role in their cognitive development [2]. The environment provided by parents play a key role in determining how much their child excel academically. The curiosity among young children should be boosted so that they can develop a new perspective and learn more and more. Their potential should be brought to light. This can only be possible if parents try to develop it in them from a young age. They should engage children in problem solving, science, reading and help them understand how to approach the new tasks.

Survey [4] states that parents-children spend less than eight hours each week. Seven in ten parents say the time is spent in silence in front of the TV because children are busy reading,

playing computer games or simply too tired to talk. Hence it is difficult for the parents to know about the mentality, emotional state, friends, and overall development of children. Therefore, parents cannot take any corrective measures on time for the children when needed. This also leads to following up with the latest trends or peer network-based recommendation of following up a regime which may work for one kid but may not be apt for another.

The available parenting applications [5] [6] are search-based and require the parents to categorize their knowledge on their kid, in a form through which the recommendations and tips are shared with the parents. This is limited to the available knowledge of the parent about the kid, while the kid may be very different amongst his friends and peers. Also the available research on activity monitors for kids [7] [8] etc. are too intrusive and targeted towards creating a competitive behavior amongst parents and kids, without really understanding what may be good for the kid aligned to his personality and interests.

To overcome the above challenges, in this paper to the best of our knowledge we propose a novel solution, called ‘Welkin’ which through the proposed device and proposed ecosystem closely monitors children and sends personalized suggestion to parents’ mobile app (application), which is specific to a kid thus enhancing the parenting effectiveness.

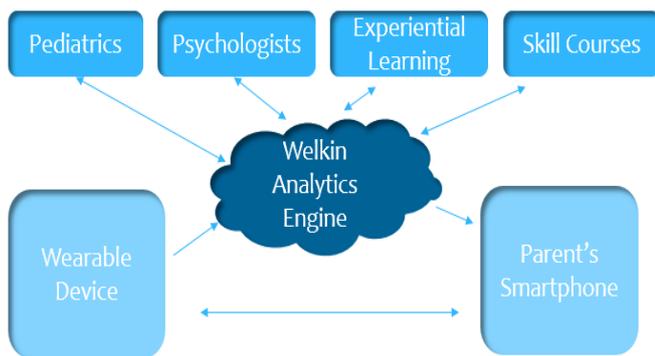


Fig. 1 Samsung Welkin Ecosystem

Fig.1 is a block diagram illustrating a system for cloud-based parenting using Internet of Things (IoT) framework. The system herein comprises an IoT wearable device, Analytics Engine and Parents’ Smartphone App. IoT wearable device is self-activating, without any parent/child intervention. IoT wearable device data is based on events/triggers. The device may not have any interface, and thus, is not going to be distracting for the child.

IoT wearable device can gather audio samples like speech, ambiance, crying/shouting sounds, and so on. Also, IoT used Ultra-Low Power Machine Type Communication (MTC) like Narrow Band IoT (NB-IoT) [1], for periodic upload, direct or via a gateway, save our Soul (SoS) kind of emergency invocations and Assisted Positioning. IoT wearable device also tracks activities like heart rate, pedometer, running speed, fall/impact of an injury, light (In-door/Outdoor), stress level using advanced sensors, and so on. IoT wearable device sends the details mentioned above to the Analytics Engine. Analytics Engine gathers metrics and maps with help of data

from pediatrics and psychologists, to classify the behavior into supervised or unsupervised categories. Analytics Engine provides a result, wherein the result is quantized information sharing with parents. Based on the result, the Analytics Engine recommends counseling/skill and activity enhancement for the kids. Analytics Engine sends the result to Parenting App running on the parents’ smartphone. IoT wearable devices can also call the parents’ smartphone directly in certain emergency scenarios. The Parenting App on the parents’ smartphone can also interact directly with the IoT wearable device for any specific feeds/information or configuration.

Through a few use case analysis on the suggested Welkin Ecosystem, we present an improvement in recommendations shared with parents, which is more suitable for a specific kid, whereas, with available literature solution [5], only a particular kind of recommendation may have been received by a parent. The Welkin ecosystem can also take in feedback from the IoT wearable device, which helps it improve the recommendations emanating from the Analytics Engine for the specific kid.

The rest of the paper is organized in the following order. Section II, covers the literature Survey, Section III elaborates solution, Section IV describes the use cases and the recommendations as compared to [5], Section V concludes the findings and discusses the scope of future work.

II. LITERATURE SURVEY

A lot of research has been done on monitoring various human aspects such as physical activity, speech, responsiveness, anxiety level, etc. using IoT. In the paper[9], a model is proposed where the attention of students is estimated automatically in the classroom during lectures. It uses 2D and 3D data from Kinetic One Sensor to develop a feature set for both body patterns and facial expressions of students including gaze angle and body postures. Various machine learning algorithms are applied to analyze the time-varying attention level of each student. For reference, human observers’ estimation of attention is taken into account. The classifier model achieved a moderate accuracy of 0.753, which is close to the results of other studies on student engagement. The results indicate that students’ average attention level and its variation with time over different subject classes can be predicted using this monitoring system.

In the paper [10], the authors proposed a model, “Kids Health Monitoring System”, referred to as KiMS. This is to monitor the health of a child. This is done using wearable sensors with embedded digital signal processing. It uses various audio signals such as cries, cough and sneeze. The classification of audio signals under varying SNR. It measures body temperature and pulse-rate using wearable. This data is recorded and sent to parents, health care specialists using the Bluetooth unit. These records help analyze the health of a child and finding the cause of certain sickness and symptoms.

As per paper[11], a wearable is designed by MIT researchers called ‘Alter Ego’. It recognizes the non-verbal prompts-“reading the mind”. A device is attached underneath the mouth and around the user’s ear and jawline. It has

electrodes that capture neuromuscular signals on the face and jawline. These signals are triggered by internal verbalization that can't be captured by the human eye. These signals are then fed to a machine learning system which analyses the data and finally provide words for specific signals.

A research is given by MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) and Institute of Medical Engineering and Science (IMES) [12], in which they introduce an AI-based wearable system that can predict whether the tone of a person is happy, sad or neutral from the voice and other body parameters. The Samsung Simband is used to acquire high-quality psychological waveforms which can tell the heart rate, body temperature, blood pressure, blood flow and body movements. The person's voice is also recorded from which an audio signal and text data can be extracted. Two algorithmic models are trained by 31 different conversations of several minutes – one can estimate the overall tone of the speech, whether happy or sad and the other one can detect in each five seconds block if the tone is positive, negative or neutral. By using this model, the person's tone can be identified.

According to the report given by Transparency Market Research [13], the global pediatric health care products and services market was valued at around US\$ 88,000 Million (Mn) and US\$ 520,000 Mn, respectively, in 2017 and is projected to expand at a CAGR of around 4.5% and 5.5%, respectively, from 2018 to 2026. A research [14] shows that the Global Wearable Technology Market is estimated to reach \$58.3 Billion by 2024; growing at a CAGR of 15.8% from 2016 to 2024.

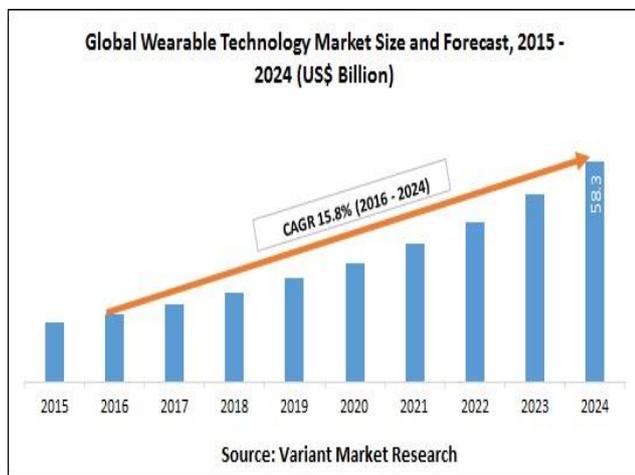


Fig. 2. Wearable Market Statistics

The global baby products market size is expected to reach USD 16.78 billion by 2025, according to a new report by Grand View Research, Inc. [15]. The market is anticipated to register a healthy CAGR of 5.5%.

Considering all these points, the market scope for a solution in the wellness of the kids market is enormous. Also, the available relevant literature like [9] [10] [11] [12], focus on improving the accuracy of the detection (for different targets), but don't solve the challenge of finding the

corrective actions after detection.

III. PROPOSED SOLUTION

From the previous research, it can be seen that the data can be collected and analyzed to indicate the problem that children's face. But none of them are suggesting the course of action to be followed by parents to overcome the problems. This paper presents a novel idea to suggest parents with a different course of action to be taken in the direction where their child's growth is being hurdled or where they are lagging behind.

We propose 'Welkin' as an IoT based kid-wearable, which captures and sends events and data to the cloud to analyze and recognize patterns learnt a priori from pediatrics and physiology using the analytic engine, and create meaningful recommendations and follow-ups for parents. Recommendations enhance kid's inherent capabilities and also alleviate potential behavioral and situational risks, allowing a parent to focus their time and energy on the right thing, which is to enjoy the process of parenting. The ecosystem and components for the 'Welkin' is shown in Fig.1.



Fig. 3. Kid Wearable, when worn like a wrist band

The proposed wearable, is a low power, interface less device, which can, for example, be worn like a wrist band, as shown in Fig.1. Some of the capabilities and feature are listed below.

Wearable Capabilities:

1. Recording and storing Audio Samples for the following use cases:
 - a. Speech Detection
 - b. Ambiance Categorization
 - c. Distinguish Crying or Shouting behaviors
2. Ultra-Low Power MTC like NB-IoT with ability to do the following:
 - a. Periodic updates directly or through a gateway
 - b. SoS Invocation, like emergency calling
 - c. Assisted Positioning to locate the device
3. Activity Tracking for the user by means of sensors like the following:

- a. Heart Rate Sensor, for measuring pulse rate changes.
- b. Pedometer for counting steps, stairs, etc.
- c. Detecting running speed.
- d. Detecting a fall or an impact.
- e. Ability to measure light to detect indoor or outdoor.
- f. Measuring stress levels via sensors.

The proposed **Analytics Engine** will have four blocks as described below:

1. **Data Collection:** Data from various sensors is collected and uploaded to the Cloud. This data will vary based on the different sensors used. E.g. Stress Sensor sends the value of Skin Conductance based on which stress level is estimated. Similarly, each sensor sends some values which are used to estimate different body parameters.
2. **Data Pre-processing:** In this block, the data is segregated based upon the activity schedule of a child. The schedule determines what kind of activity is ongoing and which parameter should be analyzed at that point of time. For example, a child should have more physical activity in games class rather than in mathematics class. Similarly, a child's voice should be more frequent in literature class than in an environmental class.
3. **Algorithmic Analysis:** After segregating the data into the physical and behavioral sections, a score is allotted to a child with the help of a certain set of algorithms. The score is based on how active the child is in that domain. A physically active child is awarded more points in Physical fitness while a child who speaks more number of distinct words in a day is awarded more points in literature. The threshold is set for each parameter by the experts. By comparing the points earned by a child in each category and the threshold, a child can be put into three categories- normal, above average, below average.
4. **Recommendations:** For each parameter (physical, mental, behavioral, social), different suggestions are provided by experts for different categories (normal, above average, below average) children. For example, the public speaking workshop is recommended for a child who is put into the below-average category in extrovert-ness. The recommendations by experts include suggestions by psychologists and pediatrics. The parents who can actively use this model can also suggest for other children. These suggestions after getting validated by the experts can be included in the recommendation data set.

The proposed **Smartphone App** is installed on the devices of the parents. This App is accessible to parents only. The time table of a child is fed by parents on this app. This information is passed on to Welkins Analytic Engine. The suggestions and recommendations from the Analytic Engine are sent to parents' smartphone app. These suggestions won't include quantitative values of parameters. Rather it will focus on the activities that can improve their child's wellness and upbringing.

IV. USE CASE

The novel idea to use this model is to monitor the child when he/she is away from parents. The major time spent by children is in schools where they can't be individually monitored. In schools, the monitoring is done based on subject periods which can tell aspects of a child – whether he/she is more logical or subjective in nature, whether he/she is physically active or not, whether he/she is responsive in class or not.

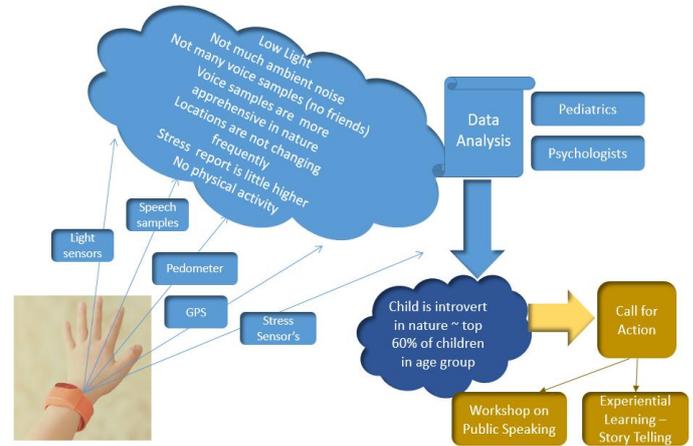


Fig. 4. Introvert child (Detection→ Action)

Fig. 4 is a flow diagram depicting a method of detecting an introvert child. The child's behavior/attitude is analyzed based on the input from IoT wearable device. Input data from Light sensors, speech samples, pedometer, stress sensors, and location details from GPS are sent to Analytics Engine.

Data such as low light, not much ambient noise, not many voice samples (no friends), voice samples are more apprehensive in nature, locations are not changing frequently, stress report is little higher, no physical activity, and so on, along with help of data from pediatrics and psychologists, provide result that the child is introvert in nature. The result is sent via Parenting App to parents' smartphone. Thereafter, corrective action is taken by the parents. For example, the corrective actions taken herein are sending the child to a workshop on public speaking, experiential learning class such as storytelling, and so on.

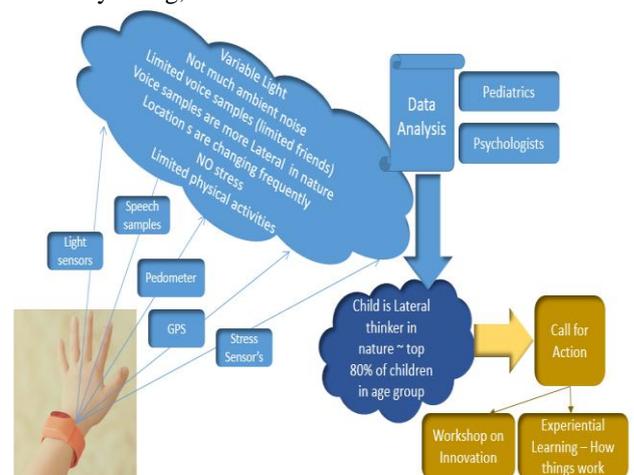


Fig. 5. Lateral thinker (Detection→ Action)

Fig. 5 is a flow chart depicting a method of detecting a child which is a lateral thinker. Data such as variable light, not much ambient noise, limited voice samples (limited friends), voice samples more lateral in nature, locations are changing frequently, no stress, limited physical activities, and so on, along with help of data from pediatrics and psychologists, provide result that the child is a lateral thinker in nature. The result is sent via Parenting App to parents' smartphone. Thereafter, the parents take improvement action. For example, the improvement actions taken herein are sending the child to a workshop on innovation, experiential learning class such as how things work, and so on.

Talking about one eye-witnessed incident, a child was having a habit to tell lie for every small incident to his parents. When parents came to know about this, they started scolding their child. This made the child to hide his feeling in the fear of getting scolded. When he grew up, he was not able to express his feelings in front of anyone. In this scenario, the Welkin App would have helped by detecting the overlooked details of the child. The Analytics Engine would have recommended the parents to become friendly with their child to make him more expressive, or sessions of moral stories during storytelling. It would have made him confront real-life problems and enhanced his personality which he is currently lacking.

V. CONCLUSION

In this paper, it is presented that a novel solution based on an IoT framework can be used to improve parenting and provide children with a better level of upbringing. A kid can leverage the wisdom of global experts and not limited to the wisdom of parents and the local environment. The solution is based on IoT wearable that will sense several parameters of kid to analyze his/her physical fitness, mental fitness and behavioral analysis. The analysis is done based on the reference provided by pediatric experts and psychologists. Using a training model, a course of action is identified to improve a child's growth. This suggestion is sent to parents on their mobile app without actually sending them the quantized information about any event.

Further advancements will include embedding new sensors into the wearable and capture other parameters (such as eating habits, time spend on TV/gadgets) with improved accuracy. The course of action can be improvised based on feedback from parents. Also, suggestions from experts in other fields like sports can be taken to present a better solution.

VI. REFERENCES

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