

# IoT-based Child Security Monitoring System

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## ABSTRACT

Nowadays, crime rate associated with children keeps increasing due to which draws peoples' attention regarding child safety. This research is conducted to propose a child security smart band utilizing IoT technology. Online questionnaire and semi-structured interview are methodologies used to collect data. The online questionnaire gains feedbacks by sending questions electronically, where answers need to be submitted online. In the semi structured interview, researcher meets and asks respondents some predetermined questions while other being asked are not planned in advanced. Through information obtained, a smart band have been proposed to monitor the safety of children. By this, parents know what is happening remotely and can take actions if something goes wrong. The future improvements of this device will be adding functions and software to make it works like a phone such as messaging, gallery, Google, YouTube, meanwhile, adding more child security features so that child safety is guaranteed.

**Keywords:** Child security system, Child monitoring system, Internet of Things (IoT), IoT device, Smart band.

## 1. INTRODUCTION

Internet of Things (IoT) is a set of systems and devices interconnected with real-world sensors and actuators to the Internet, according to [11] [27]. It is able to make decisions via detecting the surrounding environment without human interaction [14] [29]. In this research, IoT is applied to propose a wearable smart band which helps parents to monitor and get known of their child's condition at anywhere and anytime even if they are not by their children side. Via the IoT smart band, children safety is guaranteed, and crime rate is reduced as immediate actions can be taken in case the child is in danger. Besides, unlike existing smart band, which is less focusing on child security aspect, the proposed system emphasizes in getting as much data as possible so that actual situation can be identified. The use of IoT in this device is motivated by the need of child security system in Malaysia due to child safety issues resulting from increasing cases on child related crime.

In fact, IoT has been applied in domains such as smart home, smart city, smart factory, supply chain, retail, agriculture, lifestyle, transportation, emergency, health care, environment, energy, culture and tourism [4] [32]. However, it is seldom used to monitor child's safety in Malaysia. Actually, there is a need to use IoT-based child security system since the safety of children has become a major concern [14]. In fact, crimes on children keep

increasing despite actions have been taken by the government. Revealed by [9], the overall percentage of child abasements worldwide is about 80% nowadays, out of which 74% are girls and the remaining are boys. For every 40 seconds, a child is gone missing in the world. Due to that, parents are worried for their children and perhaps, a hard challenge for them to guarantee safety of their children when they are out.

To cope with the issue, the system is proposed with these objectives:

- Enable tracking of the child's location and capturing of data remotely such as temperature, pulse, respiratory rate, quality of sleep and many more.
- To show the child's actual data with reference values.
- Enable sending of notification if the child is out of location or when the device realizes abnormal conditions/situations.
- To trigger the alarm and enable automatic video recording whenever the emergency button is pressed. Then, emergency notification along with real-time video will be sent to and display in the parents' mobile apps.
- Develop a prototype of IoT wearable smart band connected to parents' mobile apps so that they can monitor the actual condition of children at anytime and anyplace.

## 2. RELATED WORK

### 2.1 Internet of Things (IoT)

Internet of things (IoT) refers to networked interconnection of objects featured with ubiquity intelligence [3] [28]. In IoT, objects are connected via internet for communication, interaction, exchanging data and making decisions automatically at anywhere and anytime. Thus, introducing the hyper connectivity concept meaning individuals and organizations able to communicate with each other effortlessly and remotely [15]. Revealed by [17] and [15], IoT is a revolution in advancing technology causing transformation in information technology, humans' lifestyle, and in businesses processes. The advancements of IoT make it possible to be used in organizations for automating and monitoring business processes [6] [37-38]. In term of society, IoT can be used for simplifying daily tasks, creating smart homes, smart cities, devices or application which improves the quality of life. However, security and privacy are the main challenges of IoT [15] [33-34] which need to be solved as it gathers much personal data capable of revealing sensitive information.

### 2.2 Sensor

Sensor known as a device measuring physical value and converts it into data. Common sensors like the temperature sensor measures heat of an object. Proximity sensor used to detect nearby objects. For the pressure sensor, it calculates pressure applied. Optical sensor able to sense the light intensity [12]. Humidity sensor will detect the presence of water vapor in the air [10]. Micro sensor is designed to collect and relays information about the environment [10].

### 2.3 Cloud

Cloud computing means shared computing resources (networks, servers, storages, applications, services) are delivered as a service [18] [30-31] over the Internet from cloud to customer. According to [7], cloud is an interconnected network of servers providing services for people or businesses. In fact, cloud supports real-time operation, processing, analyzing, connecting, managing and securing IoT devices as well as applications [5] [35-36]. In addition, it reduces cost since users are paying based on usage without building the physical infrastructure. Furthermore, it allows developers to create projects faster [7]. Organizations can also access Big Data from the cloud [7]. Discovered by [16], the core concept of cloud is to reduce processing burden on users. Consequently, different devices like PC, laptop, smart phone able to access various utility programs, storage and application development platform over the internet.

### 2.4 Safety Device

The safety device protects individuals from potential harms and dangers. A research done by [1] proposed the child safety wearable device using raspberry pi 3. The raspberry pi 3 gathers data from pi camera, pulse sensor and sound sensors. Then, send collected data to parents' smartphones by SMS using GSM shield. Images captured from pi camera and children's location detected by GPS will also be sent to parents' devices. In another study, [2] designed a wearable smart watch for women security. Sensor inside the smartwatch senses the heartbeat of a child or woman who wears it [11]. When he/she is exposed to attacks, heartbeat rate will be high [11]. When this is detected, alarm sound will be triggered [11]. It will then automatically make calls to registered contact and to the nearest police station [11]. Based on the location provided by GPS, police will arrive soon at the correct destination.

### 2.5 Similar System



**Figure 1** Gator Smart Watch

Source: <https://cdn3.volusion.com/hvqjb.rxjoy/v/vspfiles/photos/My-Gator-Watch--6.png?v-cache=1605859659>

Gator, a kid's smartwatch from Gator Group Co. It comes with a SIM card and the free app is available on Play Store and Apple App Store [19]. Gator supports calling features up to 13 different numbers, enables two-way voice messages from the app and watch. The location tracking is based on GPS tracking when children are outdoors and Wi-Fi tracking when children are indoors. Notification will also be sent to parents when children leave the geofences. Pedometer sensor is included and the SOS alarm is supported which automatically calls 3 emergency contacts when pressed for 3 seconds. Other than that, school mode is available for setting up schedules to prevent callings during the school time. Not only that, Gator is splash proofing, enables remote voice monitoring and records historical routes.



**Figure 2** Explora Go

Source: <https://images-na.ssl-images-amazon.com/images/I/610FHcb9fJL.AC.SL1383.jpg>

Explora Go, a waterproof watch phone for children branded Explora which includes pedometer, alarm clock and stopwatch. It possesses an app available at Playstore and Appstore. With GPS and multiple services, Explora Go shows children's location and supports the setup of safety zones. Meanwhile, it contains a SIM card and acts like a phone enables voice calls from 10 pre-saved contacts. Similar to a phone, Explora Go can send and receive text messages, emojis, images and voice messages. It is also equipped with the SOS button that children can press to notify emergency contacts of their location. Beyond that, Wi-Fi and Bluetooth are available in Explora Go. It also supports the schedule function in which school schedules can be specified during which watch will only display time and make emergency calls.

The table below shows comparison between systems:

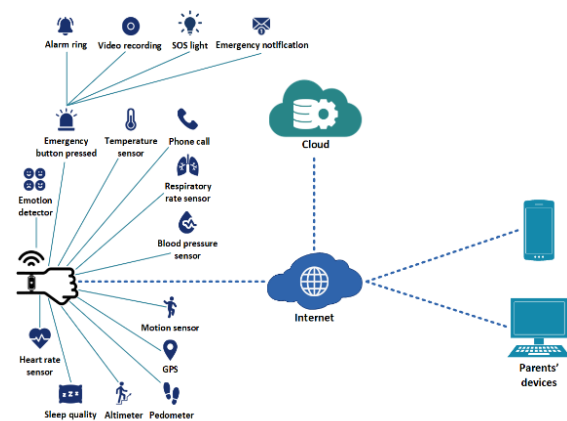
**Table 1:** Comparison between Gator Smart Watch, Explora Go and the proposed system.

	Gator	Explora Go	Proposed System
Wifi	✓	✓	✓
Phone Calls	✓	✓	✓
Waterproof	X	✓	✓
Camera	X	✓	✓
Video Record	X	X	✓
Text Messages	X	✓	X
Schedule	✓	✓	X
GPS	✓	✓	✓
Safety Zones	✓	✓	✓
Emergency Button	✓	✓	✓
SOS Light	X	X	✓
Altimeter	X	X	✓
Blood Pressure Sensor	X	X	✓
Emotion Detector	X	X	✓
Heart Rate Sensor	X	X	✓
Motion Sensor	X	X	✓
Pedometer	✓	✓	✓
Respiratory Sensor	X	X	✓
Sleep Quality Sensor	X	X	✓
Temperature Sensor	X	X	✓

Based on the table, Gator and Explora Go does not support much sensors like the proposed system to obtain children's data regarding their actual conditions. Thus, if abnormal situations occurred, Gator and Explora may not be able to realize quickly, easily and inform parents at once. Due to that, parents are less informed about children's conditions and in case the child is in danger, actions are not able to be taken immediately.

Furthermore, both systems do not record video and send it to parents during an emergency situation. Besides, SOS light function is not available in both systems but supported by the proposed system which will light up when the emergency button is pressed. In fact, Gator and Explora Go are emphasized in introducing mobile products for kids who are too young to use mobile phones. Because of that, they are less focusing on the child security aspect. On the other hand, the proposed system is more focused on tracking children's conditions that are suitable for child safety purposes

## 2.6 The Proposed System



**Figure 3** Diagram of the proposed smart band

An IoT based wearable smart band for children is proposed in this research for child security purposes. The smart band is waterproof, chargeable and equipped with sensors. Heart rate sensor measures pulse rate and BPM. Sleep quality sensor obtains children's sleep quality, cycle and positions. Altimeter detects changes in height and sense whether children are going down a slope or climbing stairs, thereby measuring calorie count. On the other hand, pedometer is used for counting steps. The motion sensor is applied to determines whether children are jogging or running. Blood pressure sensor used to measure blood pressure. In addition, the respiratory rate sensor detects breathing patterns and respiratory rate. Furthermore, the temperature sensor is used to detect body temperature. Besides, by using the emotion detector the emotional state, pressure and anxiety levels can be gained. Apart from that, this smart band contains GPS for tracking, identifying children's location and setting geofences. Via the smart band, children can also contact parents. Emergency button, a feature in which will automatically record video and automatically call 4 emergency contacts when it is pressed. An alert message along with the video clip is sent to parents' devices. The alarm and SOS light will be activated by parents through their devices. As the diagram shows, sensors are connected through the internet. They detect and capture different kinds of data. These collections of data will then be sent to the cloud over the internet for securely process, analyze, monitor, store, access and retrieve data

remotely. After that, the information indicating children's status, along with reference values will be sent to parents' devices with the app installed. If children's actual data is not within the range of reference value, alert notification and some suggestions will be sent to parents' devices. Also, when children leave geofences, notification will be sent to parents' devices.

### 3. METHOD

Research methodology, a method for identifying, collecting, processing and interpreting data using some techniques, then drawing conclusions to address the problem. It is a significant section since it allows readers to evaluate overall validity and reliability of the research paper [20]. For this research, online questionnaire and semi-structured interview are employed. Online questionnaire serves as quantitative research to measure users' attitude, behavior and factors influencing their acceptance towards the child security system. After that, a semi-structured interview is conducted as qualitative research helping in understanding trends, users' preferences, opinions and thoughts about current condition and IoT-based child security system. Besides, 50 parents nursing one or more children at most 12 years old are participating in this research. The data gathered will be used to prove the severity of current situation and the need to use IoT-based child security system.

#### 3.1 Online Questionnaire

Online questionnaire known as an electronic set of questions aimed to collect individual data about one or more specific topics [21]. Usually, it is a form sent to respondents via mediums like email, messenger or social media [22] where complete answers are required to submit online. Through the online questionnaire, large amounts of information can be obtained in a fast, convenient, affordable and effective way even though the researcher is not present [24]. In fact, the online questionnaire can be quantitative or qualitative but in this case, a quantitative online questionnaire will be conducted to measure detailed insights from respondents about the IoT-based child monitoring system. Due to that, structured close-ended questions are mostly used to obtain quantifiable data which can be used for statistical analysis. As mentioned earlier, all 50 respondents will be taking part in the online questionnaire for this research.

#### 3.2 Semi Structured Interview

Semi-structured interview refers to a qualitative research technique in which the researcher meets with respondents to ask some predetermined open-ended questions while the rest of questions being asked are not planned in advance [25]. During this pandemic, online meetings have been used to carry out interviews instead of meeting fact-to-face with respondents. In this section,

10 participants are chosen from 50 respondents who were previously involved in the online questionnaire to further study their ideas, perspectives, opinions as well as feedback regarding this topic. The data gathered help in understanding and explaining the overall concept, thought or idea. In the semi-structured interview two-way-communication is facilitated, encouraging participants to express their thoughts, feelings and reveal more information [8]. In addition, it offers reliable and comparable qualitative data useful for the research [8].

#### 3.3 Sampling Method

Quota sampling is adopted in this research. It is a non-probability sampling method where respondents are selected according to certain criteria. Quota sampling is being used as it allows the correct sample of respondents to be selected due to which becomes convenient to obtain results. Besides, the results offered are affordable and usable. Since the respondents are properly chosen, the results tend to be more accurate, precise and reliable. On top of that, quota sampling is faster and easier to conduct as it does not require a sampling frame and strict use of random sampling technique [13].

### 4. DISCUSSION

The section mainly discussed about significant of the research and why this study needs to be carried out. The child security system benefits parents as well as children. Since it aids in locating children, monitoring child's condition and security status instantly at anyplace and any time, parents who often tied up in work or neglect their children are gaining advantages from it. Through the proposed system, immediate actions can be taken forthwith in case the child is threatened. Thus, child security is guaranteed, crime rate related to children is reduced and eventually, parents can rest assured. In fact, reduction of crime rate brings about long-term positive effects such as improving country's reputation and quality of life [26], increasing community security, safety, and cohesion as well as generating economic benefits for individuals, committee and taxpayers [23]. Besides, the proposed system makes ample use of IoT, proving IoT is evolving which can be included in multiple areas comprising the child security field.

### 5. CONCLUSION

Throughout the research, it is clearly explained the IoT concept, child safety issues and the need of using child security system. Some previous studies have been included for designing the IoT-based child security smart band. It assists parents to monitor their children remotely. In case situations happen, notifications will be sent to parents so that actions can be taken. Through this, child safety can be ensured and crime rate will be reduced. However, the proposed device is not robust enough and does not contain sufficient functions to operates like a

mobile phone. Hence, the future enchantments will be adding more features, software, applications, hardware to make the proposed system capable of working more intelligently, meanwhile guarantee the safety of children.

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