Design of Children Monitoring Application for Outdoor Activities Using a Smart Watch

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Abstract. The background of this research is the increasing of criminalization in children, one of which is kidnapping of children. Meanwhile many parents have to work so they don't have enough time to be always close to their children. The purpose of this research is to develop applications that can help a parents to monitor the movements of their children's outdoor activities. The application uses a smart watch to get the child's GPS position and at the same time the device sends the last position of the child to the firebase database server. Parents can monitor the child's movements through the android smart phone device in realtime. The application design uses several UML (unified modeling Language) diagrams namely use case diagrams, activity diagrams and sequence diagrams. This application requires data objects including parent, child, family and child’s position (latitude and longitude). The main use cases in this application are sending position, case view, child location on map and view path of moving each child. The application can run only if there is an internet connection and the child uses smart time.

1. Introduction
Parents cannot monitor at all times their children’s outdoor activities. parents who are busy working cause they do not have enough time to monitor their children's activities, especially their children who are still sitting in kindergarten and elementary school. Nowadays, living expenses and living necessities require parents to work hard to full fill the needs of their families. This causes confusion for parents, in determining their priorities between working and monitoring their children. ideal conditions of course parents can balance the time between work and monitor the out door activities of their children. When parents do work in their office, they also want to know the position of their children's activities.

Today, the global positioning system (GPS) is a technology that is often used to determine the position of an object on earth [1]. GPS can also be used to trace objects [2]. GPS data is used to determine the position of children during their daily activities. GPS technology can also track which locations are frequently visited by children [4]. GPS coordinates are obtained from satellites in the form of latitude and longitude data on the location of an object. The coordinates data is sent to the server. The server will display the child's location on a map that can be accessed through a parent's smartphone. children need tools that are lightweigh and easy to carry when they are active. This tool will send location data simultaneously to the server when the child is not doing activities or when the children move to another place.
From the description above, the problem to be solved in this study is How to design an application that can monitor children's activities using lightweight GPS equipment for kindergarten, elementary and junior high school children. This application will use a smart watch (child user side) equipped with GPS equipment and on the parent side will use a smart phone to display the child's position via google map.

2. Related Work
Data with GPS is more accurate in determining the location of objects than passive mobile positioning data, there are Call Detail Record (CDR) data obtained from smartphone operators [4]. Research from Beeco, Hallo, & Brownlee, 2014, stated that the Global Positioning System (GPS) is one useful tool for planning, managing and monitoring recreational activities in neighborhood [5].
A research from Anusha R and Naidu C. using GPS, RFID, GSM and ARM processors to help track tracking of students in a school. Anusha's research aims to find out students who are not in the school location during a class [6]. Steven van der spec did research with GPS technology. in his research, steven said that GPS technology is not only used as a navigation and orientation tool, but it also as an instrument used to capture travel routes which is a sensor to measure activity on a city or regional scale. This research was developed at TU Where database processing and architecture are used to collect data on pedestrian movements in three European cities, Norwich, Rouen and Koblenz [7].
Trupti R.C conducted research focusing on tracking the position and location of children to be sent to the school's control room and parents' cellphone Trupti's research also aims to determine the presence or absence of children at school and provide the same signal to schools and parents. the cry of the child will also be recorded as identification of the child. When a child's cry at school matches, a text message containing the location of a child will be sent to parents. By using longitude and latitude values, the location of a child can be tracked by using an application on a parent's cell phone [8].

3. Firebase Database
Firebase is a NoSQL database. Unlike a relational database, Firebase NoSql stores its data in the JSON (Java Script Object Notation) tree [9] structure. Firebase server will update the latest data on Applications that are connected to it. Firebase can synchronize with various platforms including Android, iOS and Java Script SDK [10] [11]. Data is accessed by searching through the key values. Firebase uses key value pairs, making it easier to store data and very efficient in the process of finding data. This is very suitable for Big data application. Firebase can store data to a depth of 32 levels. However it is advisable to form a flat JSON tree structure and avoid multilevel data [12]. If you find complex data relations, for example there is a one-to-many or many-to-many relationship, it is more optimal to do flatten data structures by adding indexes to the corresponding keys. Requesting information for one node will automatically mean taking data from all of its child nodes as well. Firebase is realtime database, it’s mean that every time data changes, any connected device receives that update within milliseconds. It has high performance in processing large data [13] compared to relational databases.

4. Architecture System Children’s Monitoring Application
Figure 1 is a system architecture drawing that involves several tools or communication media. Figure 1 shows the group of children who are members of a family. Each child will bring an Android smartwatch that has been installed with software to activate GPS. The software on this smartwatch will send the child position coordinate, child id, date, time and timestamp to the Web Server through the data packet network simultaneously. The data will be stored in the Firebase database. The software on the parent can access all child data from one family and display the child position on the google map. This child position can be seen and updated realtime. In the special case, the child can contact the parent source by a certain push button on the smartwatch.
5. Data and Information Application Requirement
The data needed to build a child monitoring with this smartwatch, including family, parent, child, parent or child position. Family has the attributes family id, family name and address. Parent can be a father or mother. Parents have the attributes parent id, parent name, family relation, handphone number, username and password. Child has a child ID, child name, handphone number, date of birth, sex (male or female), username and password. Child Position has the attributes timestamp as unique identity, latitude, longitude, date and time position.
This application will display some information:
1. Saw all the child’s data in one family
2. See all the children’s position on google map
3. See a child’s track for one child on a certain date

6. Design System
Use Case Diagram

Figure 2 is the use case diagram of a Child Monitoring System. In the use case there are case login, sending positions, SOS requests, create family groups, view child locations in the map, view child names in groups, register members of family groups, view paths of moving each child and delete all
data paths of children. Case login is the main requirement for other case cases. The login case requires the username and password data of the child or parent as users. The username and password of the parent are inputted by the parent while the child password and username are stored internally in the smartwatch storage that is called at login via smartwatch. Case sending position is used to transmit position data from the child. Child's position is obtained by activating the GPS device on the smartwatch which will get latitude and longitude data. The smart watch used by the child will send this data to the server to be stored in the firebase database. Data will be saved from time to time with a timestamp as a differentiator. Case SOS requests are used by children to do a contact with a parent phone number in an emergency. Case group family can be used by parents to create a family name as the parent of children. One family name is only made for one child. Case view child location in map allows parents to see all positions of the children on google map in realtime. The position of each child on the map will be marked with an icon tag. This icon tag will move position in real time according to the position transfer from the child from time to time. Case view childname in group is used to view all members of the family member by parent. The case register member family group is used by parents to register children data. All child data will be stored in firebase, so that later the child will only read the data that has been stored by the parent. Case view path moves each child, used by the parent to review the path the child has passed on a certain date. Case delete all child data path, used by parent to delete child’s track data. This data can be deleted if it is no longer needed by the parent or has passed a certain time limit, for example a month or a year has passed.

Activity Diagram

![Activity Diagram](image-url)
Figure 5. Activity View Child Location On Map

Figure 6. Activity Create Group Family

Figure 7. Activity Register Member Group Family

Figure 8. Activity View Child Location On Map
Figure 9. Activity Register Member Group Family

Sequence Diagram

Figure 10. Activity View Child Location On Map

Figure 11. Activity View Child Location On Map
7. Firebase Structure for Children’s Monitoring Application

The firebase structure design for this application, is based on data objects involved in the system. Relationships between related objects, and information displayed to the user screen, are a major concern in building a firebase structure. Family has members of several parents (father or mother) and children. Children memiliki relasi dengan data posisi berdasarkan timestamp. Satu anak dapat memiliki data posisi yang banyak pada waktu yang berbeda. Sehingga data posisi kita tempatkan di dalam children. Because children and parents are members of the family, we place the children and parents inside the family. The optimal firebase structure is the flatten structure as far as possible. Flatten structure makes data access faster and more efficient in using memory. When firebase loads data on one node, then all data inside that node is loaded together. So we need to change some of the firebase structures earlier as in figure 13 and figure 14.

8. Conclusion

Designing child application monitoring for outdoor activities using smartwatch, it requires some object data including parent, child, family and child’s position from GPS. The main case in designing this application is case sending position, case view child location on map and view path moving each child. These four cases will make the application more interactive for parents to monitor their child's outdoor activity because it is combined with Google Maps in visualizing the movement of the child's position. Using firebase as a data storage database, it is hoped that the visualization of the child’s position becomes real-time.

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