

Android Based Forest Fire Monitoring System

Reza Andrea

Software Engineering Technology, Polytechnic of Agricultural, Samarinda, 17131, Indonesia
E-mail: reza@politansamarinda.ac.id

Ade Irma Wahyuni, Nur Fadila Safitri and Supryani

Software Engineering Technology, Polytechnic of Agricultural, Samarinda, 17131, Indonesia
E-mail: adeirmawahyuni321@gmail.com, nurfadila4747@gmail.com, snsebatik@gmail.com

Received: 08 February 2022; Revised: 11 March 2022; Accepted: 16 April 2022; Published: 08 June 2022

Abstract: Forest fires are burning areas of forest or land in large or small areas. Forest fires are often uncontrollable and when this happens, the fire will burn anything nearby for two reasons, one of which is burning naturally or burning caused by humans. One of the man-made fires deliberate by humans is the burning used by the community around the forest to open or clear agricultural or plantation land. The community feels that clearing land with fire does not require a long time and is more economical, if the use of fire is not used properly it can cause the forest to burn. Forest fires in Riau area are still classified as minimal or fires rarely occur. However, the community is at least aware of the forest fires in Riau due to a lack of media information about where the fire hotspots occurred. With this application, it can help the public to better know where the hotspots have been burned. This application consists of 2 levels of access, namely: admin and user. For admins and users, the manufacturing process uses the Android Studio application with Java as the programming language, this application uses Firebase as its database to find out the location of fire hotspots using the Google Maps API. Testing on the application is created to test whether the application has run as desired. Test results using white box testing method.

Index Terms: Monitoring, Fire, Android, Firebase, Google Maps.

1. Introduction

Forest fires are the burning of forest areas or land, both in large and small areas. Forest fires are often out of control, if this happens, forest fires will burn whatever is in the vicinity and spread to the wind. There are two causes of fires occur, namely natural fires and fires caused by humans. One of the human-caused fires is the burning of communities around the forest to reclaim or clear agricultural land or artificial forests. The community believes that the use of fire to clear land will not take long and is more economical, if a fire is not used properly it can cause forest fires. In recent years, many cases of forest fires have been reported, and we see them in various media or our daily lives, including electronic media and newspaper media [1]. These fires can occur anywhere, whether they occur in buildings, residential areas, shopping centers, or forests. The causes of these fires are very diverse, for example, people who accidentally throw cigarette butts or intentionally burn forests can cause widespread fires. Many losses are experienced by the community due to a lack of awareness of the dangers of fire. Losses due to fire accidents are thick smoke and even death due to fire. One way to monitor or monitor forest fires is by using a GIS application [2]. GIS (Geographic Information System) is a computer-based information system that is used to process and store geographic data or information. GIS can be used to identify disaster-prone areas, especially forest fires. Forest fires in the Riau area are prone to fires or frequent fires. However, the community is minimally aware of the existence of forest fires in the vicinity because of the lack of information media about where the hotspots of forest fires occur. This application, it can help the people of Samboja to better know where the location of the forest fire occurred. GIS (Geographic Information System) is a computer-based information system that is used to process and store geographic data or information. GIS can be used to identify disaster-prone areas, especially forest fires. Forest fires in the Riau area are prone to fires or frequent fires. However, the community is minimally aware of the existence of forest fires in the vicinity because of the lack of information media about where the hotspots of forest fires occur. This application, it can help the people of Samboja to better know where the location of the forest fire occurred one of the human-caused fires is the burning of communities around the forest to reclaim or clear agricultural land or artificial forests. The community believes that the use of fire to clear land will not take long and is more economical.

2. Literature Review

2.1 Android

Android is a Linux-based operating system for mobile phones (such as smartphones and tablets). Android provides an open platform for developers to create their applications for diaries used by various mobile devices. Initially, Google Inc. acquired Android Inc. Then developed Android and founded Open Mobile Alliance, which consists of 34 hardware, software, and telecommunications companies [3]. There are two publishers for the Android operating system. The former is fully supported by Google or Google Mail Services (GMS), the second is completely freely distributed without support directly from Google, called Open Handset Distribution (OHD). Features on Android include:

- a) One kind. The application framework allows recycling and replacement of components.
- b) An integrated browser based on the open-source WebKit engine, which is also used in iPhone and Nokia S60v3
- c) Phone design. This platform can adapt to the needs of the VGA graphics library (Video Graphics Adapter), larger 2D and 3D based on the OpenGL ES 1.0 and specifications traditional smartphone layout.
- d) Multi touch. Android has built-in support for multi-touch and the latest phones (like HTC Hero) provides multi-touch.
- e) Additional hardware support. Android supports the use of cameras, touch screens, GPS (Global Positioning System), speedometer, magnetometer, 2D bit acceleration (with hardware orientation, zoom, pixel format conversion) and 3D graphics acceleration [4].

2.2 System Design

2.2.1 GIS (Geographic Information System)

ESRI (Environmental Systems Research Institute) defines GIS as a collection of organized hardware, software, geographic data, and computer personnel, which can be effectively designed to acquire, store, update, operate, analyze, and display various forms of personnel geographic reference information. GIS is a system for processing geographic information. Based on technology and information, GIS can be divided into three applications, namely desktop-based GIS (Desktop GIS), web-based GIS (Web GIS), and mobile-based GIS (Mobile GIS) where the three are interconnected [5]. Mobile GIS is integration between mobile device technology, Global Positioning System (GPS) and wireless communications used to access GIS Internet. Combination of This technology enables mobile GIS to accurately capture, store, update, manipulate, analyze, and display geographic information. By In this way, technology can also create databases that can be directly accessed by field personnel anytime and anywhere. The system can add real-time information to the database and the application is based on the speed of access, display, and decision making. Mobile GIS defined as the integration of hardware and software practices to access data and geospatial services via mobile devices via wired or wireless networks [6]. GIS can be presented in the form of desktop applications or Android-based applications. GIS can also explain an event, make forecasts of events, and other strategic planning and can help analyze common problems such as economic problems, population, social governance, defense, and tourism [7]. Using geographic information systems to perform accurate mapping, where The Geographic Information System in this monitoring system can determine coordinate points automatically quickly and precisely which will later be stored in the database making it easier to mapping of fire points in the Samboja area.

2.2.2 Databases

A database is a container or a gathering place for tables with attributes and data. Tables in databases are interrelated to form the information required by the user. Information display processed using applications or computer programs [8]. Using geographic information systems to perform accurate mapping, where the Geographic Information System in this monitoring system can determine the coordinate points quickly and precisely which will later be stored in the database so that making it easier to map fire points in the Samboja area [9].

2.2.3 Databases

A database is a container or a gathering place for tables with attributes and data. Tables in databases are interrelated to form the information required by the user. Information display processed using applications or computer programs [8]. Using geographic information systems to perform accurate mapping, where the Geographic Information System in this monitoring system can determine the coordinate points quickly and precisely which will later be stored in the database so that making it easier to map fire points in the Samboja area [9].

2.2.4 Databases

A database is a container or a gathering place for tables with attributes and data. Tables in databases are interrelated to form the information required by the user. Information display processed using applications or computer programs [8]. Using geographic information systems to perform accurate mapping, where the Geographic Information System in this monitoring system can determine the coordinate points quickly and precisely which will later be stored in the database so that making it easier to map fire points in the Samboja area [9].

2.2.5 Google maps API

An API or application programming interface is a document that contains interfaces, functions, class, structure, etc. Used to build software, using APIs, programmers can more easily "disassemble" software so that it can be developed or integrated with other software. API can connect an application with other applications that allow them to use system functions [10]. This process managed by the operating system, the advantage of this API is that it allows applications to associate and interact with other applications. Programming language used Google Maps consists of HTML, Javascript, AJAX, and XML which can display Google Maps on other sites [11]. Google also provides Google Maps API services, and developers can integrate Google Maps into their website by adding their data points alone. By using the Google Maps API, Google Maps can be displayed on websites external. In this application, each point will be mapped on a digital map via the Google Map API. The design of the GIS architecture for this monitoring can be seen in the following Fig. 1.

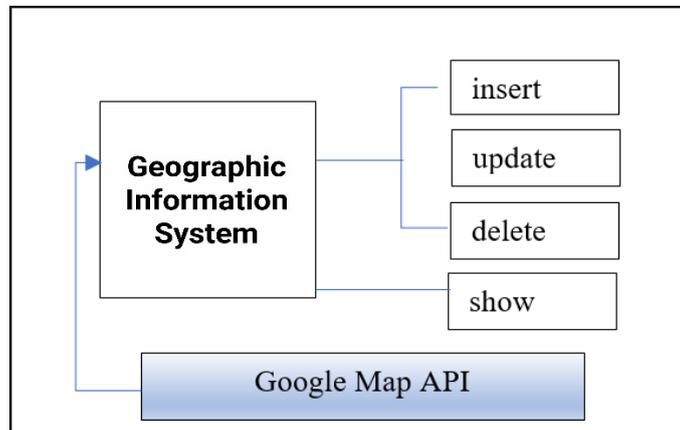


Fig. 1. Google Map API System Architecture

2.3 Firebase

A Firebase database is a non-SQL database store that can be used to store various types of data. These data types include String, Long, and Boolean. Data in database Firebase is stored as a JSON tree object. After adding data, this will be a node in the JSON structure. Nodes are nodes that contain data and can have branches in the form of nodes containing data. The process of entering data into the Firebase database is called "pushing." Besides Firebase database, Firebase also provides several other services that are also used in the development of this application. This service includes Firebase authentication, storage, and messaging cloud [12]. Firebase is a platform for real-time applications. When the data changes, the apps that connect to Firebase will update it directly through every device on the website or mobile devices [13]. This forest fire monitoring application uses Firebase as a tool database to store data. This Firebase database has 2 tables, namely admin and user can be seen in the following table 1 and table 2.

Table 1. Admin

Field	Description
email	E-Mail Administrator
password	Password Administrator

Table 2. User

Field	Description
Id	Id <i>user</i>
date	Accident date
O'clock	Accident Hour
Fire Location	Location Of Fire
Fire Location Latitude	Latitude
Fire Location Longitude	Longitude
Phone number	<i>User Phone number</i>
Cause Of Fire	The Cause Of The Fire
status	Fire Status
email	E-Mail <i>Administrator</i>
Password	Password <i>Administrator</i>

3. Methodology

The methodology steps are as follows:

- Planning Stage. This stage is the preparation of several plans for research activities as a whole and solutions used to solve problems.
- Identification Stage. This stage analyzes the resource requirements needed to solve the problem, including what needs are needed in research, including hardware and software.
- Design Stage. The application design stage uses architectural design and interface design.
- Beta Application Development Stage After knowing what parts have been determined to be made, at this stage Applications are made using existing designs.
- Testing Stage. After the program has been written, the application is ready to run, this stage includes testing an application that includes the compatibility between the design and the expected system capabilities with the implementation and capabilities of the resulting system.
- Application Development Stage. We have tested this development stage and then see what the shortcomings of the application are.
- Implementation. This stage is a form of the application of a forest fire monitoring system based on android to be made, where this is the most decisive stage the success of making an Android-based forest fire monitoring system application that has been previously designed. The design of the methodology can be seen in the following Fig. 2.

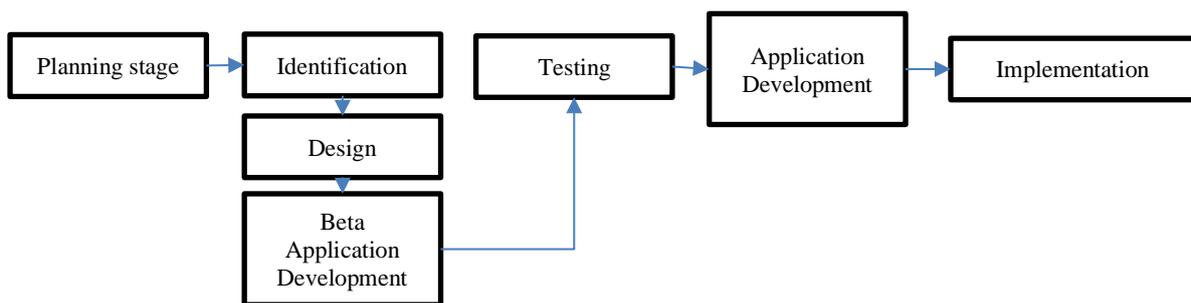


Fig. 2. Methodology

4. Result and Discussion

4.1 Flowchart

At this stage is the creation of a Flowchart of the system from the Fire Monitoring application Forest after completion of the design and planning stages. Analyzing the needs and the system will be used in the process of making the Forest Fire Monitoring application continuously detailed, besides that it can also provide an overview of what information can be obtained generated by the designed system. For more details, it will be explained later each flow of the system flowchart running on the system. This part of the flowchart describes the system flow of the Android-Based Forest Fire Monitoring Application. The design of the admin and user flowchart can be seen in the following Fig. 3 and Fig. 4.

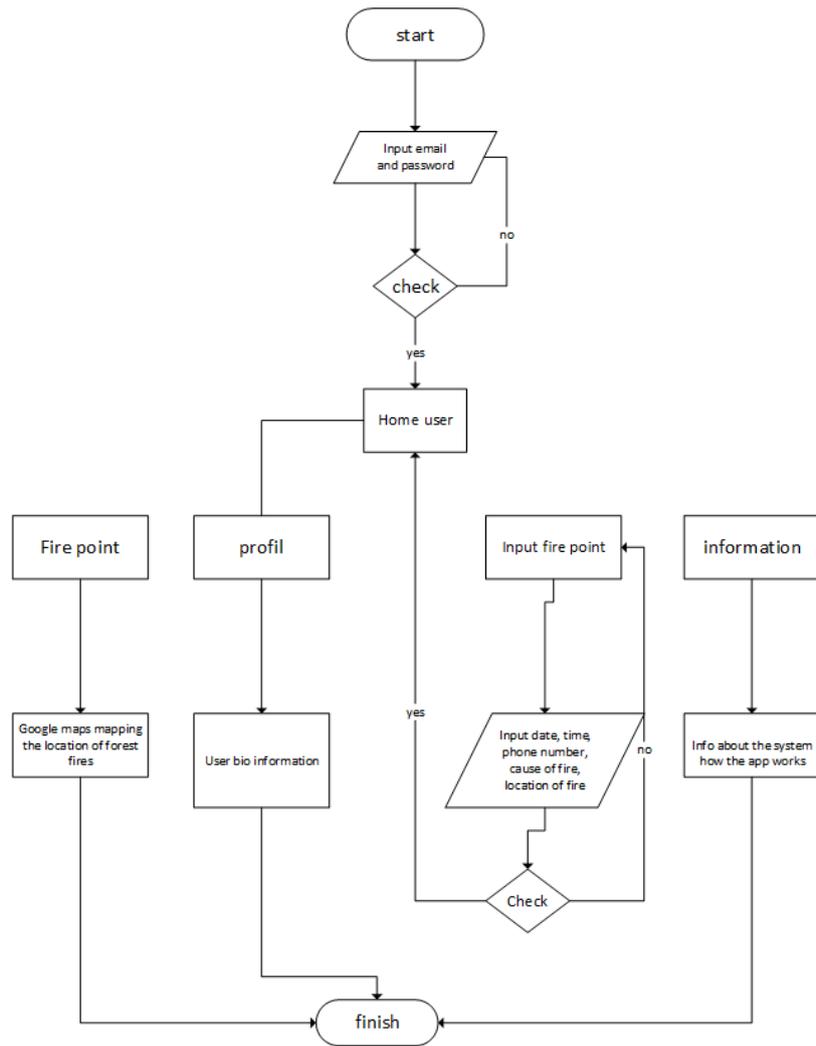


Fig. 3. Admin Flowchart

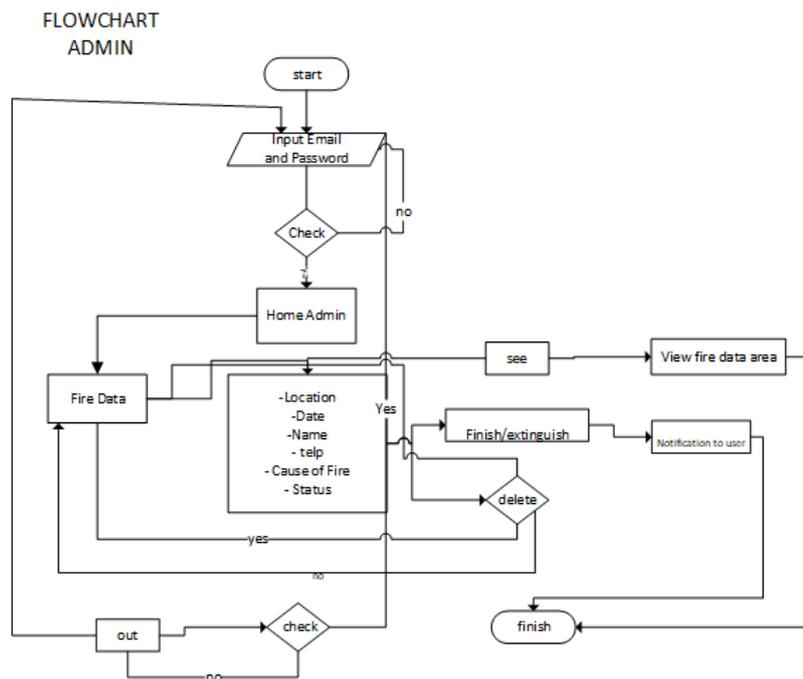


Fig. 4. User Flowchart

4.2 Use Case Diagram System

There are 2 levels of access, namely: Admin and User, each has its role. In access level users can register an account first to be able to use the application, at the admin access level, the administrator can manage data from users such as see the location area that has been inputted by the user, at the access level, complete the demo of the hotspots, what have you done processed or extinguished. The design of use case can be seen on Fig. 5.

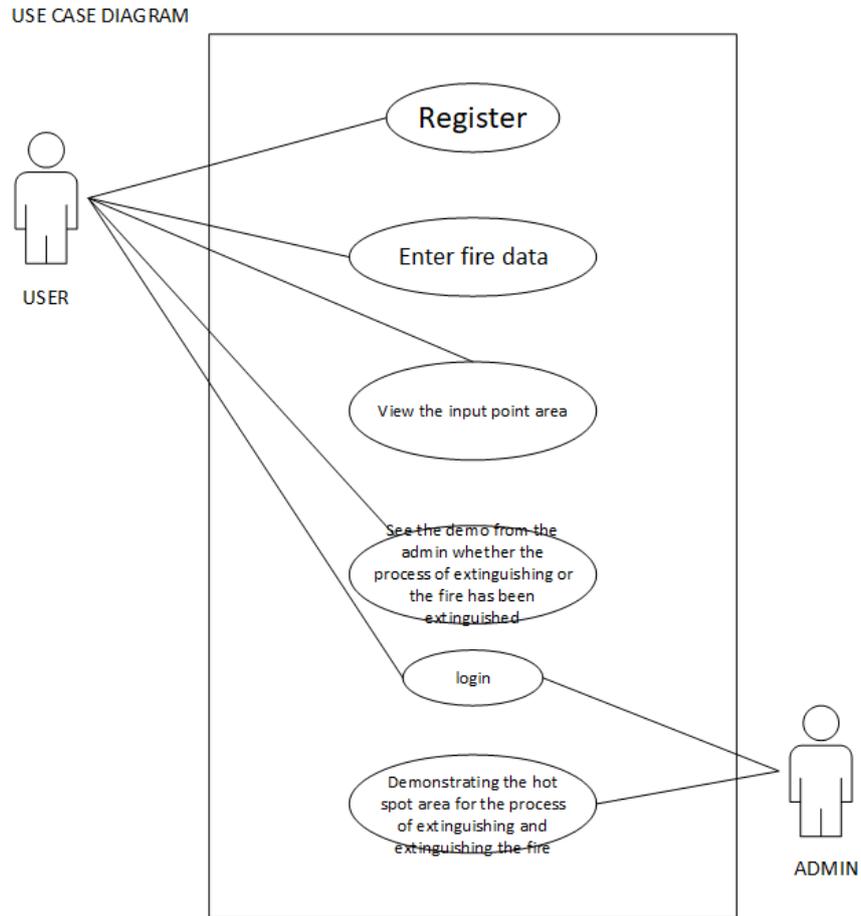


Fig. 5. Use Case Diagram

4.3 Application Interface

The Admin Login functions so that administrators can enter the system. The design can be seen on 6 (a). Here when a user wants to use the app but doesn't have an account yet, they can register and fill in the available data. The design can be seen on 6 (b). When the user wants to use the application, he must first log in using an account that has been registered they register, the design can be seen on Fig. 6 (c).

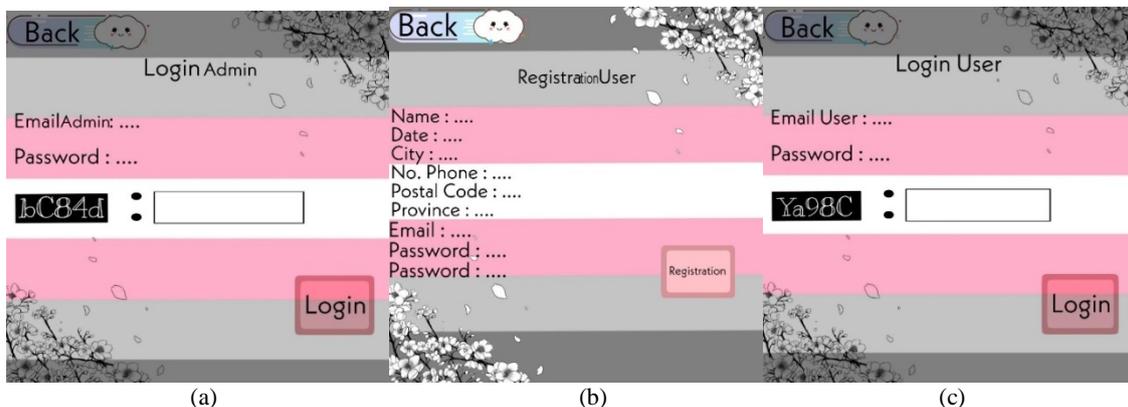


Fig.6. Admin Login (a), user registration (b), and user login (c)

4.4 Application Implementation

The following is the implementation of the Android-Based Forest Fire Monitoring System.

- a. After logging in, the admin will move to the Home page of the system admin 7 (a).
- b. The user's home display, where there are hotspots, profiles, input fire points, and Info 7 (b).

The design of display home and home user can be seen on Fig. 7.

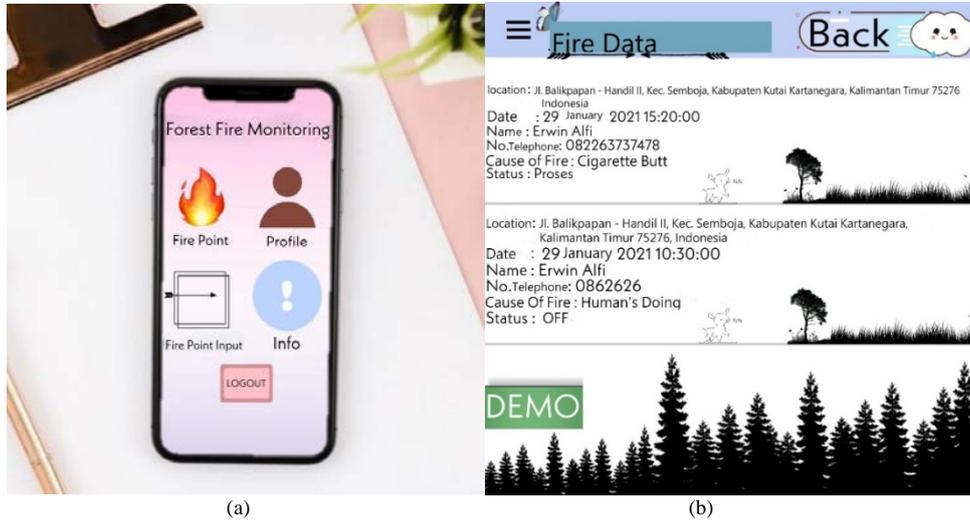


Fig.7. Display Admin Home (a) and User Home (b)

The design of Fire point input and Fire point location can be seen on Fig. 8.

- a. Input Hotspots here, if the user sees a fire, they can input the hotspots after do registration. There are several inputs such as date, time, phone number, cause fire, fire location 8 (a)
- b. Hotspots here see the hotspot location area entered by the user 8 (b)

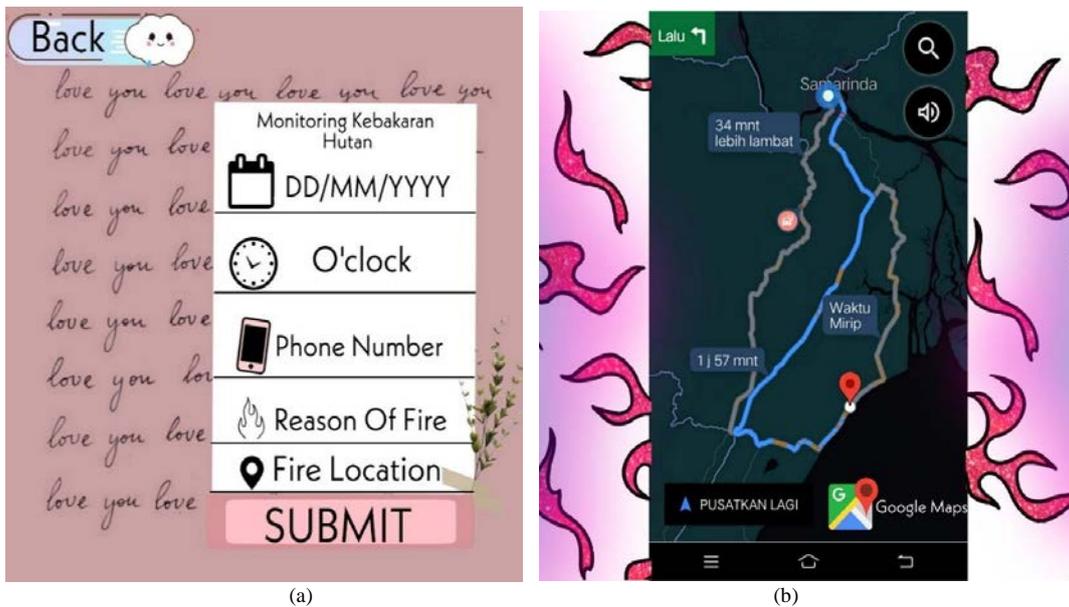


Fig. 8. Fire point input (a) and Fire point location (b)

4.5 Testing

Testing on applications that have been made to test whether the application is running properly with the desired. The test results using the white box testing method can be found in the following table. The testing table can be seen on table 3.

Table 3. The Result for Android Based Forest Fire monitoring application

Test	Input	Output	Result
Test Admin	Enter email and password admin	Admin start page	fail
Testing fire list data	See the location data input from the user	Location visible	succeed
Testing fire list data	Turn off	Blue fire location sign (process blackout)	succeed
Testing fire list data	Finish	Green fire location sign (fire extinguished)	succeed
Testing fire list data	Delete fire data	Data deleted from database	succeed
Test button function go out	Go out	Move to Login page Admin	succeed
Testing User Apps	Register and login into the application	Get an account and move to home user	succeed
Testing the Register menu function on the login page user	Enter full name, note, email, password	User registration is stored in database	succeed
Testing the Forgot Password menu function on the login page	Enter email	Send a message to email user in the form of a link	succeed
Testing the function of the hotspot input button	Input date, time, note, cause of fire, location	Submit fire data	succeed
Testing the dot menu function fire	View location area input fire from user	Location visible	succeed

5. Conclusion

This forest fire monitoring system is designed using a simple design so that can be understood [14-20]. In the display of this forest fire monitoring system, there must be registered so that people can register and can use the system, must use email valid. After the account is successfully registered, if there is a forest fire in the area, you can enter the data that is already available, and the data automatically issues a notification to admins. And the data will be followed up by the admin before being displayed This Forest Fire Monitoring System was created using Android Studio as application manufacture, where the programming language uses the Java language. For storage database using Firebase, as data storage in real-time using data synchronization every time we make data changes and Google Maps API for location points.

References

- [1] P. Proctor, P. C. Van Deusen, L. S. Heath, and J. H. Gove, "The Open-Source Movement: An Introduction for Forestry Professionals," pp. 203–208, 2003.
- [2] P. Wikström *et al.*, "The heureka forestry decision support system: An overview," *Math. Comput. For. Nat. Sci.*, vol. 3, no. 2, pp. 87–95, 2011.
- [3] I. Zamula, M. Tanasiieva, V. Travin, V. Nitsenko, T. Balezentis, and D. Streimikiene, "Assessment of the profitability of environmental activities in forestry," *Sustain.*, vol. 12, no. 7, pp. 1–15, 2020, doi: 10.3390/su12072998.
- [4] B. Felbermeier, A. Hahn, and T. Schneider, "Study on User Requirements for Remote Sensing Applications in Forestry," *ISPRS TC VII Symp. – 100 Years ISPRS*, vol. 38, p. 7B, 2010, [Online]. Available: http://www.isprs.org/proceedings/XXXVIII/part7/b/pdf/210_XXXVIII-part7B.pdf.
- [5] A. Jaafari, J. Rezaeian, and M. S. Omrani, "Spatial prediction of slope failures in support of forestry operations safety," *Croat. J. For. Eng.*, vol. 38, no. 1, pp. 107–118, 2017.
- [6] G. Schüller, "Identification of flood-generating forest areas and forestry measures for water retention," *For. Snow Landsc. Res.*, vol. 80, no. 1, pp. 99–114, 2006.
- [7] T. Zhang and Z. Tao, "The channels and demands analysis for Chinese farmers' agricultural information acquisition," *International Journal of Wireless and Microwave Technologies*, vol. 2, no. 3, pp. 56–61, 2012.
- [8] K. Hamzah, "Remote Sensing, GIS and GPS as a Tool To Support Precision Forestry Practice in Malaysia," *Pap. Present. 22nd Asian Conf. ...*, no. November, pp. 5–9, 2001, [Online]. Available: <http://www.a-a-r-s.org/acrs/proceeding/ACRS2001/Papers/FRR1-03.pdf>.
- [9] L.-juan QIAO, X.-song JIAO, and Y.-na Du, "Research on implementation of undergraduate tutorial system in economy and management specialty in the Agricultural and Forestry University," *International Journal of Education and Management Engineering*, vol. 2, no. 2, pp. 34–41, 2012.
- [10] E. Istomin, S. Stepanov, Y. Petrov, O. Kolbina, and A. Sidorenko, "Model of optimum integration of diverse geodata for the benefit of management of forestry," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 316, no. 1, 2019, doi: 10.1088/1755-1315/316/1/012013.

- [11] S. Tang, L. Tang, G. Shao, and L. Dai, "Digital forestry research in China," *Sci. China, Ser. E Technol. Sci.*, vol. 49, no. SUPPL. 1, pp. 1–8, 2006, doi: 10.1007/s11431-006-8101-5.
- [12] E. Chuvieco *et al.*, "Development of a framework for fire risk assessment using remote sensing and geographic information system technologies," *Ecol. Modell.*, vol. 221, no. 1, pp. 46–58, 2010, doi: 10.1016/j.ecolmodel.2008.11.017.
- [13] R. Epstein *et al.*, "A combinatorial heuristic approach for solving real-size machinery location and road design problems in forestry planning," *Oper. Res.*, vol. 54, no. 6, pp. 1017–1027, 2006, doi: 10.1287/opre.1060.0331.
- [14] M. Simanjuntak, A. Daryanto, and T. Rusolono, "Forestry Company Satisfaction Towards Online Information System Implementation of Forest Product Management (Si-Puhh)," *Indones. J. Bus. Entrep.*, vol. 2, no. 1, pp. 12–22, 2016, doi: 10.17358/ijbe.2.1.12.
- [15] B. Woziwoda, M. Potocki, J. Sagan, Z. Michał, R. Tomusiak, and S. Wilczyński, "Commercial forestry as a vector of alien tree species -the case of *Quercus rubra* L. Introduction in Poland," *Balt. For.*, vol. 20, no. 1, pp. 131–141, 2014.
- [16] S. Ionut and M. Bogdan, "Geographic information system (GIS) application for windthrow mapping and management in Iezer Mountains, Southern Carpathians," *J. For. Res.*, vol. 23, no. 2, pp. 175–184, 2012, doi: 10.1007/s11676-011-0213-5.
- [17] D. L. Martell, "A review of recent forest and wildland fire management decision support systems research," *Curr. For. Reports*, vol. 1, no. 2, pp. 128–137, 2015, doi: 10.1007/s40725-015-0011-y.
- [18] E. Prolonged, "California Department of Forestry and Fire Protection," no. 916, p. 2019, 2014.
- [19] J. S. Fried, J. K. Gillies, and R. E. Martin, "PSW-101 Berkeley, CA. Pacific Southwest Forest and Range Experiment Station," *Gen. Tech. Rep.*, pp. 212–217, 1987.
- [20] D. Martell, "The development and implementation of forest fire management decision support systems in Ontario, Canada: Personal reflections on past practices and emerging challenges," *Math. Comput. For. Nat. Sci.*, vol. 3, no. 1, pp. 18–26, 2011.

Authors' Profiles



Reza Andrea earned his Bachelor's degree from Computer Science, Mulawarman University in 2012. In 2013 he was involved in a game development project as a leader of Bibir Design Studio and he was awarded the best 2D game developers of Indonesia Game Show (IGS). In 2014, Reza Andrea earned his master's degree in business engineering from Department of Computer Engineering, STMIK Eresha, Jakarta. Now, he is a lecturer in Software Engineering Department in Polytechnic Agriculture of Samarinda and Expert Staff of Research Department in STMIK Widya Cipta Dharma.



Ade Irma Wahyuni was born in Bontang December 18 1999. I am currently studying at the Samarinda State Agricultural Polytechnic majoring in software engineering technology. During college, I participated in various campus activities such as dancing, English club, and Student Execution Agency. I have a hobby of cooking, singing and dancing. I am the second of three siblings. I am Javanese and Padangnese but I was born and raised in Bontang. My favorite color is red. I like traveling to some beautiful places in Indonesia. I also like to play games and photography, the games I often play are mobile legends and I like to capture beautiful things that I meet through photos.



Supryani was born in Samarinda on April 10, 2001. She's activities are studying, running a business, organization. She has a future desire to open his own shop and booth, so she can help people who don't have jobs. Keep the spirit even though the are many obstacles that must be passed. Now the activity that I actively participate in is the Indonesian Red Cross Voluntary Corps organization. This activity was carried out on my campus. From here I learned what it means to be together and work together to help others. Not only on campus. This organization also often holds off-campus activities such as visiting nursing homes.



Nur Fadila Safitri was born in Mojokerto on January 4, 2001. She is a student of Software Engineering Technology, Polytechnic of Agricultural, Samarinda since 2019. She is a graduate of Madina Boarding School Samarinda and became one of the students with the best grades and memorization. She really likes sports especially playing basketball and table tennis. Now she is active in an external campus organization, namely Indonesian Muslim Student Action unit (KAMMI) Samarinda.

How to cite this paper: Reza Andrea, Ade Irma Wahyuni, Nur Fadila Safitri, Supryani, " Android Based Forest Fire Monitoring System", *International Journal of Information Engineering and Electronic Business(IJIEEB)*, Vol.14, No.3, pp. 1-9, 2022. DOI: 10.5815/ijieeb.2022.03.01