

# IMPLEMENTATION ROAD QUALITY DETECTION USING ACCELEROMETER AND PHOTO TAGGING BASED ON ANDROID AT CV.NGESTI UTAMA

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## ABSTRACT

The rapid development of technology affects humans in carrying out almost all jobs by utilizing technology, this is because it can simplify and shorten the time of work and the costs incurred become less. Likewise in the survey of road construction projects carried out by CV. Ngesti Utama, based on the results of interviews conducted with employees in charge of field implementers assessing that it still takes a lot of time and a large cost burden when conducting survey activities on the location of road construction projects. As a company engaged in construction services, CV. Ngesti Utama is the location of case studies to implement android-based applications as road quality detectors utilizing accelerometer and photo tagging in the process of road construction activities, especially pre-construction road conditions survey activities. Smartphones with road quality detection applications are paired on car vehicles with phone holders to record shocks that occur during driving vehicles based on road conditions traveled by vehicles and applications can photograph damaged road conditions and find out the location point of GPS based road conditions.

**Keywords :** Accelerometer, Photo Tagging, GPS, Vehicle, Project, Construction.

## 1. INTRODUCTION

### 1.1 Background

CV. Ngesti Utama is a company engaged in construction services located in Ngestiharjo Wates, Kab. Kulon Progo, D.I Yogyakarta. The usual projects handled by CV. Ngesti Utama includes road construction, road reconstruction, and building construction.

In carrying out construction projects, it requires very careful preparation so that when the project implementation process goes well without obstacles, then before implementing a project, the contractor must conduct a field survey or know in advance all the

conditions of the project activity location so that the handling should be done by the company and will affect the planned costs that will be incurred during the course of a project.

Based on the results of the interview with Mr. Surtpto on August 7, 2018 as the person in charge of the CV.Ngesti Utama field implementer, a problem was found. After reporting the road condition in the form of photographs, the officers still found it difficult to find out the location or name of the damaged road, because the damaged road report was not include the name of the street or location, still in the form of photographs stored in the storage or smartphone gallery, this results in the preparation of irregular photo documentation of the project, officers must first sort photos of related projects that have been collected as reports.

Based on the problems that have been described, it can be concluded that the need for an application that can facilitate the process of surveying the quality of the highway before the project takes place and can provide location information on a photo taken by the officer so that the location of the photo is easy, because the officer using a smartphone as a reporting medium, this application will be made on an Android basis, to answer the first problem, namely the survey process of road quality conditions that are still manual.

Based on the research of Yuchuan (2014) this application utilizes an accelerometer and GPS sensor on an Android smartphone as a measure of road quality [1]. By assessing the shocks that occur on the Y-axis and Z-axis of the vehicle caused by holes or road bumps during the implementation of the survey [2] [3]. and in road quality assessments, researchers used the International Roughness Index (IRI) as a road quality reference index, this assessment has been widely used for road infrastructure maintenance and long road condition monitoring [4] [5].

Then the photo tagging technology is to answer the second problem, namely the process of pinning location information based on GPS in the image taken by the surveyor's survey. Nurzaman (2017) states that photo tagging technology is needed because it can describe the condition of an event in real time.

## 1.2 Purpose and Objectives

Based on the problems described, the purpose of this thesis is to build a road quality detection application utilizing accelerometer and photo tagging. The objectives to be achieved from the construction of the application for detecting the quality of this road include:

1. Helping for officers to carry out the road quality assessment process.
2. Helping Officers for officers in the process of documentation of road conditions.
3. Helping officers to know the locations of damaged roads.

## 1.3 Software Development Method

The method of building software applications is using the Waterfall method. Waterfall method is a classic model that is systematic, sequential in building software, starting with determining the requirements so that the functional and non-functional requirements can be obtained, and continue to enter the design phase which includes system design and interface. The next stage is implementation, namely the development of applications from designs that have been made. After implementation, the application is tested by giving questions before and after students use the learning media, to see whether this learning media is successful or not in achieving its objectives. The last step is maintenance periodically to improve application functionality.

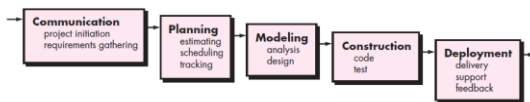


Figure 1. Waterfall Method

# 1 Content of the Study

## 2.1 Application

Application is computer software that is composed of a collection of instructions or statements (statements) so that the computer can process the input into output. Based on the Large Dictionary of Indonesian Language, Applications are computer programs that are built to work on, implement and facilitate specific tasks of the user.

## 2.2 Android

Android is an operating system used by mobile devices based on Linux, Android is designed for touch screen devices such as smartphones and tablet computers, including operating systems, middleware and applications. Android is open for developers (developers) to create their own applications. Initially, Android was developed by Android Inc. financially supported by Google which then bought it in 2005. Officially the Android operating system was released

in 2007 and formed the Open Handset Alliance which is the consortium of companies of software, hardware and telecommunications, aiming to advance the standards of mobile devices.

In September 2007, Google then introduced Nexus One, one of the mobile devices that uses Android as the device's operating system. Nexus One was produced by HTC Corporation and marketed on January 5, 2008.

## 2.3 Accelerometer

Accelerometer is a sensor or transducer device that functions to measure acceleration, detect vibration and measure it, and measure acceleration due to Earth's gravity. In this study, the accelerometer is used to detect vibrations from a vehicle due to a broken hole or road.

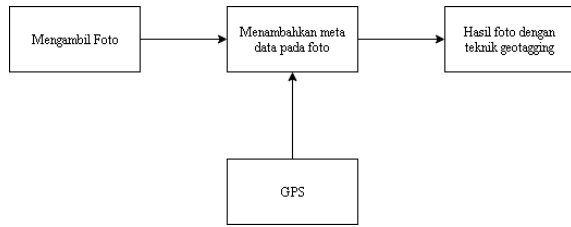
Acceleration is a state of change in speed with time, If the speed is slowing down than the previous speed, it is called deceleration. Acceleration depends on direction or orientation because of the decrease in speed which is a vector quantity.

Today's smartphones generally have an Accelerometer sensor for various needs such as changing the screen display from portrait to landscape or vice versa by tilting the cellphone's body, this occurs because there is a change in the x, y, z coordinates of a Smartphone

## 2.4 Photo Tagging

Photo Tagging is a technique of embedding information in a digital photo, can information about identifying one's identity, color recognition, objects to embed GPS data position information (Latitude, Longitude, Altitude) in this study photo tagging used is embedding location or position information a digital photo called Geotagging Technology.

Geotagging is the process of embedding or adding metadata information such as time and coordinates to the media in a digital photo, to find out the location where and when the photo was taken. Smartphones that support internal GPS receivers generally have a photo tagging feature. Photo tagging mechanism is when a photo is taken by a user using a smartphone digital camera, the camera or smartphone will record a lot of information. The information is in the form of time and data when a photo is taken, as well as the orientation of the camera (portrait or landscape), whether shooting using flash lights and other camera details used such as Exposure, Aperture, and Local Length. All this data is stored in a place called EXIF Headers.



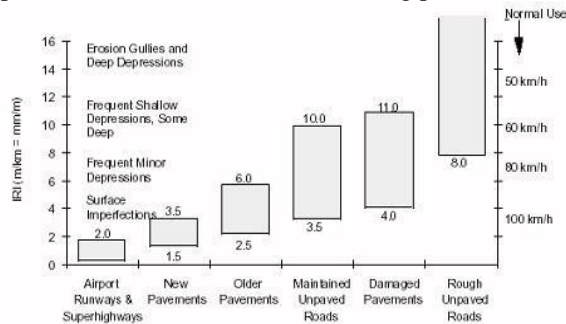
**Figure 2 Geotagging Technology Flow**

## 2.5 Road

Road is a transportation infrastructure for land vehicles that covers all parts of the road, including complementary buildings and equipment intended for traffic, which is at ground level, above ground level, the quality of road surface is assessed from the flatness condition of a road whether it is good with flat surface and not hollow or damaged caused by a hole. In this study, the type of road assessed for quality is the type of asphalt road and concrete road.

## 2.6 International Roughness Index (IRI)

The International Roughness Index is a road unevenness parameter calculated from longitudinal measurements of road conditions with accumulated output from four-wheeled vehicles and divided by distance or length of road conditions using GPS location point data to produce a summary of inequality indexes with slope units. The smaller the IRI value, the better the quality of the road [4]. The IRI index parameter can be seen in the following picture:



**Figure 3. IRI Parameter Value**

## 2.7 Camera

The camera is a device that serves to capture an object into an image in the form of a place or event that is the result of projection from a lens. The working principle of the camera has similarities with the eyes. A camera lens is a part of a camera that has a function to form a shadow, similar to a lens in the eye. The results of photos or recordings taken by digital cameras or smartphones have the same format, only different from the quality.

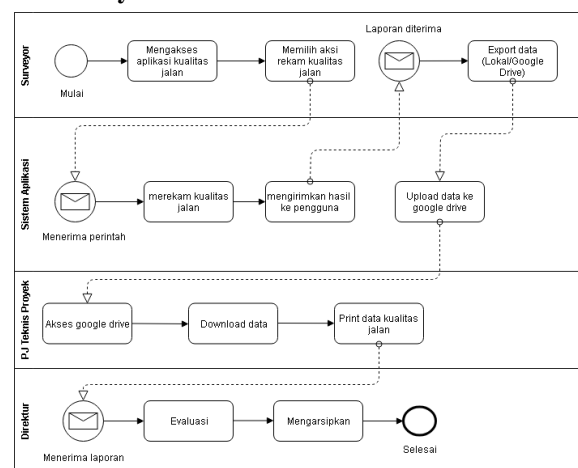
In this study, the camera is used as a tool to take pictures of the conditions of damage - road damage found by the user.

## 2.8 Global Positioning System (GPS)

GPS is a satellite navigation system that provides coordinate information for a location and time in any weather conditions, anywhere on the surface of the earth, as long as it still receives GPS signals emitted by satellites. To be able to find out the position of a person or a device, a tool called a GPS receiver is needed to receive signals sent by GPS satellites. The position is in the form of coordinate points in the form of a latitude position called latitude, and the position of longitude or longitude from a person's position or a location which will then appear on the electronic map screen. GPS receivers consist of several integrated circuits (IC). GPS can be used for various purposes, such as cars, ships, aircraft that can be integrated with a computer or mobile device.

GPS can work in a variety of weather conditions, day and night. GPS has an accuracy of 15 meters from the actual point, with the development of the latest model equipped with Wide Area Augmentation System (WAAS) technology, its accuracy in detecting locations can reach 3 meters. Because GPS works on satellites, the use of GPS is recommended in an open place. GPS accuracy will not be optimal if it is used in a closed place such as a building or room. Accurate time calculations will determine the accuracy of calculations in determining location information. The more satellite signals received, the more precise position data will be generated. In addition, altitude also affects the GPS work process, the higher the location point, the wider the space, so that the interference is less.

## 2.9 Analysis of Procedures to be Built



**Figure 4. The Concept of the System to Be Built**

Analysis of procedures to be built contains a big picture of the procedure to be built. The procedure to be built consists of 4 (four) actors who will carry out company procedures. The following is an explanation regarding the drawing of the procedure to be built.

1. The Officer / Surveyor accesses the road quality application
2. The Officer / Surveyor chooses the road quality record menu
3. The application system responds to the command given by the officer
4. Road quality recording system
5. The system sends road quality record data to the user / officer
6. The Officer / Surveyor receives road quality record data
7. The Officer / Surveyor exports road quality record data to Google Drive by naming the files specified by the Director
8. The system uploads the road record data to Google Drive
9. The Project Technical Officer / Pj accesses the google drive on the computer
10. Project Technical Officer / Pj downloads road quality record data
11. Project Technical Officer / Pj prints road quality record data
12. The Project Technical Officer / Pj provides the road quality record data file to the Director
13. The director receives the road quality record data file, evaluates the data then files

3. Android devices request map services, Google Maps API provides service maps
4. The device exports data to the Google Drive storage media
5. The application detects vibrations that occur while the vehicle is running
6. The device is in a vehicle

### 2.11 GPS Analysis and Google Map

The Global Positioning System (GPS) is used by a system to detect the coordinates or location of a device in the process of calculating the distance and speed of a vehicle that moves from the starting point to the end point. Besides measuring distance and speed, GPS functions to indicate the coordinates or location of photo tagging which will then be visualized on Google Maps. The use of GPS technology can be seen in the following figure.

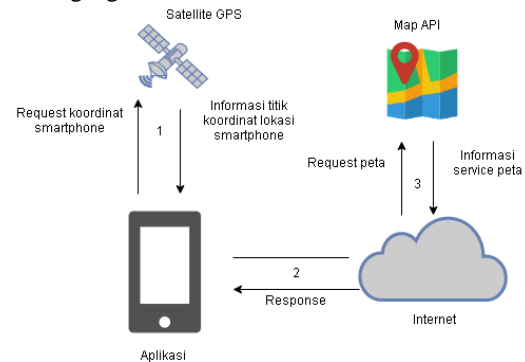


Figure 6. GPS analysis

### 2.10 Arsitektur Sistem

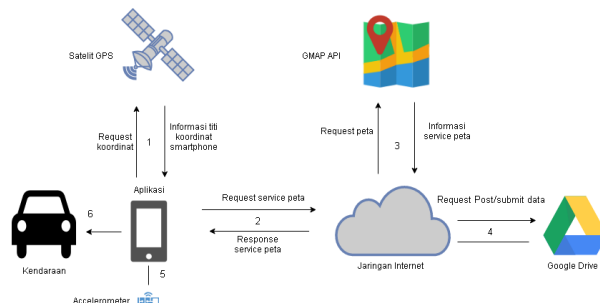


Figure 5. System Architecture

In figure 6 there is an overview of system architecture consisting of vehicles, smartphones and the internet that are connected with GPS Satellite, API and Google Drive. The explanation of the system architecture images is as follows.

1. Android device asks for smartphone coordinates, satellite gps gives the position of smartphone coordinates.
2. Android devices enter the internet network

### 2.12 Geotagging Technology Analysis

GPS Photo Tagging, also known as geotagging, is the process of embedding GPS data position information (Latitude, Longitude, Altitude) in a digital photo. The way geotagging works on this system is when a user takes a photo of a damaged road with a cellphone camera whose geotagging feature has been turned on, simultaneously the cellphone will attach data coordinates (latitude, longitude) to the photo. Where the coordinate data (latitude, longitude) added to the photo will be stored with other photo captions data, such as the date of taking photos, dimensions, exposure, ISO and aperture at a location called EXIF Header. The coordinate data on the EXIF Header will be used by the officer to find out the location of the damaged road that has been reported.

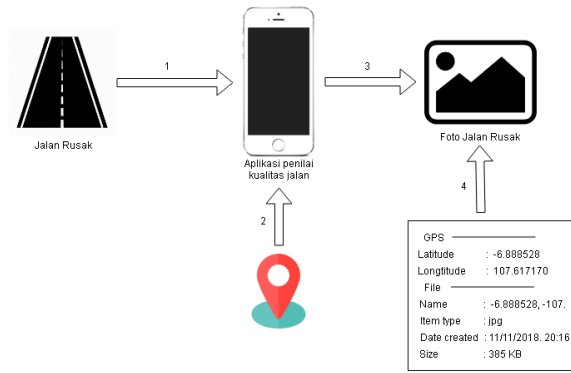


Figure 7. Geotagging Technology Analysis

### 2.13 Use Case Diagram

Use case diagrams are used to find out what can be done by the user or actor on the functionality contained in the application designed.

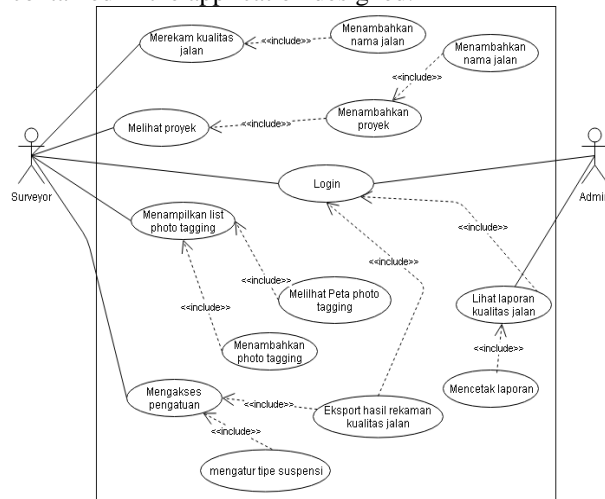


Figure 8. Use Case

### 2.14 Road Quality Assessment Analysis

Based on the IRI explanation, the sum of all sampling intervals, then divided by the value of the distance (S) with the count:

$$IRI = \frac{\sum_{i=2}^n Vh_i}{S} = \frac{\sum_{i=2}^n |h_i - h_{i-1}|}{S} \quad (2)$$

When calculating IRI, it takes the total distance traveled (S) and the result of the vertical accelerometer transfer to each sampling time. Mileage can be calculated via GPS. However, vertical displacement is not a value that can be obtained directly and derived from the results of the accelerometer sensor, in known physics formulas:

$$Vv = \frac{dvh}{dt}$$

$$\alpha v = \frac{dvv}{dt} = \frac{d^2vh}{dt^2} \quad (3)$$

Where t is time, Vv is vertical speed,  $\alpha v$  is vertical acceleration, and Vh is vertical displacement. Then:

$$\sum Vh = \iint_{t_{awal}}^{t_{akhir}} |\alpha v| (dt^2) \quad (4)$$

By adding the distance traveled, the above formula can be summarized as follows:

$$IRI = \frac{\sum_{i=2}^n Vhi}{S} = \frac{\iint_{t_{awal}}^{t_{akhir}} |\alpha v| (dt^2)}{S} \quad (5)$$

### 2.15 Interface Design

Interface design is done to design the appearance of software applications to be built, designed in such a way as to be able to describe the system needed by the user first. The following is the interface design that describes the android-based road quality assessment application interface.

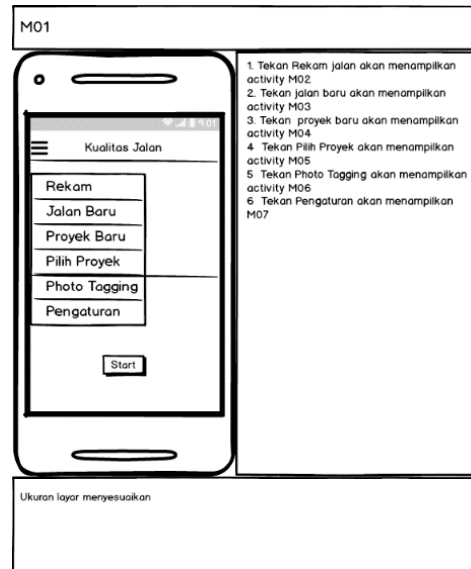


Figure 9. Designing Menu Interfaces

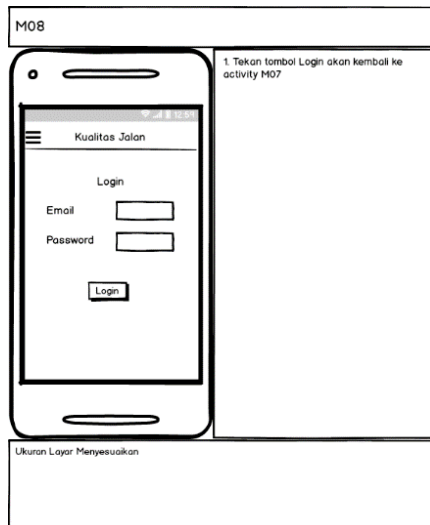


Figure 10. Login Interface Design

### 2.16 Message Design

This is the design of a road quality assessment app.

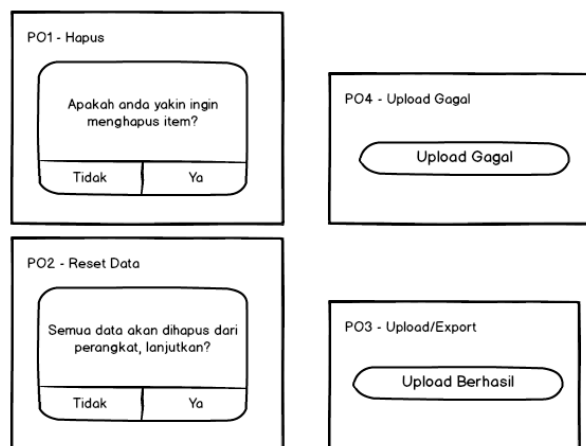


Figure 11. Messages Design

## 3 FINALE

### 3.1 Conclusion

From research, implementation and testing, the authors draw the conclusion that in the research and development of Road Quality Detection Applications in the CV. Ngesti Utama are as follows:

1. Applications that are built using an accelerometer, GPS and Photo Tagging can make it easier for officers to carry out the road quality assessment process.
2. Applications that are built can make it easier for officers in the process of documentation of road conditions.

3. With Photo Tagging Technology implemented in the application can help officers in knowing the locations of damaged road conditions.

### 3.1 Suggestion

To develop a road quality detection application so that the information produced is more complete, the authors provide suggestions that are expected to be realized and form the basis of further research. The suggestions from the author are:

1. Develop a Web Administrator that is integrated directly with the application.
2. Developing accuracy of road quality assessment on two-wheeled vehicles.

### BIBLIOGRAPHY

- [1] Chenglong, Difei, Yuchuan, "Measurement of International Roughness Index by using Z-Axis Accelerometers and GPS," *Hindawi Journal*, p. 10, 2014.
- [2] Sagar, Rahul "Road Bum and Intensity Detection using Smartphone Sensors," *IJIRCCE*, vol. 4, no. 5, p. 8, 2016.
- [3] Yehezkiel, Otniel "Rancang Bangun Sistem Pendeteksi Bump Menggunakan Android Smartphone dengan Sensor Akselerometer," *Jurnal Teknik ITS*, vol. 5, no. 2, p. 6, 2016.
- [4] Mahajan dan D. V, "Estimation of Road Roughness Condition By Using Sensors In Smartphone," *IJCET*, vol. 6, no. 7, p. 9, 2015.
- [5] Harshgandha, "Roadside Quality And Ghat Complexity Analysis," vol. 1, no. 11, p. 5, 2015.
- [6] E. Mulyatiningsih, *Metodologi Penelitian Terapan Bidang Pendidikan*, Bandung: Alfabeta, 2012
- [7] Z. Nurzaman, "Implementation of Geotagging Technology On Traffic Accident Relief Application," vol. 1, p. 8, 2017.
- [8] R. S. Presman, *Software Engineering*, McGraw-Hill Education, 2010.
- [9] Marzuki, "Survei dan Pemetaan Menggunakan GPS dan GIS," 2016.
- [10] S. M. Kaiyue Zang, "Assessing and Mapping of Road Surface Roughness based on GPS and Accelerometer Sensors," *MDPI*, vol. 1, p. 17, 2018.