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Vehicle Speed Observation Models Based on the Data on the Smartphone GPS

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Abstract: The development of GPS (global positioning system) receiver now can be integrated on a smartphone. GPS receiver on smartphones has been developed for location-based applications. Smartphones are very suitable to be used as an experimental tool, because smartphones are usually equipped with various types of sensors. This paper proposes a model observation vehicle speed on a road section based on the GPS data on the smartphone. Observations made by calculating the speed of the speed of vehicles moving through the data transfer at the GPS location of the smartphone, the data are then sent periodically to the server and server processing and storage of vehicle speed data. After tested with test reliability indicators use RMSE, observations with model observations speed, speed based on GPS data on a smartphone are relevant when compared with the speed directly from the vehicle's speedometer with the difference between the value of the difference of speed that is 3.1785 km/h.

Key words: GPS, smartphone, vehicle speed, observations.

1. Introduction

Vehicle speed is the magnitude of the value of the transfer of vehicles at one point to the other can be represented by a unit of time. Observation of the movement of the moving vehicle or speed is generally used to identify the movement of the traffic flow on roads as basic information to road users about traffic conditions [1].

Observation speed of the vehicle can be done by observing directly the so-called Direct Method or by doing observation based on data recorded by using monitoring tools such as monitoring traffic cameras, sensors monitor traffic and spatial data such as traffic monitors specific GPS [2].

GPS receivers are already growing and are now capable of integrated smartphone. A variety of innovations for the development of GPS smartphones have a lot done like vehicle tracking system, GPS on smartphones with media that are used to make it easier to monitor directly the position of the vehicle. On a smartphone GPS system developed to support mobility surveys such as the survey to map the terrain of the land, through GPS on smartphones is very easy to send land survey coordinates so that it makes the data more accurate. Medical activities in a GPS on a smartphone used to line the shortest route search system for ambulance, so the ambulance carrying patients who are able to figure out the quickest path to reach the intended hospital [3-6].

Innovation in the development of GPS smartphones is not just for location-based applications only. GPS on smartphones, allows developed in other innovations such as calculating displacement velocity of the vehicle is moving. Smartphone is very suitable as a tool of experimental, because smartphones usually come with a number of sensors. For example, most smartphones have a microphone, acceleration sensor, magnetic field strength sensor, light sensor and GPS receiver. Because all sensors can be read by an application which is required, a number of quantitative research can be done with smartphones [7].

This paper proposed a model of vehicle speed on an observation of the standards based on GPS data on

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smartphone. The observation model of speed is done by calculating the speed of a moving vehicle through the data transfer location on a GPS smartphone with the determination of the area of observation using the geofence. Further data are sent periodically to a server then the server doing the processing and storage of the vehicle speed data.

Through the application of a model of vehicle speed based on observation data of GPS on smartphones that are proposed in this paper, observations on the speed almost fit when compared to speed directly from the vehicle's speedometer.

This paper is organized as follows: Section 1 presents background, observations about the speed of the vehicle-based GPS and smartphone, Section 2 presents proposal of a model of vehicle speed based on observation data of GPS on smartphones, Section 3 presents the implementation of a model of vehicle speed based on observation data of GPS on smartphones, Section 4 elaborates on the results and analysis of the implementation model observations of the speed of the vehicle and Section 5 is the conclusion of this paper.

2. Proposed Model

This paper has proposed a model of the vehicle's speed using the observed data movement of location on GPS smartphone. The speed of the vehicle is retrieved from the value of the distance the vehicle divided by the time it takes to traverse the distance. Calculating the speed of a vehicle with GPS smartphone uses the value of the mileage of the displacement coordinates in units of seconds, which was later converted into a speed value expressed in units of speed km/h. Some of the features that are used in the implementation model observations geofence feature are speed on GPS, sensor-sensor on the smartphones GPS and data transmission GPRS (general packet radio service).

2.1 Observation of Speed with a Geofence Model

Geofence feature is an integrated component that utilizes GPS on smartphones which serves to determine the geographical area of virtually. Geofence works by mapping a location or a specific area based on the magnitudes of the radius is already determined. With a very easy to map a geofence or specify a virtual area on the map, geofence benefits are as varied as the example charted the area offices, warehouse areas, map out the area of the location of the customer or as a surveillance area.

As shown in Fig. 1, it features a geofence placed on

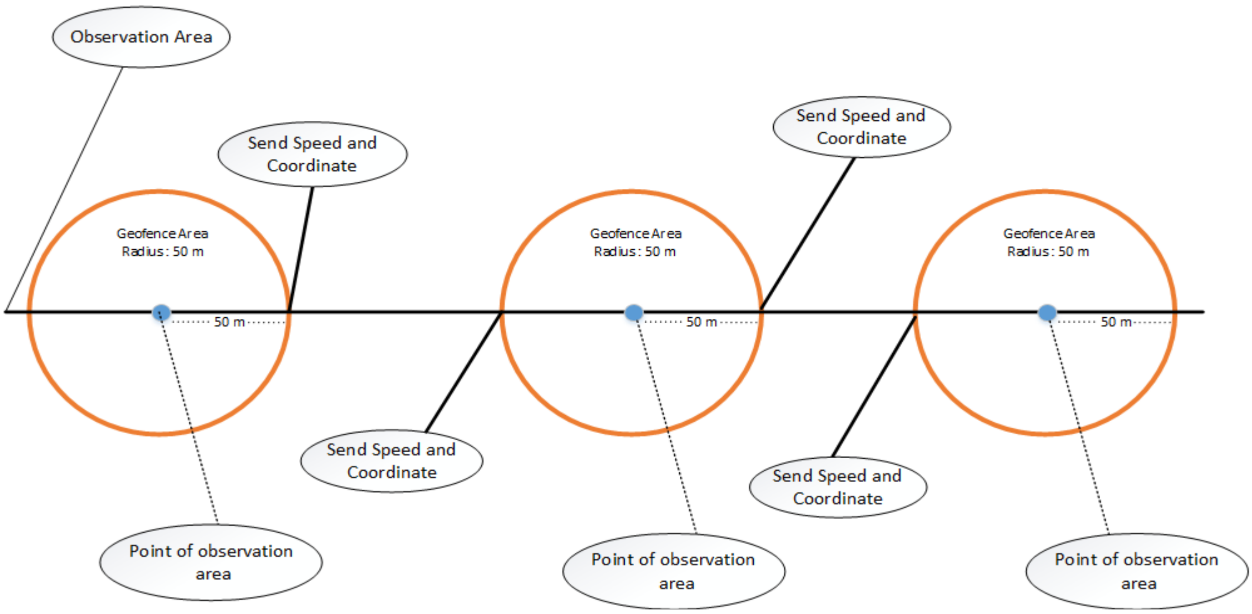

Fig. 1 The architecture of the geofence area for vehicle speed observation model.

area road speed observation vehicle, which is a head to give the trigger on the data retrieval process. Radius is set in the area of observation which is 50 m from the point of observation.

Geofence set on two systems of observation area. If the vehicle will enter into the radius of the geofence or touching the line beginning geofence radius, then the system will automatically send the value of speed and coordinate vehicle. If the vehicle will be out of the area or touch the line ends of the geofence radius geofence area, then the system will automatically send the value of speed and the vehicle's coordinates in Fig. 3 architecture of the geofence area for model vehicles, the speed.

Observations indicate a number of observation points of the area then called links, each link is a midpoint coordinate. If the vehicle passes the object link area at a distance of 50 m before approaching themed point coordinates link system will automatically send the magnitude of the speed of the vehicle and the server will be recorded as the transition in 1 (one) in the links area. If the vehicle is already past the midpoint coordinates link at a distance of 50 m, the system will send back a quantity of vehicle speed, then the server will record as the transition to 2 (two) at the link in question.

2.2 GPS

Geofence model works through GPS features of a smartphone. GPS is a system of determining the position and global navigation integrated with satellite. First evolved GPS systems for survey and mapping for the benefit of military and civilian Department of Defense developed by America. GPS system has a first name which is NAVSTAR GPS (navigation satellite timing and ranging global positioning system). GPS has three important segments, namely: satellite, controllers and receiver or the recipient. GPS satellites are orbiting the Earth, with a fixed position and orbit, totaling 24 satellites where 21 satellites and 3 pieces of actively working the rest are reserved. It was on duty to receive and store the data transmitted by the control stations, store and maintain the information of high precision time (determined by the satellite's atomic clock) and emit the signal and information continuously to the receiver (receiver) from the user.

2.3 Architecture GPS on Smartphones

In the digital age as currently, the approach of collecting data based on GPS on smartphones is very possible. Since 2000, the mobile phone manufacturer in the United States and Canada has instilled A-GPS (assisted global positioning system) Chip on mobile devices to enhance the mobile location-based services. In general the workings of A-GPS in the smartphone locking a position of a location to a satellite aided by locked by the network the internet on WIFI hotspots and smartphones such as the BTS (base transceiver stations) transmitter operator phone [8].

GPS on smartphone android especially consists of the Union of several hardware and software components of the unit so that it becomes a good service location. Here are the components of the GPS on Android smartphone:

(1) Chip GPS: serves as a radio frequency receiver that directly communicate with a satellite.

(2) GPS Driver: system software that uses a low lever functioning APIs does communication between the GPS chip with the android OS.

(3) GL Engine: is an important component of system GPS android. This system serves to find out locations taken at BTS transmitter telephone operators to help A-GPS lock location. GL Engine can detect several GPS satellites at once, but to lock requires other information such as altitude place time and others for which this information can only be obtained by downloading from one of the GPS satellites. Sometimes in downloading information from GPS satellites take a long time depending on internet connection to gain access SUPL/NTP server. After that, the data will be stored in NVRAM to use next.

(4) Android Location Services: consists of several

framework classes such as location manager needed an application that uses the GL Engine.

(5) User Application: Android apps that use GPS android like Google map, GPS essential and others.

2.4 Data Transmission with GPRS

Mobile telecommunication technologies currently applied are GSM, GPRS, 3G, and 4G, and will be followed by a standard 5G. GPRS is a packet data communication which features on GSM technology, allows it to transmit data at high speed through the terminals/mobile devices.

GPRS data transfer is generally calculated by kilobyte of data transferred. This contrasts with data transfer cable-based counts per minute so the user is still prompted to pay although not to transfer any data [9].

GPRS has different types of services such as the SMS (short message service), MMS (multimedia messaging service), WAP (wireless application protocol) and data-based services such as email and word wide word (www).

2.5 Testing Method

The reliability of the results of the observation model, when the vehicle speed on smartphones GPS data determined using indicators of reliability test that is the RMSE. RMSE is a measure of the error based on the difference between the two values that correspond, which define as follows:

$$RMSE = \sqrt{\frac{1}{n}\sum_{i-1}^{n} |Ti - \widehat{Ti}|} \quad (1)$$

Where, n is the number of sample data, Ti is the vehicle speed speedometer (Km/h), $\widehat{Ti}$ is the vehicle speed model observations (Km/h).

3. Implementation

Implementation of the system in this paper through three phases, namely stages of implementation model geofence in the observation area, stages of the process the data on the server and the stages of monitoring data already recorded on the server. In general, the vehicle speed observation model is seen in Fig. 2.

3.1 Implementation of the Model of the Geofence on the Area of Observation

Geofence model for vehicle speed observation area applied to the Trans Sarbagita bus line corridor I namely on the streets of Denpasar sesetan—by pass Ngurah rai with the long observation area is 5.4 km, based on the proposed model of the geofence as in Fig. 1 architecture of the geofence area of the vehicle speed observation model. Line observations are divided into several segments of the road called links,

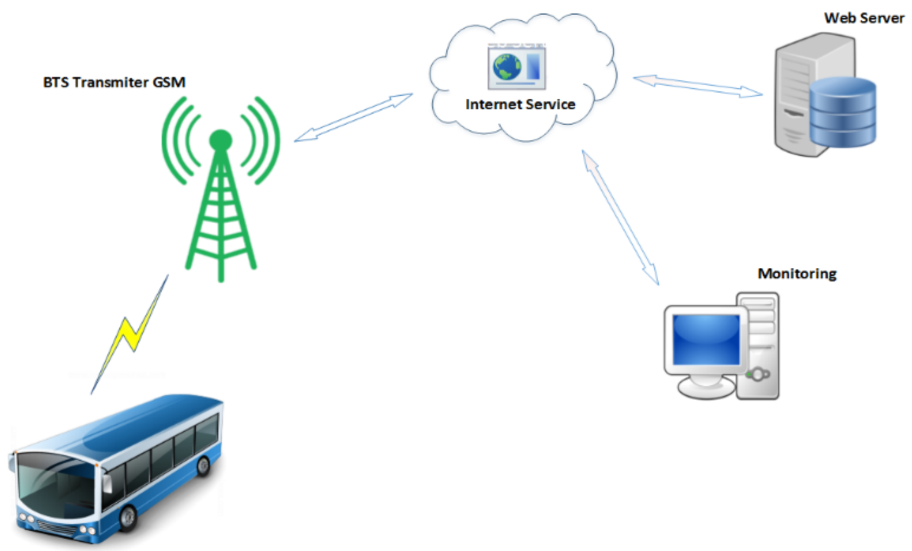

Fig. 2 Architecture observations with the speed of the vehicle.

as shown in Fig. 3, each link has a different length with a total number of links in the area of observation that is 10 links.

In the implementation of the observation, on a Bus Trans Sarbagita put a smartphone device that is mounted android-based applications with features such as geofence on Fig. 1. The application is able to send the coordinates and speed the movement of buses to the server periodically. The server records the movements of each location coordinates and the speed of the bus.

3.2 Processing Data on the Server

Through the transmission of data from an application on a smartphone in the next processing of data is done on the server. Identification of the coordinates of a link that is already stored in the table of links on the database server used to process data acquisition links on the model of the geofence. The speed and the coordinates are sent periodically based on transition links on area geofence then processed on the server as a link record. The Groove in the processing of the data on the server is shown in Fig. 4.

3.3 Monitoring Vehicle Speed Data

Monitoring is conducted to monitor the speed of the vehicle at the time of the links transition on the geofence model. Further analysis of the data conducted a successful speed recorded on the server through the vehicle's speed based on the observation model of GPS data on smartphone.

4. Results and Discussion

4.1 GPS-Based Smartphone Application Interface

The interface on the smartphone application placed on the bus is used to ensure that the application is already well underway and have been able to detect the coordinates and speed of the vehicle via GPS on smartphone. Application interface is shown in Fig. 5.

A series of processes on the model of vehicle speed based on observations of GPS data on a smartphone

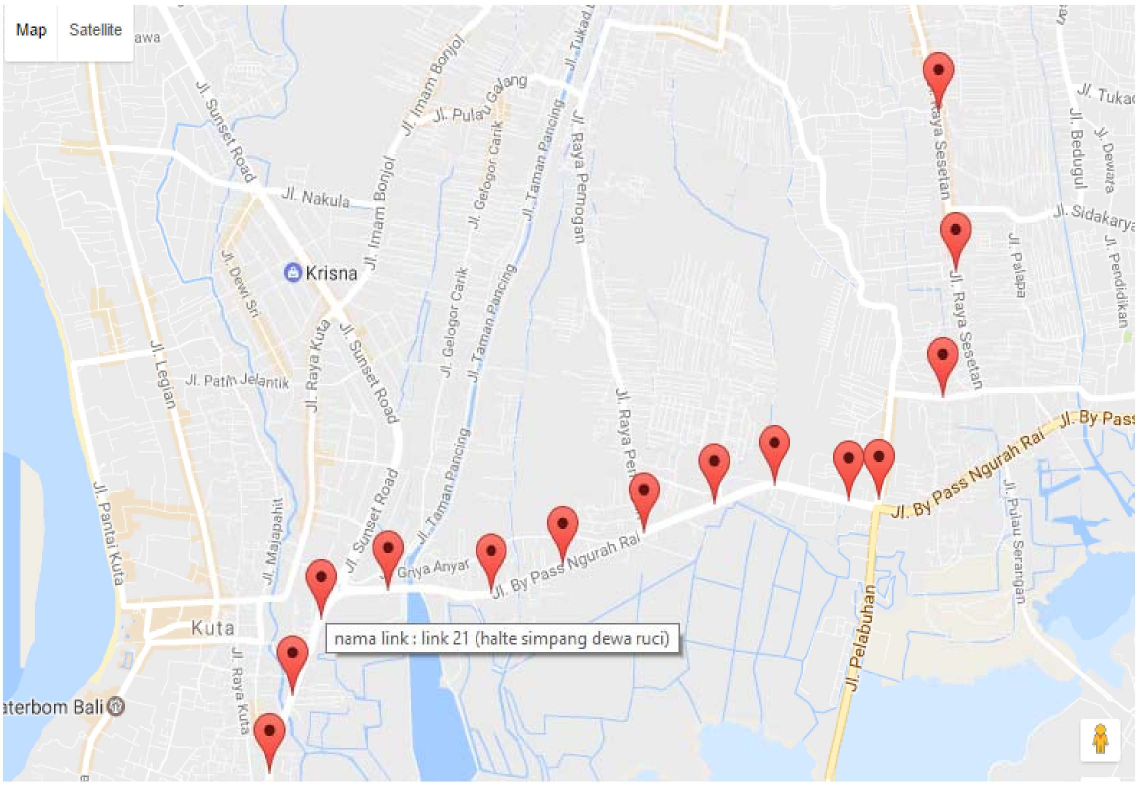

Fig. 3 Links on the observation speed.

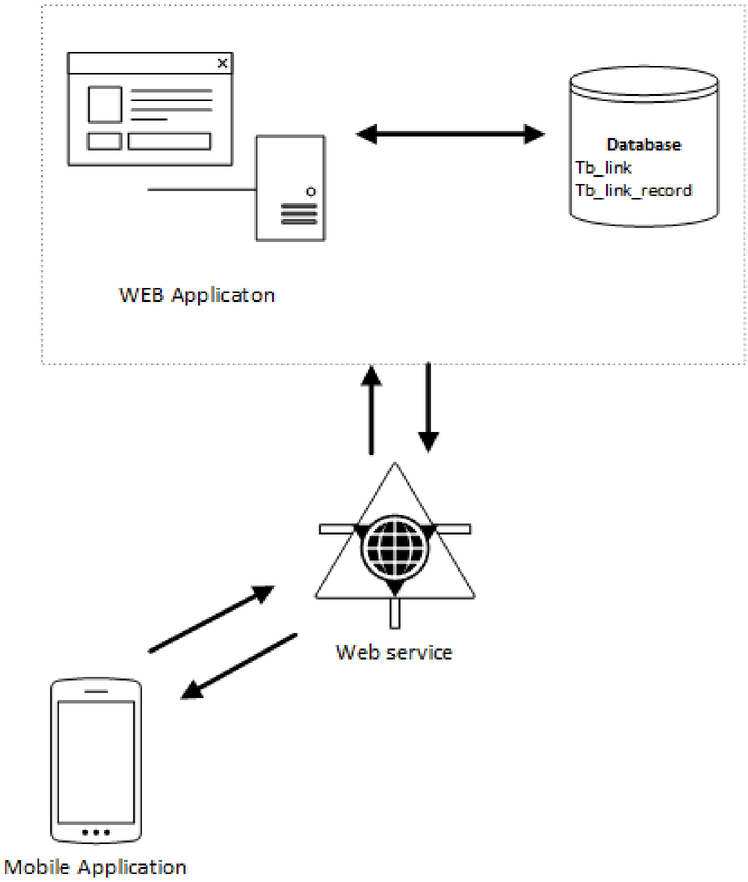

Fig. 4 Processing on the server.

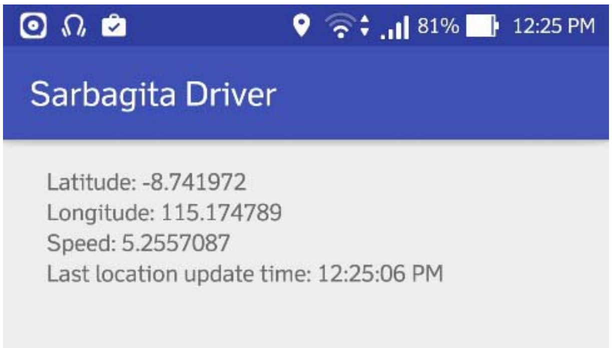

Fig. 5 Application of GPS-based smartphone interface.

has managed to do. The server is already capable of noting the speed at each transition from model link geofence. In Fig. 6, vehicle speed records on the server show the result of travel of the vehicle.

4.2 Observations of Vehicle Speed

Observations on the speed are divided into two: observations from the model of vehicle speed, based on the speed of data recorded on the server smartphone and the observations made in the actual use of data the vehicle speedometer. Observations on the speed of the vehicle are shown in Table 1.

Based on the results of the observational record speed of the vehicle shown at the Table 1, observations on the speed of vehicles, graphically the comparison of the results of the observation model of vehicle speed based on GPS data on smartphone with direct observation from the vehicle's speedometer can be seen in Fig. 7.

4.3 Analysis of the Observations

In general the observations with the model vehicle speed based on observation data of GPS on smartphones compared to the value of the speed of the vehicle's speedometer are quite relevant, but there are still some differences. The difference with the highest value on observation area links 15 transition 1 with difference, the difference of speed 3.5 km/h.

nama_link	lat	long	speed	transition	tanggal
link 12	-8.711009	115.218996	32.28714	1	2016-11-23 06:49:46
link 12	-8.711009	115.218996	41.13793	2	2016-11-23 06:49:55
link 13	-8.716735	115.215191	32.20252	1	2016-11-23 06:51:47
link 13	-8.716735	115.215191	23.595427	2	2016-11-23 06:52:00
link 14 (halte pesanggaran)	-8.716831	115.213384	37.284664	1	2016-11-23 06:52:11
link 14 (halte pesanggaran)	-8.716831	115.213384	41.01577	2	2016-11-23 06:52:19
link 15	-8.715909	115.208933	36.443542	1	2016-11-23 06:52:49
link 15	-8.715909	115.208933	42.704144	2	2016-11-23 06:52:58
link 16 (halte pedungan 1)	-8.716980	115.205324	38.97175	1	2016-11-23 06:53:21
link 16 (halte pedungan 1)	-8.716980	115.205324	41.259583	2	2016-11-23 06:53:27
link 17 (halte pedungan 2)	-8.718563	115.201063	48.312614	1	2016-11-23 06:53:59
link 17 (halte pedungan 2)	-8.718563	115.201063	38.67229	2	2016-11-23 06:54:05
link 18	-8.720405	115.196198	35.37684	1	2016-11-23 06:54:48
link 18	-8.720405	115.196198	34.061836	2	2016-11-23 06:54:54
link 19	-8.721975	115.191932	35.565136	1	2016-11-23 06:55:32
link 19	-8.721975	115.191932	38.98292	2	2016-11-23 06:55:42
link 20 (halte mall galeria)	-8.721786	115.185722	44.804333	1	2016-11-23 06:56:55
link 20 (halte mall galeria)	-8.721786	115.185722	44.9532	2	2016-11-23 06:57:01
link 21 (halte simpang dewa ruci)	-8.723422	115.181698	25.182272	1	2016-11-23 06:57:40
link 21 (halte simpang dewa ruci)	-8.723422	115.181698	13.460138	2	2016-11-23 06:57:51

Fig. 6 Vehicle speed records on the server.

Table 1 Results, observations the speed of the vehicle.

No	Observation area	Coordinate	Model result	Actual result
1	Link 12 (T1)	-8.711009,115.218996	32.28714	35
2	Link 12 (T2)	-8.711009,115.218996	41.13793	40
3	Link 13 (T1)	-8.716735,115.215191	32.20252	38
4	Link 13 (T2)	-8.716735,115.215191	23.59542	25
5	Link 14 (T1)	-8.716831,115.213384	37.28466	35
6	Link 14 (T2)	-8.716831,115.213384	41.01577	41
7	Link 15 (T1)	-8.715909,115.208933	36.44354	40
8	Link 15 (T2)	-8.715909,115.208933	42.70414	42
9	Link 16 (T1)	-8.716980,115.205324	38.97175	40
10	Link 16 (T2)	-8.716980,115.205324	41.25958	41
11	Link 17 (T1)	-8.718563,115.201063	48.31261	48
12	Link 17 (T2)	8.718563,115.201063	38.67229	40
13	Link 18 (T1)	-8.720405,115.196198	35.37684	35
14	Link 18 (T2)	-8.720405,115.196198	34.061836	35
15	Link 19 (T1)	-8.721975,115.191932	35.565136	35
16	Link 19 (T2)	-8.721975,115.191932	38.98292	40
17	Link 20 (T1)	-8.721786,115.185722	44.804333	45
18	Link 20 (T2)	-8.721786,115.185722	44.9532	45
19	Link 21 (T1)	-8.723422,115.181698	25.182272	25
20	Link 21 (T2)	-8.723422,115.181698	13.460138	15
21	Link 22 (T1)	-8.727675,115.179992	33.833847	35
22	Link 22 (T2)	-8.727675,115.179992	26.100544	25
23	Link 23 (T1)	-8.731934,115.178643	43.64075	45
24	Link 23 (T2)	-8.731934,115.178643	50.05536	50
25	Link 24 (T1)	-8.736328,115.179579	14.466024	15
26	Link 24 (T2)	-8.736328,115.179579	27.561855	28
27	Link 25 (T1)	-8.738536,115.180116	32.169777	30
28	Link 25 (T2)	-8.738536,115.180116	32.9914	35

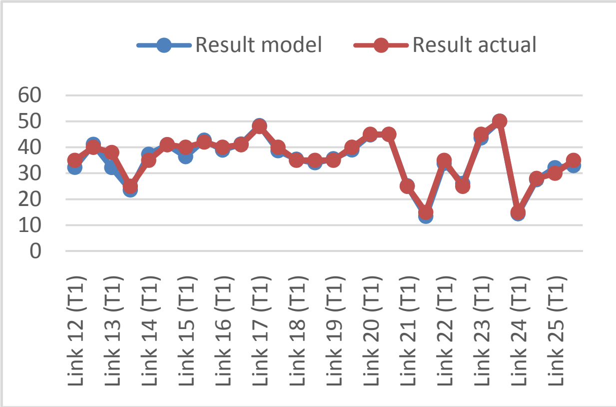

Fig. 7 Comparison of results observations.

5. Conclusion

This paper has presented the model of the vehicle's speed based on the observations of GPS data on smartphone. By applying the model observations on bus line Trans Sarbagita road corridor I, in Denpasar Sesetan—by pass Ngurah Rai. After tested with test reliability indicators use RMSE, observations with model observations speed, speed based on GPS data on a smartphone are relevant when compared with the speed directly from the vehicle's speedometer with the difference between the value of the difference of speed that is 3.1785 km/h.

References

[1] Shintal, M., Dharro, V. D., and Kantilal. P. R. 2015. "Intelligent Bus Stand Monitoring and Control Using Combination of GSM, GPS & IR Sensor." *IJIRSET* 4 (7): 5646-9.

[2] Ruimin, L., Geoffrey, R., and Majid, S. 2006. "Evaluation of Speed-Based Travel Time Estimation Models." *Journal of Transportation Enginering ASCE* 132 (7).

[3] I Made Oka Widyantara, and Nyoman Putra Sastra. 2015. "Internet of Things for Intelligent Traffic Monitoring System: A Case Study in Denpasar." *IJCTT* 30 (3): 169-73.

[4] Hannan, M. A., and Mustapha, A. M. 2011. "Implementing Bus Identification and Monitoring System." *Electrical, Control and Computer Engineering (INECCE)*, 2014.

[5] Avinas, H., Meghana Illur, Prakteek V Shetti, Padmini Avadhani, P., and Geethalaxmi. 2016. "Map Land Surveying System." *Imperial Journal of Interdisciplinary Research (IJIR)* 2 (5).

[6] Dekreneris. 2010. "Integrating GIS, GPS and GSM Technologies for the Effective Management of Ambulances." *Computer Environment and Urban System* 25 (3): 267-78.

[7] Kuhn, J., and Vogt, P. 2013. "Application and Examples of Experiments with Mobile Phone and Smartphone in Physics Lessons." *Frontier in Sensor (FS)* 1 (4): 67-73.

[8] Giovanni, P., and Valerio Mario, S. 2012. "A GPS Based Architecture to Control Bus Trough an IOS Application." Kore University of Enna, Italy. http://isad12s.guap.ru/files/publications/if2011/pau.pdf.

[9] Xiao, L., and Wang, Z. 2011. "Internet of Things: A New Application for Intelligent Traffic Monitoring System." *Journal of Network* 6 (6): 887-94.