Venus as a Reference for Determining the Qibla Direction in Indonesia

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Abstract

One needs of Muslims in worship is to determine the direction of qibla. For Muslims who do not have advanced technology equipment, they can not determine the Qibla at noon, there is one alternative to know the Qibla direction using objects in the night sky that is the planet Venus. Based on observations using astronomical calculations in mind that Venus appeared very luminous in the western horizon when the sky conditions at the time it was sunny and the sun had set perfectly. Conversely at dawn in the eastern horizon, we can also see one of the planet is called the morning star. This research answer the question how the stage of determine the direction of Qibla somewhere using the position of the planet Venus and what a proof calculation of position of Venus in the sky. To obtain the direction of Qibla in Indonesia is looking for the planet Venus position data using the coordinate system horizon (altitude and azimuth planet Venus) somewhere and then applied to the theodolite. After that, direct the lens of the theodolite toward the position of the planets Venus and rotate clockwise (equal to the difference between the azimuth angle with azimuth mecca of Venus) to get the true direction of Qibla. So the position of the planet Venus can be used as an alternative to determine the direction of qibla

Key Words: Venus, Qibla direction, and Indonesia

1. Introduction

Determine qibla means to determine the direction from any point on the earth's surface to face *Baitullah* at Mecca. The Qibla is the Kaaba in Mecca located at coordinates 21º 25' 21,02" N and 39º 49' 34,25" E.[1] The argument about the qibla is as follows legal basic of al-Qur'an which is Surah al baqarah verses 149-150 that talking about compulsory Moeslim from whatsoever place you come forth and turn your face towards the Sacred Mosque. In addition based on the opinions of scholars associated schools an obligation to attempt to determine the direction of Qibla, one of them with signs of nature. Based on that arguments, it is clear that facing the Qibla is important. Many ways to determine the direction of Qibla are as follows: azimuth qibla, rashd al qibla, qibla every time methods etc.[2] This paper will describe how to determine the Qibla direction using the planet Venus, as a second celestial brightness after the Moon.

Determining the direction of Qibla is calculated using *spherical trigonometry*. *Spherical trigonometry* calculation using the formula refers to three points forming a triangle points at the Ka'bah, a point at the North Pole, and point one place on the earth's surface.[3] In addition, Qibla direction can also be determined by calculating the time when the shadow of an object on the earth's surface indicates the direction of Qibla. This time is known as the shadow of the direction of Qibla (Rasydul Qibla) either global and local.[4] Moreover, the method of determining the direction of Qibla is calculated by reference to the celestial bodies, namely the sun or the moon, where the sun or the moon is used as a reference to determine the direction of Qibla somewhere on the Earth's surface. In addition, we can use other celestial bodies, namely the planet Venus can be observed in the morning and evening. Using the planet Venus as a reference point the direction of Qibla is not contrary to the argument, because the method of calculation is the same as the calculation using the sun and the moon[5] as a reference point.

Moments before sunrise we will see a celestial object that shine bright in the eastern sky. Likewise, at other times when he saw the western sky just after sunset, we will see a bright light sky objects all. These celestial objects so bright in the morning when the sky was already getting light as sunlight, this thing is still visible. Tribe Java in Indonesia mention this celestial objects as *Panjer Esuk*, star shining in the morning. Whereas objects referred to above is actually not a star but a planet that were located very close to the earth, namely Venus.

Toward evening, Muslims can use celestial bodies appear to know the direction of Qibla. During this determination Qibla direction using only the sun and moon, whereas other planets like Venus can be observed in the morning and afternoon to be used as an object direction. Moreover, Indonesia is geographically located on the equator which has a strategic position to view the sunrise and sunset are perfect. Venus is referred to as the third brightest object after the sun and moon, it is this which later became one of the ease of getting directions. In this paper will be assessed on the existence of the position of Venus and its benefits to show the direction of Qibla in Indonesia.

2. Materials and Methods

2.1 Data sets

Data on the planet Venus in this research include a definition, physical movements and positions of Venus in the solar system. Information on the definition, physical and movement of the planet Venus were obtained from literature such as books and journals. Some of the

literature is used as a theoretical basis, namely basic book about the coordinate system horizon to explain the position of the planet in the form of coordinates, namely the azimuth angle and height of celestial bodies.

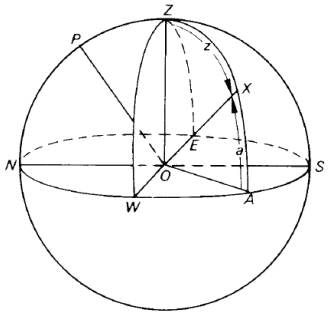
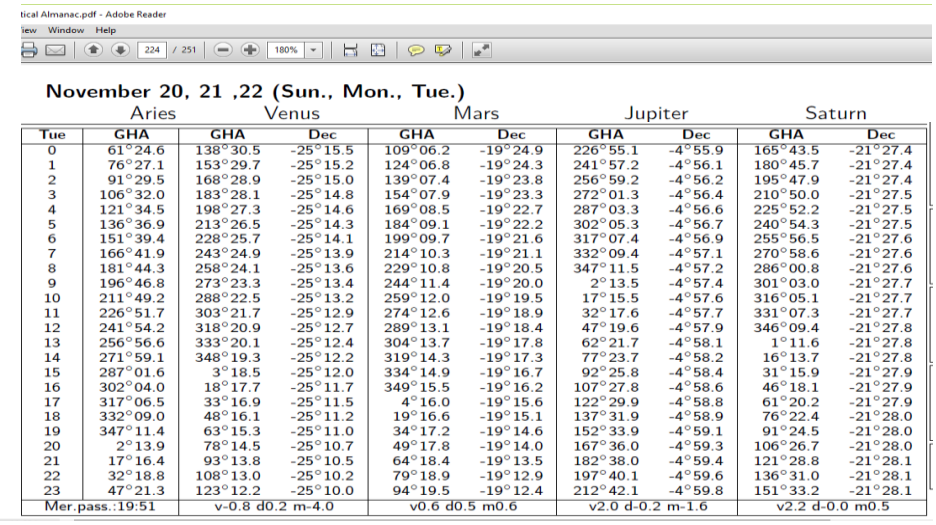


Figure 1. The observer's celestial sphere.

The horizontal (alt-azimuth) system is the most primitive system, most immediately related to the observer's impression of being on a flat plane and at the centre of a vast hemisphere across which the heavenly bodies move. In figure 1, the observer at *O*, northern latitude φ, can define the point directly opposite to the direction in which a plumb-line hangs as the zenith, *Z*. The plumb-line direction is known as the nadir, leading to the Earth's centre, if we assume the Earth to be spherical. On all sides, the plane stretches out to meet the base of the celestial hemisphere at the horizon. The azimuth may be defined as the angle between the vertical through the south point and the vertical through the object X, measured westwards along the horizon from 0◦ to 360◦, or the angle between the vertical through the north point and the vertical through the object X, measured eastwards or westwards from 0◦ to 180◦ along the horizon. A third definition commonly used is to measure the azimuth from the north point eastwards from 0◦ to 360◦.[6]

In addition, data on Venus from data gathered Nautical Almanac. Nautical Almanac is ephemeris data containing data about the sun, moon, planets and stars to be used in navigation purposes.[7] But apparently the Almanac can also be used to calculate the position of the planet Venus that allows us to know the direction of the Qibla of the Indonesian state.



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November 20, 21 ,22 (Sun., Mon., Tue.)

	Aries	Venus		Mars		Jupiter		Saturn	
Tue	GHA	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec
0	61°24.6	138°30.5	-25°15.5	109°06.2	-19°24.9	226°55.1	-4°55.9	165°43.5	-21°27.4
1	76°27.1	153°29.7	-25°15.2	124°06.8	-19°24.3	241°57.2	-4°56.1	180°45.7	-21°27.4
2	91°29.5	168°28.9	-25°15.0	139°07.4	-19°23.8	256°59.2	-4°56.2	195°47.9	-21°27.4
3	106°32.0	183°28.1	-25°14.8	154°07.9	-19°23.3	272°01.3	-4°56.4	210°50.0	-21°27.5
4	121°34.5	198°27.3	-25°14.6	169°08.5	-19°22.7	287°03.3	-4°56.6	225°52.2	-21°27.5
5	136°36.9	213°26.5	-25°14.3	184°09.1	-19°22.2	302°05.3	-4°56.7	240°54.3	-21°27.5
6	151°39.4	228°25.7	-25°14.1	199°09.7	-19°21.6	317°07.4	-4°56.9	255°56.5	-21°27.6
7	166°41.9	243°24.9	-25°13.9	214°10.3	-19°21.1	332°09.4	-4°57.1	270°58.6	-21°27.6
8	181°44.3	258°24.1	-25°13.6	229°10.8	-19°20.5	347°11.5	-4°57.2	286°00.8	-21°27.6
9	196°46.8	273°23.3	-25°13.4	244°11.4	-19°20.0	2°13.5	-4°57.4	301°03.0	-21°27.7
10	211°49.2	288°22.5	-25°13.2	259°12.0	-19°19.5	17°15.5	-4°57.6	316°05.1	-21°27.7
11	226°51.7	303°21.7	-25°12.9	274°12.6	-19°18.9	32°17.6	-4°57.7	331°07.3	-21°27.7
12	241°54.2	318°20.9	-25°12.7	289°13.1	-19°18.4	47°19.6	-4°57.9	346°09.4	-21°27.8
13	256°56.6	333°20.1	-25°12.4	304°13.7	-19°17.8	62°21.7	-4°58.1	1°11.6	-21°27.8
14	271°59.1	348°19.3	-25°12.2	319°14.3	-19°17.3	77°23.7	-4°58.2	16°13.7	-21°27.8
15	287°01.6	3°18.5	-25°12.0	334°14.9	-19°16.7	92°25.8	-4°58.4	31°15.9	-21°27.9
16	302°04.0	18°17.7	-25°11.7	349°15.5	-19°16.2	107°27.8	-4°58.6	46°18.1	-21°27.9
17	317°06.5	33°16.9	-25°11.5	4°16.0	-19°15.6	122°29.9	-4°58.8	61°20.2	-21°27.9
18	332°09.0	48°16.1	-25°11.2	19°16.6	-19°15.1	137°31.9	-4°58.9	76°22.4	-21°28.0
19	347°11.4	63°15.3	-25°11.0	34°17.2	-19°14.6	152°33.9	-4°59.1	91°24.5	-21°28.0
20	2°13.9	78°14.5	-25°10.7	49°17.8	-19°14.0	167°36.0	-4°59.3	106°26.7	-21°28.0
21	17°16.4	93°13.8	-25°10.5	64°18.4	-19°13.5	182°38.0	-4°59.4	121°28.8	-21°28.1
22	32°18.8	108°13.0	-25°10.2	79°18.9	-19°12.9	197°40.1	-4°59.6	136°31.0	-21°28.1
23	47°21.3	123°12.2	-25°10.0	94°19.5	-19°12.4	212°42.1	-4°59.8	151°33.2	-21°28.1
Mer.pass.:19:51		v-0.8 d0.2 m-4.0		v0.6 d0.5 m0.6		v2.0 d-0.2 m-1.6		v2.2 d-0.0 m0.5	

Figure 2. Nautical Almanac Data (source: TheNauticalAlmanac.com)

In calculating the Qibla direction we need a coordinate data point will be calculated and the coordinates of the Kaaba in Mecca via GPS (*Global Positioning System*). Then to do a comparison, the authors use the software Stellarium 0.15.0.

2.2 Research Methods

This study is a descriptive analysis, relevant explanations and exposure data both with words and cultural objects whatever has to be translated into the language, both orally and in writing. In this case, the researchers tried to explain how to use the position of Venus to determine the direction of Qibla. Investigators collect evidence planet Venus shoot either using the eyes or using the equipment to indicate that the planet Venus is a planet that is easy to find in the morning before sunrise, and when the afternoon when the sun is going down.

Subsequently, researchers attempted to explain how the procedure for calculating the position of the planet Venus as a method of determining the direction of Qibla. To describe this, researchers used theoretical calculations spherical trigonometry to determine the Qibla then take into account the azimuth angles of the Qibla of azimuth Venus who already are targeted using the equipment.

In this study there are data comparison between the position of Venus calculations using the data nautical almanac and Stellarium software. Reasons of comparison using Stellarium software is because the software is widely accessible to the public freely, so the comparisons of this software Stellarium also shows the validity of the presentation of the position of objects sky. Other than that Stellarium is a free open source planetarium for computer. It shows a realistic sky in 3D, just like what we see with the naked eye, binoculars or a telescope.[8]

3. Results and Discussion

3.1. The View of Venus from the Earth

Before we use the planet Venus as a reference point determining the qibla direction, we must first know the characteristics of the planet Venus. this in order not to be mistaken in the observations. To be able to describe the physical state of the planet, can be explain into several points. Venus is a terrestrial planet with a radius of 6051.8 km. Venus rotates in the opposite direction from the other planets (from east to west) and very slowly so that one day on Venus is longer than 1 year. Almost no magnetic field detected in Venus. Venus has more volcanoes than the other terrestrial planets. Pioneer and Magellan radar data showed that the surface of Venus is very smooth / flat. Topographic variations on Venus is almost 14.6 km. This occurs due to lava that fills small craters and covered almost the entire surface of Venus. [9]

Venus is visible at the edges of night, lingering near either dawn or dusk. It hangs low and bright in the morning or evening sky, sometimes near the crescent Moon. Because Venus' greatest angular distance from the Sun, known as its maximum elongation, is 47 degrees, it appears as the evening star just after sunset or as morning star just before sunrise, but never as both an evening and morning star on the same day.

When viewed through a telescope, Venus brightens and fades and also in apparent size, during its dance around the Sun. As notices Galileo Galilei (1564-1642) in 1610, the planets exhibits a complete sequence of Moon-like phases, which mean that Venus should orbit the Sun rather than the Earth. Its apparent illumination goes from a full round disk to a narrow crescent and back to rotundity again every 19 months. Venus also appears to grow when it approaches us in its orbit and shrinks as it recedes. When Venus is farthest from the Earth, on the opposite side of the Sun, it is fully illuminated and smallest. As the planet comes closer to Earth, it looks partly illuminated and larger.[10] All this shows that Venus has a characteristic to be used as a reference in determining the direction of Qibla.

3.2. Stage of Calculation Qibla direction using the position of Venus

Calculation Qibla direction using the position of Venus in the morning and evening, briefly divided into four parts as well as using the Sun as point reference in determining qibla direction[11]: *first*, to prepare the data Venus using a calculation system coordinates horizon (altitude and azimuth of the planet Venus), *the second* is to calculate the direction of Qibla

city of Yogyakarta, and *the third* stage is a step of using theodolite in determining the direction of Qibla.

1) The calculation of the position Venus

a. Hour angle of Venus

$$t = GHA + \lambda, \quad (1.1)$$

Where *t* is hour angle, and GHA is Greenwich Hour Angle and λ is longitude of Yogyakarta

b. Declination of Venus

$$\delta_{venus} = A - (A - B).C \quad (1.2)$$

Where δ is declination of Venus, and A is the first data (dec 1), and B is the second data (dec 2), and C is deviation of times

c. Altitude of Venus

$$Sin\ h = \sin\phi.\sin\delta + \cos\phi.\cos\delta.\cos t \quad (1.3)$$

Where h is altitude of Venus, and ϕ is the latitude, and δ is declination of Venus and t is hour angle of Venus, respectively.

d. Azimuth of Venus

$$Cotan\ Az = \frac{\tan\delta_v.\cos\phi_x}{\sin t} - \frac{\sin\phi_x}{\tan t} \quad (1.4)$$

Where Az is azimuth of Venus and δ is declination of Venus and ϕ is latitude and t is hour angle of Venus

2) The calculation of qibla direction (Yogyakarta)

$$Cotan\ Az = \frac{\tan\phi_k.\cos\phi_x}{\sin C} - \frac{\sin\phi_x}{\tan C} \quad (1.5)$$

Where Az is azimuth of qibla and ϕ_k is latitude of Ka'ba and ϕ_x is latitude of Yogyakarta and C is diference of longitude both Yogyakarta and Ka'bah. The position of Ka'ba is 21˚ 25′ 21,02″ N and 39˚ 49′ 34,25″ E, whereas Yogyakarta (7˚ 47′ 02,6″ S and 110˚ 26′ 07,2″ E)

3) Using theodolite as a tools

Use the lens theodolite to aim Venus during the afternoon. After obtaining the focal point of the planet, lock the horizontal angle and the position on the condition of zero degrees. Then turn the theodolite clockwise by the difference between the azimuth angle mecca of the city of Yogyakarta with azimuth Venus.

Through the above calculation formula, the authors calculate the Qibla direction Yogyakarta using the position of Venus on 22 November 2016 at 18: 15 pm. The conclusions are qibla angle of Yogyakarta is 294º 41' 31.6" and GHA of Venus is 307º 6' 30" and

declination of Venus is -25º 12' 51" and h Venus is 32º 35' 54.65" and azimuth of Venus is 244º 58' 45.2 ".

The results of the above calculation indicated that the planet Venus can be used to direct the Qibla. During this time, the related research Qibla direction very much that such Qibla and the shadow of the gnomon by Sun[12], analysis of Qibla calculation on the software and the accuracy of the many methods of determining the direction of Qibla[13] and the accuracy of the many methods of determining the direction of Qibla.

3.3 Comparison of the results of calculations based on the Nautical Almanac and Software Stellarium

Comparison of the results of the calculation of the position of Venus using nautical almanac data and software Stellarium showed no significant difference. Here is a comparison of the position of Venus on 22 November 2016 at 18:15 pm.

Table 1. Comparison of the position of Venus using the Nautical Almanac and Stellarium

Time		Coordinate Venus	Nautical Almanac	Stellarium	Deviation
22 Nov 2016	04.30 WIB	H	32º 35’ 54,65”	32º 29’ 30”	00º 6’ 24.65”
		Az	244º 58’ 45,2”	244º 58’ 08.0”	00º 0’ 37.2”

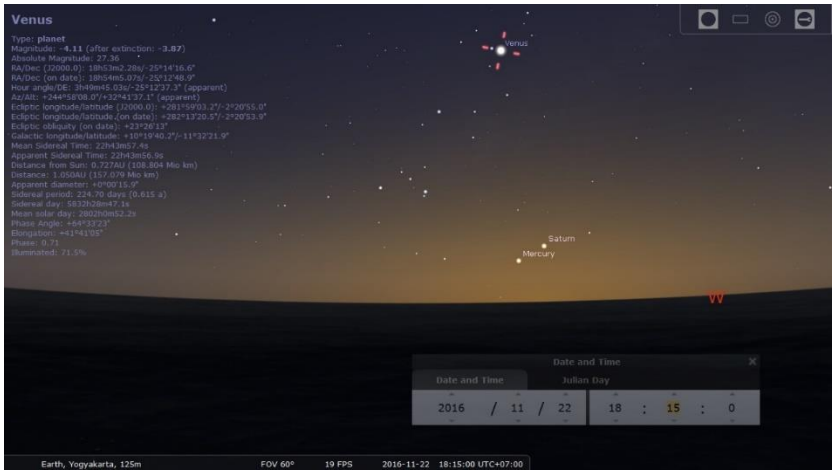

Figure 3. The position of Venus on the west horizon on November 22, 2016 at Yogyakarta (source: stellarium 0.15.0)

4. Conclusion

Determination of qibla direction using the position or azimuth of Venus is an alternative way that can be done, because the calculation step has the same steps using the sun or moon azimuth. To be able to prove the exact position of Venus, the researchers use a theodolite to

make comparisons with Stellarium software that is quite familiar in the community. The conclusion is the result of the calculation of the position of Venus manually has similarities with data on Stellarium.

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