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THE USE OF ARTIFICIAL INTELLIGENCE (AI) IN DETERMINING THE QIBLA DIRECTION

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Abstract

Facing the Qibla is one of the prerequisites for valid prayer. The methods of determining the Qibla direction have been extensively explored, ranging from simple methods to using highly advanced technology. The emergence of Artificial Intelligence (AI) technology, which is currently evolving, is designed to address various issues, including the Qibla direction. One of the evolving models is Natural Language Processing (NLP), which enables computers to understand human natural language. Even when given questions about the Qibla direction of a place, AI can respond with the azimuth value according to the desired city input by the user. The aim of this paper is to examine how the use of artificial intelligence (AI) in determining the Qibla direction, and to determine the accuracy of the Qibla direction produced by Artificial Intelligence. The method used in this research is a qualitative method with an experimental approach, which is used to investigate the influence of certain treatments on others under controlled conditions. In this case, primary data sources are taken from artificial intelligence given keywords (prompts) to obtain the Qibla direction of a city. Then, the results of the Qibla direction from the artificial intelligence machine (AI) are analyzed based on fiqh (Islamic jurisprudence) and astronomical principles. The results of this study indicate that there is artificial intelligence that produces accurate calculations of the direction of the Qibla, namely ChatGPT, while others are still not completely accurate because the answers produced by the artificial intelligence have not applied mathematical principles in their calculations so that they cannot be relied on as a guideline in determining the direction of the Qibla. Therefore, further development is needed in the use of artificial intelligence (AI) in determining the direction of the Qibla.

Keywords: Qibla Direction, Artificial Intelligence, Natural Language Processing

A. Introduction

Facing the Qibla is an obligation for people who are praying. There are currently many methods that can be used to determine the direction of the Qibla. In general, determining the direction of the Qibla cannot be separated from two processes, namely calculation and measurement. One of the challenges in determining the direction of the Qibla today is the presence of Artificial Intelligence (AI) technology which can determine the direction of the Qibla easily and practically without going through lengthy calculations.[1]

Artificial Intelligence (AI) technology is one of the most important innovations that has great potential to influence various aspects of human life. AI refers to the ability of machines to mimic or imitate human intelligence, including the ability to learn, solve problems, make decisions, and interact with their environment. AI currently being developed has been applied in various sectors, such as health, transportation, finance, manufacturing, and many more with the aim of increasing efficiency, productivity, and quality of human life.[2] The technology currently being developed is Natural Language Processing (NLP), which allows machines to assess a piece of text, identify the key points of a sentence, and conclude the message the book or journal author wants to convey.[3]

One of the Artificial Intelligence (AI) technologies that is currently widely used is ChatGPT. ChatGPT is a natural language AI chatbot. At the most basic level, that means we can ask any question and it will produce an answer.[4] In this case, we can ask questions about the Qibla direction of a city to get answers from AI. From several experiments that have been carried out, there are several AI's that can answer even the results of the Qibla azimuth number for a particular city. This certainly attracted the attention of the author to research the use of Artificial Intelligence (AI) in determining the direction of the Qibla.

The study of determining the direction of the Qibla has been widely discussed by researchers. Previous research that is relevant to this research includes dealing with conventional applications such as Google Earth as conducted by Arifin (2021) and Mustaqim

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[1] Nur Afny Awwalany, Sippah Chotban, and Subhan Khalik, "Peluang Dan Tantangan Ilmu Falak Di Indonesia Era Digital," *Hisabuna* 4, no. 3 (2023): 143.
[2] Lukman, Riska Agustina, and Rihadatul Aisy, "Problematika Penggunaan Artificial Intelligence (AI) Untuk Pembelajaran Di Kalangan Mahasiswa STIT Pemalang," *Jurnal Madaniyah* 13, no. 2 (2023).
[3] Ardiansyah Salim, *Birokrasi 4.0: Penerapan Artificial Intelligence* (Depok: Rajawali Pers, 2021), 33.
[4] Emi Sita Eriana and Afrizal Zein, *Artificial Intelligence (AI)* (Purbalingga: Eureka Media Aksara, 2023).

(2017).[5] Determining the Qibla direction using the sun's shadow was carried out by Muhamad Syazwan Faid, et al (2022).[6] Determining the Qibla direction using the RDQ method using GNSS Built-in Computer Software carried out by Mohammed Jassim, et al.[7]

However, until now no research has been conducted and published to determine AI's ability to determine the direction of the Qibla. Therefore, it is hoped that this research can contribute to current studies regarding the ability of Artificial Intelligence to determine the Qibla direction. So, this research aims to find out how Artificial Intelligence (AI) can help in determining the Qibla direction, and by using Artificial Intelligence (AI) technology whether it can produce an accurate Qibla direction in accordance with the principles of astronomy.

This research uses a descriptive qualitative method by collecting data through exploration of several Artificial Intelligence (AI) currently developing, including ChatGPT, Microsoft Copilot, Gemini and Question AI. Processed through three stages, namely codification, presentation and drawing conclusions. Data was collected by providing keywords to the AI to produce Qibla direction and then analyzed using descriptive analysis using inductive and comparative thinking methods to get a complete picture regarding the accuracy of the results.

B. Result And Discussion

1. Use of Artificial Intelligence in Determining Qibla Direction

One model of Artificial Intelligence (AI) is Natural Language Processing (NLP). Natural language processing is a field of artificial intelligence that deals with understanding human language. Natural Language Processing (NLP) is the science of artificial intelligence which studies how natural language is processed which was used by humans in communicating with one another.[8] One example is software that can complete various tasks such as translation, answering questions, and completing text. This artificial intelligence is generally based on software that has been trained with a collection of data sourced from websites, books, and articles. Once trained, the model can generate new text by predicting the next word in a

[5] Riza Aftian Mustaqim, "Penggunaan Google Earth Sebagai Calibrator Arah Kiblat," *Jurnal Justisia* 6, no. 2 (2021); Zainul Arifin, "Akurasi Google Earth Dalam Pengukuran Arah Kiblat," *Jurnal Ulumuddin* 7, no. 2 (2017).

[6] Muhammad Syazwan Faid et al., "Development of Qibla Direction Determinant Using Sun Shadow," *Online Journal of Research in Islamic Studies* 9, no. 1 (2022).

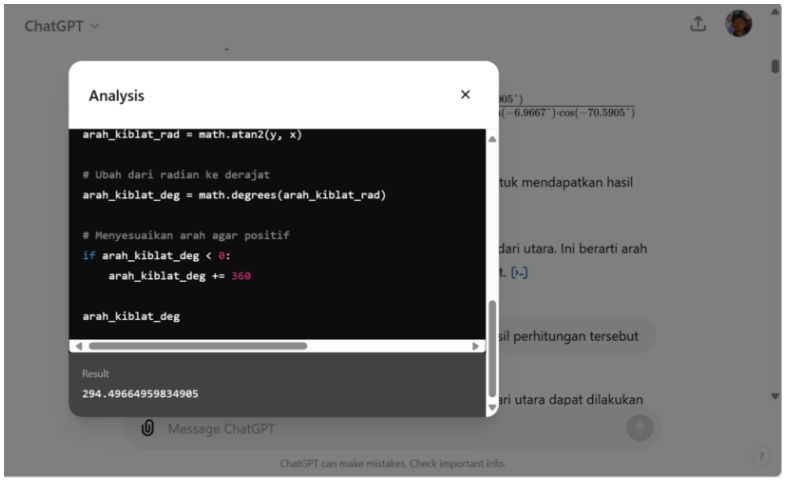
[7] Mohammed Jassim, Ahmed Al-Talabany, and Mohammed Mohammed, "Novel (RDQ) Method for Precise Qibla Determination Using GNSS Built in a Computer Software," *ZANCO Journal of Pure and Applied Science* 28 (2016).

[8] A. Cucus, R. Y. Endra, and T. Naralita, "Chatter Bot Untuk Konsultasi Akademik Di Perguruan Tinggi," *Explore: Jurnal Sistem Informasi Dan Telematika (Telekomunikasi, Multimedia Dan Informatika)* 10, no. 1 (2019).

sentence, given a specific command or context. This process is repeated until the model produces a complete sentence or the required number of words. The model also uses attention mechanisms when generating text. This mechanism allows selective focus on specific parts of the input for a more accurate and coherent response.[9]

There are several Artificial Intelligence (AI) applications based on Natural Language Processing (NLP) that are currently being developed, including ChatGPT, Microsoft Copilot, Gemini, and Question AI. These applications can provide answers to the questions asked. This is what is called a Question Answering System (QAS). QAS is a computer system designed to answer user questions in a natural and, easy to understand way. Unlike traditional search engines that only display a list of links, QAS processes your questions and provides immediate answers, just like a conversation with a human.[10] So in this case it could be used to speed up determining the direction of the Qibla by asking AI for the direction of the Qibla for a particular city. QAS, like an intelligent assistant, will understand your questions and provide informative and comprehensive answers.

Figure 1. Response output from ChatGPT combined with Python



The results of data exploration through the use of Artificial Intelligence (AI) in determining Qibla direction using the aforementioned AI are presented in table form, as follows:

Table 1. Results of several AIs in determining Qibla direction

[9] J An, W Ding, and C Lin, "ChatGPT," *Tackle the Growing Carbon Footprint of Generative AI* 615 (2023): 586.
[10] Widodo Budiharto and Derwin Suhartono, *Artificial Intelligence Konsep Dan Penerapannya* (Yogjakarta: Andi Offset, 2014), 209.

Types of AI	Results
ChatGPT	Provides the results of calculating the direction of the Qibla along with the steps taken logically. Displays coordinate data for the city you are looking for as well as the Qibla azimuth. And tips for measuring the Qibla direction are given. Even in more detailed calculations, ChatGPT works with Python to calculate the Qibla direction value.
Microsoft Copilot	Provides results without explanation of calculations. The results obtained include Qibla angle, Qibla angle for compass, distance to Kaaba, Magnetic Deflection and Coordinates.
Gemini	Provides explanation results regarding the direction of the Qibla in a place which is not uniform. As well as providing a basis
Question AI	Only provides Qibla direction results

From this table, it can be seen that the Qibla direction results obtained through several types of AI get different results due to differences in algorithms, data, and calculation methods.

The algorithms contained in AI can vary in level of complexity and accuracy. More complex algorithms usually consider more factors and produce more accurate results, but require more time to calculate. Like ChatGPT uses complex algorithms and accurate data, resulting in the most complete and informative results. Meanwhile, Microsoft Copilot and Gemini use simpler algorithms, resulting in simpler and more concise results. Question AI only uses basic algorithms and limited data, so it only provides direction results without additional information.

AI uses calculation methods to determine different Qibla directions. ChatGPT uses a method based on the theory of spherical trigonometry. This method uses trigonometry formulas to calculate the Qibla angle from the geographic coordinates of the location and the coordinates of the Kaaba. This method is relatively simple and easy to implement, but its accuracy can be affected by factors such as the Earth's magnetic field and altitude. In chatGPT, accurate calculations are done with Python programming. While the other AIs do not explain the

calculation methods used, it is very likely that the three of them only take results from sources available in online media.

2. Accuracy of Determining Qibla Direction with AI

The following is a comparison of manual calculations using AI in determining Qibla direction in several locations in Indonesia. The author carried out a comparison by carrying out manual calculations using the spherical trigonometry formula. The spherical trigonometry formula is used in the calculations because the steps taken are simple and the results are accurate enough for determining the Qibla direction

Table 2. Comparison of ChatGPT with Manual Calculations

City	Manuals	ChatGPT	Difference
Semarang[11]	294° 29' 47,94''	294° 29' 47.94''	0
Surabaya[12]	294° 02' 04,41"	294° 2' 4.41''	0
Banyuwangi[13]	293° 51' 56,43''	293° 51' 56,43''	0
Jakarta[14]	295° 09' 06,24"	295° 09' 06,24"	0
Aceh[15]	292° 09' 58,67"	292° 09' 58,67"	0

The table shows that there is no difference in the Qibla direction produced from ChatGPT and manual calculations, because in producing ChatGPT answers using spherical trigonometry formulas combined using Python programming so that the results obtained are based on definite calculations. The reference coordinate data used in calculating the Qibla direction between ChatGPT and manual calculations has the same value so that there is no difference in the results.

Table 3. Comparison of Microsoft Copilot with Manual Calculations

City	Manuals	AI Copilot	Difference
Semarang	294° 29' 47,94''	292.30°	2°11'47,97''
Surabaya	294° 02' 04,41"	294°	0°2'4,41''
Banyuwangi	293° 51' 56,43''	292.5	1° 21'56,43''

[11] With latitude coordinates = 6.9667° S, longitude 110.4167° E
[12] With latitude coordinates = 7.2575° S, longitude 112.7521° E
[13] With latitude coordinates = 8.2192° South Latitude and longitude 114.3691° East Longitude
[14] [14]With latitude coordinates = 6.2088° South Latitude, and longitude 106.8456° East Longitude
[15] With latitude coordinates = 5.5483° N, and longitude 95.3238° E

Jakarta	295° 09' 06,24"	292.79°	2°21’42,24’’
Aceh	292° 09' 58,67"	143.33°	148°50’10,67’’

The table shows that the resulting difference is very large because the way Microsoft Copilot AI works does not directly calculate the Qibla direction of a city but takes it from sources on the internet so errors can occur.

Table 4. Comparison of Gemini with manual calculation of Qibla direction

City	**Manuals**	**GeminiAI**	**Difference**
Semarang	294° 29' 47,94’’	294°20'41.76"	0° 9’ 6,18’’
Surabaya	294° 02' 04,41"	294°01'45.6"	18,81’’
Banyuwangi	293° 51' 56,43’’	292°58'22.8"	53’’33,63’’
Jakarta	295° 09' 06,24"	294°58'22.8"	10’43,44’’
Aceh	292° 09' 58,67"	295°01'22.4"	2°51’23,73’’

The table presented contains a comparison of the Qibla direction produced by Google Gemini Al with the Qibla direction manual in five cities in Indonesia: Semarang, Surabaya, Banyuwangi, Jakarta and Aceh. There is an insignificant difference between the Qibla direction generated by Gemini AI and the manual calculation of the Qibla direction in all the cities compared. The difference ranges from 0°9' 6.18" to 2° 51' 23.73". This difference can occur due to differences in the coordinate data used as a reference in calculating the Qibla direction. However, determining the Qibla direction with Gemini AI still needs to be taken into account in the results. because the algorithm used cannot be confirmed so there is a greater possibility of errors occurring.

Table 5. Comparison of Question AI with Qibla direction manual

City	**Manuals**	**Question AI**	**Difference**
Semarang	294° 29' 47,94’’	117,5°	176° 59' 47,94"
Surabaya	294° 02' 04,41"	118,2°	175° 50' 04,41"
Banyuwangi	293° 51' 56,43’’	118,3°	175° 33' 56,43"
Jakarta	295° 09' 06,24"	119,2°	175° 57' 06,24"
Aceh	292° 09' 58,67"	120,5°	171° 39' 58,67"

There is a significant difference between the Qibla direction produced by the Question Al application and the manual calculation of the Qibla direction in all the cities compared. The

difference ranges from 171° 39' 58.67" to 176° 59' 47.94". This very significant difference in results can be caused by several factors. First, the location coordinate data and Kaaba coordinates used by Question Al may be inaccurate or do not match the data used in calculating the proper direction of the Qibla. Second, the algorithm used by Question Al to calculate the Qibla direction may be different from the method used to determine the Qibla direction conventionally. So Question Ai cannot be used to determine the direction of the Qibla because the difference in the results is very large and it deviates greatly from the actual direction of the Qibla.

According to Slamet Hambali, the level of accuracy of the direction of the Qibla is divided into four categories. First, very accurate, if the results of the direction of the Qibla are exactly facing the Kaaba. Second, accurate, if the deviation of the direction of the Qibla is not more than 0˚42'46.43". Third, less accurate if the direction of the Qibla has a deviation between 0˚42'46.43"-22˚30'. Finally, inaccurate, if the results of the direction of the Qibla have a deviation of more than 22˚30'.[16] Looking at the four types of AI in producing the direction of the Qibla, ChatGPT produces a very accurate direction of the Qibla. Gemini results are less accurate because they are in the range of 18.81 " to 2 ° 51'23.73 ". Meanwhile, for Microsoft Copilot and Question AI, they can be said to be inaccurate because there is a very significant deviation.

3. Analysis of the Use of Artificial Intelligence in determining Qibla Direction

The problem of determining the precise direction of the Qibla is not a difficult or difficult problem to do, considering the current advances in science. There are many methods that can be used to determine the Qibla direction, ranging from simple to high technology based. The use of Artificial Intelligence (AI) has great potential to help Muslims determine the direction of the Qibla more easily, accurately and efficiently. The use of AI also makes it easier for users to determine the Qibla direction. AI-based applications and websites can be accessed by anyone with a smartphone or internet device. This allows Muslims around the world, including in remote areas, to determine the direction of the Qibla easily.

Determining the Qibla direction using AI can be done, but there are several analyzes that can influence the results of calculating the Qibla direction of a place. Elements that can influence accuracy are point coordinate data, both location and Kaaba coordinates, and the algorithm used to calculate the direction of the Qibla.

[16] Slamet Hambali, "Menguji Tingkat Keakuratan Hasil Pengukuraan Arah Kiblat Menggunakan Istiwaaini Karya Slamet Hambali" (Semarang, 2014), 49–53.

One thing that is used to assess the accuracy of data is completeness, meaning that when looking at data on the coordinates of the Kaaba and location coordinates, whether the data is truly valid, that is, it includes the accuracy of the data which takes into account the determination of the position of a point on the Earth's surface and how accurate the data is. So, to analyze the correctness of the results of calculating the Qibla direction, the data source used and the calculation algorithm used are also looked at.

In AI chatGPT it is stated that the latitude of the Kaaba is 21.4225° N, and the longitude of the Kaaba is 39.8262°. in this case ChatGPT has the ability to determine the coordinates of a place correctly. Even though the coordinate data source is not included, the results show that the location is still included in the city area in question. Apart from that, the Qibla direction calculation used in ChatGPT uses spherical trigonometry theory to calculate the Qibla direction of a place. In the context of determining the direction of the Qibla, spherical trigonometry is used to calculate the angle between a location and the Kaaba, taking into account the curvature of the earth. In the calculation process, ChatGPT also utilizes Python programming, This allows ChatGPT to perform spherical trigonometry calculations accurately and efficiently. Even though it has the ability to calculate the Qibla direction properly and correctly, ChatGPT still has a weakness, namely that its use is limited by quota, so you cannot freely use it in several places at a certain time.

When using Microsoft Copilot AI to determine the Qibla direction there, you use a method that refers to other sources on the internet. Determining location coordinates in Copilot AI still has problems, the coordinate data displayed in the answer is still very far from being correct. For example, when determining the Qibla direction, the city of Semarang states that it has latitude 21.4222 and longitude 39.8272. This will cause confusion among users, plus the information that the distance to the Kaaba is 106 meters. This proves that when using Microsoft Copilot AI it cannot be used as a reference in determining the Qibla direction.

Gemini AI, previously known as Bard, is a large language model developed by Google AI that is free to use. Google Gemini determines location coordinates correctly when asked for the Qibla direction of a place. For example, the coordinates for Banyuwangi are stated to have a latitude of 8°23'S, 114°21'E. These coordinates are still included in the Banyuwangi area. However, in its calculations Google Gemini does not mention the theory used in the calculation process. Gemini takes from online sources to determine its Qibla direction calculations. So this is what causes there to be a difference between the actual calculations.

Lastly there is Question AI, Question AI is a platform that uses artificial intelligence to generate and solve questions. The platform is designed to help users understand and learn about various topics in an interactive and engaging way. Question AI uses advanced algorithms and machine learning models to generate relevant and accurate questions, and provide clear and concise answers. The platform can be used by individuals, teachers, and educators for a variety of purposes, including learning, research, and evaluation. In determining the direction of the Qibla using Question AI, it produces answers that are still very far from the truth. Question AI only answers with incorrect directional angle values without accompanying coordinates of a place and the calculation algorithm used is also not explained. So the results of the Qibla direction using question AI are very inaccurate.

According to Thomas Djamaluddin in Falak and Astronomy, insignificant errors in determining the direction of the Qibla can still be tolerated considering that it is impossible for us to keep our body posture absolutely always straight towards the Qibla. The direction of the prayer congregation's Qibla will not look different if the difference between the congregation is only a few degrees. It is very possible that, in very tight conditions (as often happens in some mosques), the shoulder position is sometimes slightly tilted, the right shoulder in front of the congregation on the right, the left shoulder behind the congregation on the left. However, to be more stable in terms of worship, it would be better to determine the direction of the Qibla more carefully.

Of the several AIs that have been tested to determine the Qibla direction, there are still many things that need to be evaluated. Only chatGPT can determine the direction of the Qibla with precision in accordance with the rules for calculating the direction of the Qibla that are currently being developed. This is an opportunity for academics and practitioners of astronomy to continue to develop AI-based Qibla direction technology . So that education in the field of astronomy can go hand in hand in accordance with today's technological advances.

4. Challenges of Applying Artificial Intelligence in Determining Qibla Direction

Although Artificial Intelligence (AI) offers many opportunities to help Muslims determine the direction of the Qibla, there are several challenges and considerations that need to be taken into account. AI algorithms require accurate and complete data, but data limitations in remote areas can hinder their accuracy. AI algorithms, no matter how sophisticated, are not free from potential errors, as explained above, there are several AI that produce Qibla directions that are very far from the proper Qibla direction.

Dependence on this technology can trigger forgetting traditional methods such as manually calculating the Qibla. No matter how sophisticated AI is in determining the Qibla direction, don't forget education about the importance of determining the Qibla direction using traditional methods. Awareness and adoption of this technology in underserved communities is another challenge. Finally, the impact on local traditions and culture regarding determining the direction of the Qibla must be carefully considered. So that harmony can be established between existing technological developments and religion.

D. Conclusion

Based on research conducted, AI has great potential to be used in determining Qibla direction. One AI that can determine the Qibla direction accurately is ChatGPT. ChatGPT uses the spherical triangle method and the calculations are equipped with Python programming so that it can produce accurate results. However, it is important to note that other AIs still have some limitations in producing the Qibla direction which is still far from the proper Qibla direction. The results of AI still cannot be applied properly. So further research and development is needed to produce a product that can determine the direction of Qibla based on AI that is more applicable.

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