

Determination Dawn of Shadiq in Masalembu Island by Using Image Processing Sobel Edge Detection Technique

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Abstract:

The value of the sun's elevation -20 below the horizon as criteria for Subuh prayer began to be reviewed again by researchers and fuqaha. The results of some research were different with Ministry Religion Affairs and raise doubts for some Muslims then need to require re-verification. Astrophotography and image processing techniques are introduced to solve this problem. The rising of morning twilight can be detecting and analyze by image processing because the image before and after will have different pixel values. Capturing image as the data of this research started when the altitude of the sun is -23° below the horizon. The duration of capturing the picture every once in a minute. After the image has been collected in 7 days, Sobel image processing utilizes to identify the edge of the horizon when the dawn light appears. Combining proper setting camera calibration with nice weather, the Sobel operator's edge detection successfully detects dawn shadiq as the beginning of subuh prayer. The value of the sun's altitude obtained in this research based on image processing is -19.7128 with a standard deviation (σ) of 1.114429.

Keywords: Dawn of Shadiq, Sobel Edge Detection, Subuh Prayer.

Introduction

The criteria of the beginning of dawn time set by the Ministry of Religious Affairs of the Republic of Indonesia began to be doubted by Muslims since Mamduh Farhan Al Buhairi and Agus Hasan Bashori stated that the dawn in Indonesia is too early until 24 minutes.¹ The utilization of sun's altitude -20° below the horizon as a criterion of beginning subuh prayer from Ministry Religion Affairs is considered only following the historical opinion of Saadoe'din Jambek. Saadoe'din Jambek's opinion comes from Shaykh Muhammad Thahir Jalaluddin's

¹ Al-Bukhairi Mamduh Farhan and Agus Hasan Bashori, *Koreksi Awal Waktu Shubuh*, 2010.

thoughts². In addition, some researchers also stated a value of -20 not based on the results of adequate research and observation but based on historical^{3 4}.

The legal basis to analyze the astronomical characteristics beginning of subuh prayer found in Al Baqoroh [2]: 187:

وَكُلُوا وَاشْرَبُوا حَتَّى يَتَبَيَّنَ لَكُمُ الْخَيْطُ الْأَبْيَضُ مِنَ الْخَيْطِ الْأَسْوَدِ مِنَ الْفَجْرِ

Meaning: "And eat and drink until it becomes clear to you the white thread from the black thread from the dawn".

The word "white thread" and "black thread" are figurative words. "White thread" represents the rising of dawn *shadiq*, on the other hand, the word "black thread" represents the darkness of the night. Based on this verse, it can be concluded that the starting subuh prayer begins when a beam of light rises like a black thread on a white thread. In fact, *Fuqaha* have agreed that the phenomenon of the arrival *shadiq* dawn is the beginning of the subuh prayer⁵ as explained in the following hadith:

عَنِ ابْنِ عَبَّاسٍ رَضِيَ اللَّهُ عَنْهُمَا قَالَ: قَالَ رَسُولُ اللَّهِ صَلَّى اللَّهُ عَلَيْهِ وَسَلَّمَ: الْفَجْرُ فَجْرَانِ، فَجْرٌ يُحْرَمُ الطَّعَامُ وَتَحِلُّ فِيهِ الصَّلَاةُ، وَفَجْرٌ تَحْرُمُ فِيهِ الصَّلَاةُ، أَيْ صَلَاةُ الصَّبْحِ، وَيَحِلُّ فِيهِ الطَّعَامُ رَوَاهُ ابْنُ خُرَيْمَةَ، وَالحَاكِمُ، وَصَحَّاهُ

Meaning: "There are two dawns; (First) the dawn in which food is forbidden and prayer is permitted, the (second) dawn in which food is permitted and the Fajr prayer is forbidden." (Sahih al-Bani in Sahih Al-Jami no. 4279).

Based on the hadith above, there are two types of dawn. The first dawn, namely the *shadiq* dawn, is when fasting getting forbidden and prayer is permitted. While the second type of dawn, namely *kadzib* dawn, is the dawn where fasting getting lawful but praying is forbidden. However, until now, no observatory has been able to formulate the value of the sun's altitude for the beginning of dawn. Some information and research even tend to write based on the author's reference⁶.

Praying is not valid when they are not performed according to its right time⁷. However, determining a false time for the dawn prayer can have an impact on several issues of the law worship for Muslims⁸. Some of them are the obligation to

² Arwin Juli Rakhmadi Butar-Butar, "Kontribusi Syaikh Muhammad Thahir Jalaluddin Dalam Bidang Ilmu Falak," *MIQOT: Jurnal Ilmu-Ilmu Keislaman* 42, no. 2 (2019): 300, <https://doi.org/10.30821/miqot.v42i2.553>.

³ Bahali Kasim, "Measuring the Sun Depression Angle of Dawn with a DSLR Camera" 47, no. 11 (2018): 2877–85.

⁴ Dhani Herdiwijaya, "Sky Brightness and Twilight Measurements at Jogjakarta City, Indonesia," *Journal of Physics: Conference Series* 771, no. 1 (2016): 1–5, <https://doi.org/10.1088/1742-6596/771/1/012033>.

⁵ Nihayatur Rohmah, "The Effect of Atmospheric Humidity Level to the Determination of Islamic Fajr/Morning Prayer Time and Twilight Appearance," *Journal of Physics: Conference Series* 771, no. 1 (2016): 16–19, <https://doi.org/10.1088/1742-6596/771/1/012048>.

⁶ Molvi Ahmed Yaqub Miftahi, *Fajar and Isya Times & Twilight*, 2005.

⁷ Ahmad Sarwat, *Waktu Shalat* (Jakarta: Rumah Fiqh Publishing, 2018).

⁸ Abdul Mughits, "Problematika Jadwal Waktu Salat Subuh Di Indonesia Pendahuluan Akhir-Akhir Ini Jadwal Waktu Salat Subuh Di Indonesia Telah 'Digugat' Oleh Sebagian Dari Kalangan

fast for women after menstruation or nifas when their blood stop between these times. On the other side, one of the sunnah from prophet Muhammad to eating sahur at the end of the time is inappropriate. It was also mentioned that if someone has doubts about their time of prayer, even though it is already in time, then the prayer is still invalid⁹. So it is necessary to review the beginning of subuh prayer in the morning.

Table 1. Previous research that related to the criteria of dawn time summarized

No	Researcher	Location	Sun Altitude
1.	Arumaningtyas et al. (2012) ¹⁰	Bandung and Jombang	-10 °
2.	Rohmah (2016) ¹¹	Central Java (Juwiring, Pati, Yogyakarta), East Java (Kaibon), and West Java (Bandung)	-18.5°
3.	Noor & Hamdani (2018) ¹²	Central Java (Tayu Pati Beach)	-17°
4.	Saksono & Fulazzaky (2020) ¹³	West Java (Depok)	14° ± 0.6
5.	Basthoni (2021) ¹⁴	East Java (Banyuwangi) and Central Java (Karimunjawa)	-20±0.2
6.	Rusli ¹⁵	East Java (Malang)	-20°

Correcting or verifying the validity of subuh prayer's criteria is not enough based only on the observation of true dawn in one or two locations. It is necessary to observe long-term in Indonesia by paying attention to the variations and

Umat Islam Karena Dinilai Masih Terlalu Pagi , Terutama Setelah Terbitnya Beberapa Tulisan y" 48, no. 2 (2014).

⁹ Wahbah az Zuhaili, *Al-Fiqh al-Islami Wa Adillatuh*, 3rd ed. (Beirut: Dar Al-Fikr, 1989).

¹⁰ Eka Puspita Arumaningtyas, Moedji Raharto, and Dhani Herdiwijaya, "Morning Twilight Measured at Bandung and Jombang," *AIP Conference Proceedings* 1454, no. 1 (2011): 29–31, <https://doi.org/10.1063/1.4730680>.

¹¹ Rohmah, "The Effect of Atmospheric Humidity Level to the Determination of Islamic Fajr/Morning Prayer Time and Twilight Appearance."

¹² Laksmiyanti Annake et al., "THE DAWN SKY BRIGHTNESS OBSERVATIONS IN THE PRELIMINARY SHUBUH PRAYER TIME Beginning of the Entry Time to Undergo the Shubuh Prayer" 6, no. 1 (2018).

¹³ Tono Saksono and Mohamad Ali Fulazzaky, "Predicting the Accurate Period of True Dawn Using a Third-Degree Polynomial Model," *NRIAG Journal of Astronomy and Geophysics* 9, no. 1 (2020): 238–44, <https://doi.org/10.1080/20909977.2020.1738106>.

¹⁴ Moch Basthoni, "A Prototype of True Dawn Observation Automation System (Prototipe Sistem A Prototype of True Dawn Observation Automation System (Prototipe Sistem Otomatisasi Observasi Fajar)," *Jurnal Sains Dirgantara* 18, no. December 2020 (2021): 33–42, <https://doi.org/10.30536/j.jsd.2020.v18.a3475>.

¹⁵ Rusli, Niswatul Kariimah, and Asni Furaida, "Image Processing Application to Know the Dawn of Shadiq Using Matlab Software" 529 (2021): 777–81.

properties of each region.¹⁶ The combination of technology with field observation is expected to facilitate research at the beginning of dawn. Image processing techniques were introduced to help humans getting better interpretations and improve more image information¹⁷. Differences in two consecutive images due to the appearance of dawn that cannot be detected by the naked eye can be detected through image processing techniques¹⁸. In the image of dawn, there is a change in light between data with one another. The results of changes in light, color, shadow, and texture are called in image processing called edges¹⁹.

There are a variety of edge detection techniques in image processing, some of which are canny, prewitt, and sobel. Canny is the best technique, sensitive, and has a low error value. How canny works by detecting the edge of an image vertically, horizontally, or diagonally.²⁰ So canny edge detection will become very sensitive, although there is a disturbance in the form of light pollution. On the other side, the Sobel operator has high edge detection accuracy. It works by detecting edge objects from vertical and horizontal directions. So in this study, the Sobel edge detection method can be chosen for the initial determination of the beginning of *shadiq* dawn.

A research method to correcting the value of sun altitude use astrophotography techniques. The research data are digital images that capturing when the sun's altitude is around -23° below the horizon or about 15 minutes before dawn. The duration of capturing a picture is every once in a minute. This duration was selected because the scheduling of prayers is done every minute. The *shadiq* dawn can be detected in areas with a night sky brightness of more than 21 mpsas²¹. It shows that the location has low light pollution. Masalembu island has 22 mpsas a night sky brightness, so it can be expected that dawn *shadiq* can be visible. Masalembu is located in Sumenep Regency, East Java with coordinates -05° 32' 14" South Latitude and 114° 24'50" East Longitude.

¹⁶ Basthoni, "A Prototype of True Dawn Observation Automation System (Prototipe Sistem A Prototype of True Dawn Observation Automation System (Prototipe Sistem Otomatisasi Observasi Fajar)."

¹⁷ Achal Sharma, "Analysis of Sobel Edge Detection Technique for Face Recognition," *International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)* 4, no. May 2015 (2015).

¹⁸ Tono Saksono, Adi Damanhuri, and Zamah Sari, "Awal Subuh Dan Isya: Tinjauan Beragam Teknologi Dan Proses 1," *Halaqah Ahli Hisab Muhammadiyah Yogyakarta*, 5-6 Mei 2018 M, 2018.

¹⁹ Rajshree Kumari et al., "A Review on Comparative Study of Different Edge Detection Techniques," 2020, 748–54.

²⁰ Kumari et al.

²¹ Basthoni, "A Prototype of True Dawn Observation Automation System (Prototipe Sistem A Prototype of True Dawn Observation Automation System (Prototipe Sistem Otomatisasi Observasi Fajar)."

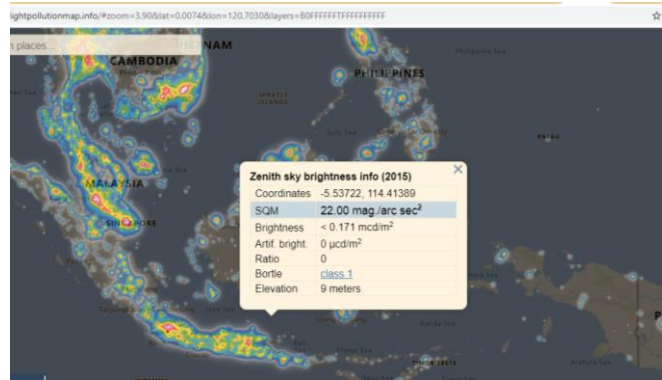


Figure 1: The brightness of the sky at the research site, Masalembu



Figure 2: *Shadiq* Dawn on Masalembu Island

This study used the Canon EOS Kiss X7 along with a camera tripod as the main instrument. The processing of this research data by using Matlab Software version 2017a. The data processing algorithm is described as follows:

- Capturing image every minute
- Changing RGB image type to grayscale
- Processing image with sobel operator
- Analyzing image to know the beginning of dawn *shadiq*
- Analyzing and calculating the value of the sun's altitude
- Declaring the conclusion value of the sun's altitude by using statistics

On the other side, calculating the value of the sun's altitude by the flow chart below:

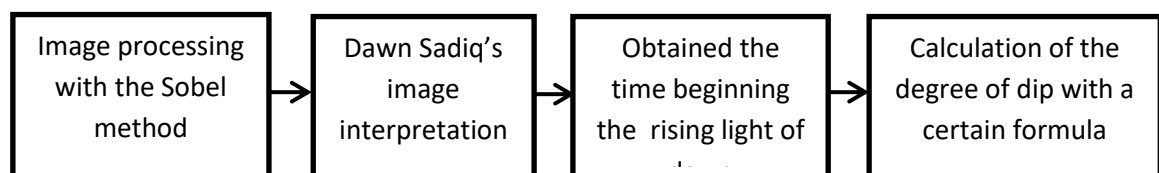


Figure 3: Flowchart of the calculation of the sun's altitude

While the formula for calculating the sun's altitude is:

$$\sin h = (\cos t + \tan \rho \tan d) \cos \rho \cos d \quad (1)$$

$$h = \arcsin (\cos t + \tan \rho \tan d) \cos \rho \cos d \quad (2)$$

Where ρ is the latitude of the place.

d is the sun's declination.

t is the solar time angle.

h is the height of the sun.

The beginning rise of light is characterized by the detection of an elongated outline on the eastern horizon. Based on the results obtained, data is collected in Microsoft Excel for analyzing and declaring conclusions. The last, sun altitude's data will be analyzed by collecting them all using statistics to formulate parameter beginning of dawn *shadiq*.

Result and Discussion

Image processing using sobel operator edge detection can be used to detect dawn *shadiq*'s light on the eastern horizon in Masalembu Island. Edge detection operators can be optimized to see horizontal, vertical, or diagonal edges of the image. But, detecting dawn only based on horizontal and vertical directions to reduce noise like light pollution. Using horizontal and vertical direction to detect the edge of beginning dawn because the light's dawn of *kadzib* rising vertically upwards. On the other hand, the dawn of *shadiq*'s light spreading from north to south. So, using horizontal and vertical directions got a better result.

The result of image processing by using sobel edge detection show in the table below. The images before and after dawn are different because the light of sunrise makes the horizon's line visible. It represents just like a line in the middle. The horizon's line can be visible because of the light of dawn spreading on horizon.

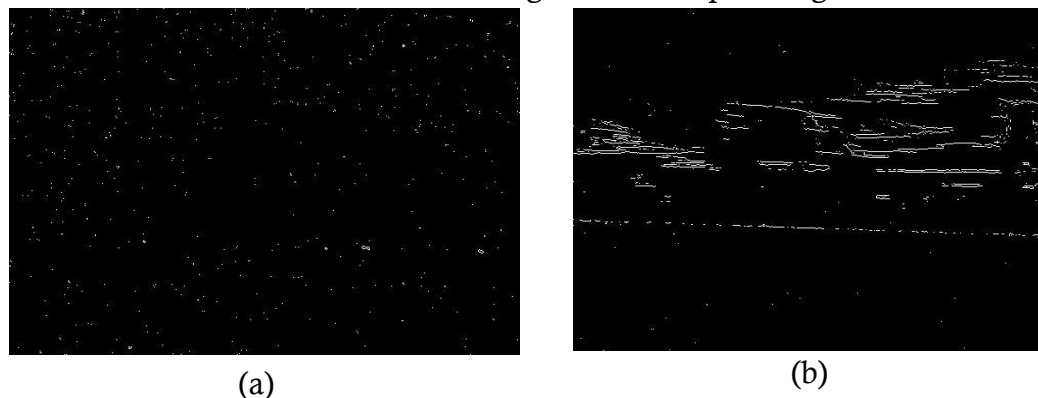


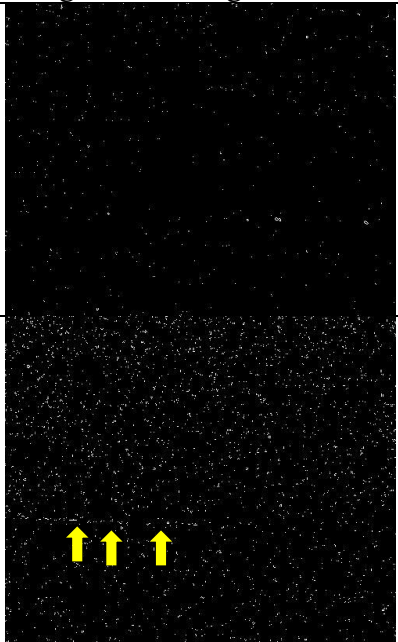
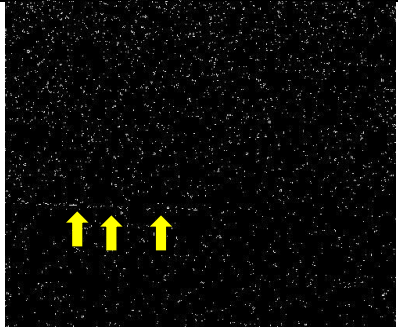
Figure 4: The results of processing the dawn image using the sobel operator. Picture 4(a) is the image before dawn *shadiq* appears, and picture 4(b) is after dawn *shadiq* appears

The result of image processing using edge detection shows white thread on black thread phenomena because of the sunrise's light. The rising of the sun representation white thread on a black thread, according to the definition of dawn.

It's in accordance with the interpretation of the verse Q.S Al-Baqoroh [2]: 187. As shown in the picture (3), the horizontal dawn light of *shadiq* stretches across the eastern horizon like a white thread. Whereas because there is no light other than light coming from the rising of the sun, the edges of other objects are indistinguishable. This is in accordance with the principle of human vision, the edges of objects can be seen and can be distinguished from each other when there is a light.

Before dawn *shadiq* appears, first begins with the appearance of the dawn *kadzib*. Fajr *kadzib* is the result of the scattering of sunlight by interplanetary dust. But the dawn of *shadiq* phenomena comes from the scattering of sunlight by the Earth's atmosphere. The appearance of *kadzib* dawn begins from a weak beam of light then overlapping with the dawn light of *shadiq*. It can be seen in Figure 3a that there is no outline of the horizon as shown in Figure 3b.

The basic idea of image processing using the edge detection method is the change of pixels due to the appearance of a beam of light then make the border between objects become visible. In the context of this study, the beginning of dawn light is still weak, but pixel changes will make the horizon boundary of the research location in offshore beaches will be visible. For more details, the image processing results are shown in the image below::

Dawn image data	Image Processing Results	Information
		Image processing before dawn <i>shadiq</i> detected
		The beginning of the dawn. The horizon line is starting to be detected, although it is very weak.

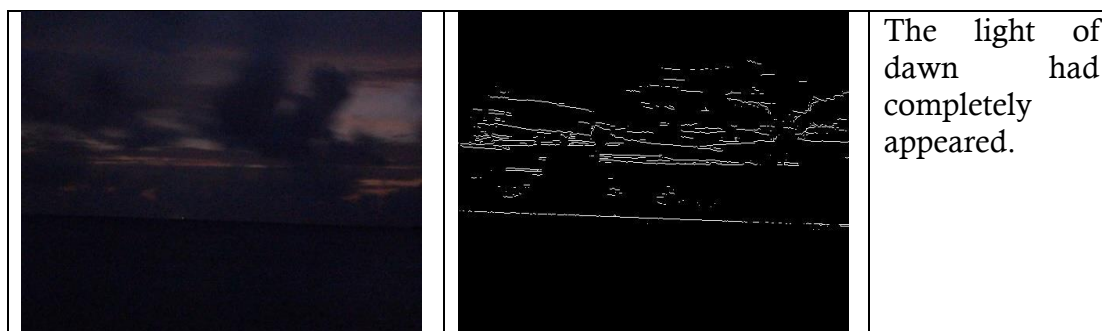


Figure 5: Image processing results on September 28, 2020

After analyzing the image of the appearance of dawn in the morning, then the value of sun altitude below the horizon is calculated. It's will be a very important thing because sun altitude value is used in the future for calculating the prayer schedule. Collecting Imagery data is conducted for one week from the middle until the end of September 2020. The time of collection is not carried out continuously due to weather considerations and noise from moonlight. After doing image processing, the results of data processing are shown in the following table:

Table 2. The results of research data in Masalembu Island.

No	Date	Morning time Ministry of Religion	Morning time research results	Dip	Average dip (°)	Standard deviation (σ)
1	18-09-2020	3:57	3:57	-20.6265	-19.7128	1.114429
2	19-09-2020	3:56	4:06	-18.2648		
3	21-09-2020	3:55	3:55	-20,7502		
4	22-09-2020	3:55	3:56	-20.3761		
5	27-09-2020	3:52	3:53	-20.3616		
6	28-09-2020	3:52	3:56	-19.4895		
7	29-09-2020	3:51	4:01	-18.1212		

After processing the data, it can be concluded that the results of the average dip are -19.7128 with a standard deviation (σ) as big as 1.114429. Standard deviation is important to measure that how much variation or dispersion of the mean value. A low standard deviation indicates that the data value very close to the mean, while a high standard deviation value indicates the opposite. A smaller standard deviation indicates that the data are clustered tightly around the mean; normal distribution will be higher. Because the standard deviation (σ) btained in this study in the range of 1, so it can be concluded that the data is collected around the mean value. It means that the sun altitude value of this research is centered around the average value. The standard deviation value is 1.114429 states that 68% of the calculated results are in the statistical range between -18.59° and -20.82°. The value of -18.59841384° is obtained from the results of the average added to the standard deviation value (-19.7128° + 1.114429). Meanwhile, the value of -20.82727188° was obtained from the average dip subtracted by the standard deviation value (-19.7128° -1.114429).

Conclusion

The application of image processing disciplines, especially edge detection sobel technique, is one of the innovations that can be used to detect early entry of dawn time prayer. Sobel operator can detect the edge of the eastern horizon in the research location as the appearance of the dawn rays of *shadiq* very well. After taking and processing data for 7 days, it can be concluded that the sun's altitude value (dep) in Masalembu is -19.7128° with a standard deviation (σ) of 1.114429. The standard deviation value of 1.114429 indicates that 68% of the calculated results are in the statistical range between -18.59° and -20.82° .

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