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Image processing analysis to determine fajr time using the imagej application

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Abstract

The determination of early prayer times is an essential aspect as it is one of the five pillars in Islam and prerequisites for prayers to be accepted. The government has set a standard for carrying out the fajr prayer by determining the degree of appearance of the fajr as-Sadiq at -20. This study aims to compare the initial determination of the government's fajr time using different sensors. In this case, the drones as the image sensor. The drone was chosen because it has several advantages. The result of data is in the form of images. Then the images were processed using digital image processing software, called Imagej. The data from Imagej processing were in the form of mean and standard deviation. All data were then recapitulated using Microsoft excel and plotted to form data which was then carried out by a polynomial approach to determine the cut-off point as an early indicator of the beginning of fajr. The method used in this study is using a qualitative analysis method with a polynomial 5 approach. The conclusion obtained in this study is that the government's fajr time is 21 minutes faster. The standard used in this study is a DIP of -13.95. Unlike the SQM with 2D drone data, the 3D version generates more accurate data analysis and is not easy to manipulate because it can be verified with image data.

Keywords: Drone; Imagej; Polynomials; Fajr Time; DIP

Introduction

The determination of early prayer times is an essential aspect for Muslim as it is one of the five pillars in Islam and prerequisites for prayers to be accepted. Prayer times are determined based on the sun's elevation to the earth. The time for the Dhuhr prayer can be measured by the image of an object vertically slipping from the position of the cut-off point [1]. The Asr prayer is closely related to the sun when it is at its culmination [2]. It is marked when the shadow of an object is in the same length. The time for the Maghrib prayer can be seen when the sun has set. Then, the time for the Isha prayer begins when the red light has disappeared in the sky. Then, the time of Fajr is when the beginning of the dawn.

The determination of accurate time for the Dhuhr, Asr, and Maghrib is not too difficult because it can be verified by the position of the sun's movement and measured by the length of the shadow that is clearly visible [3]. Since the apparent path of the sun is relatively constant, it is easy to calculate the position of the sun at the beginning of prayer times every day of the year. Thus, it will be easier to the people who want to perform the prayer at the beginning of the time.

The times for Fajr and Isha prayers refer to the beginning and end of the astronomical twilight. The time of Isha begins with the fading of the red light (syafaq) on the western horizon, a sign of the beginning of night until the arrival of Sadiq as (fajr time) [4]. However, there are some difficulties in determining the accurate time for the Fajr and Isha prayers because the sun is below the horizon. Therefore, the shadow measurement cannot be displayed [5].

In addition, the existence of lined skyscrapers, the lights that now adorn cities around the world, and the increasing amount of air pollution are increasingly preventing Muslims from knowing the start of prayer times accurately. Therefore, the Falak and astronomy scientists created tools that can be used to help determine the beginning of prayer times.

The government has set a standard for Muslims to perform the Fajr prayer. It is done by determining the degree of appearance of the fajr as sadiq at -20^{O} below the eastern horizon obtained by the government, under the agency of Hisab and Rukyat chaired by Prof. Thomas Djamaluddin [6]. The data collection was carried out in Labuan Bajo with a non-image sensor called the Sky Quality Meter (SQM).

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Based on the explanation above, the researchers want to compare the initial determination of the government's Fajr time using different sensors, such as drones as image sensors. The drone was chosen because it has many advantages. The result of the data was in the form of images to be verified and hard to manipulate. This research includes field research [7]. The method used in this study is a polynomial approach to determine the cut-off point as the beginning of the fajrs as sadiq which marks the beginning of fajr time.

Method

A. Image Processing Technique

An image is a figure or photo of a two-dimensional display that visualizes an object [8]. The image can be displayed in printed or digital form [9]. In the image processing technique, some images will be processed as input which then produces images as output [10]. This technique can be easily processed using a laptop as a computational tool in processing images. In a digital image, there is a two-dimensional matrix f(x,y) consisting of M columns and N rows [11], where the intersection between the columns and rows is called the pixel or the smallest element of an image. Image processing aims to improve image quality to be easily interpreted by the senses of the human vision or machine (computer)[12].

There are three types of digital images generally used in image processing techniques that are the color images with RGB (Red, Green, Blue) colors. Each base color uses 8 bits of storage = 1 byte in color images, which means that each color has a gradation of 255 colors [13]. The second is a gray scale image. Each pixel have a color gradation from white to black with a pixel range of 8bit or 1 byte in this image. Next, the third is binary image. It is often referred to as B&W image (black and white) or monochrome image [14]. It takes 1 bit in memory to store these two colors.

B. Histogram

Histogram is a graph that depicts the distribution of pixel intensity values of an image or a certain part in the image. From the histogram we will get the relative frequency of occurrence of the image intensity [15]. Histograms can also tell you a lot about the brightness and contrast of an image. Contrast is the level of spread of pixels into color intensity. Therefore, histogram is a valuable tool in image processing work both in a qualitative and quantitative way [16].

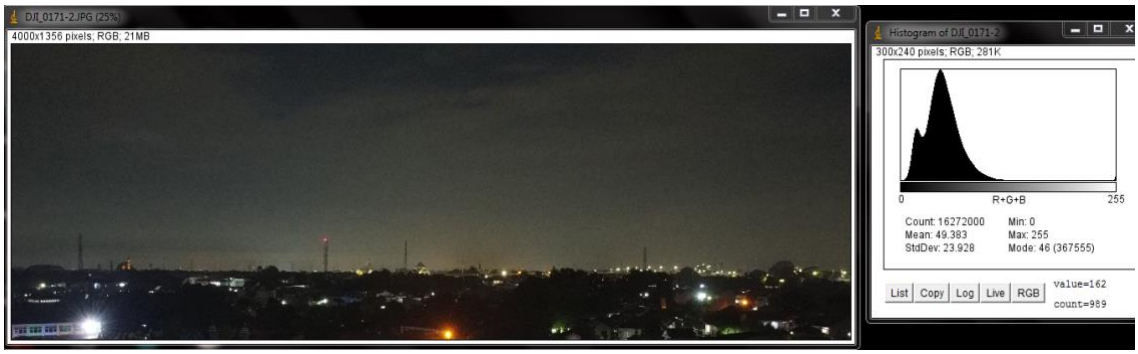

Figure 1. The Image of Sky and RGB Histogram

C. Value of solar dip (Sun depression angle)

The solar dip referred to in the book entitled "Early Evaluation of Fajr and Isha prayer times" is similar to the sun in the perspective of astronomy. The reason in the book uses the term dip of the horizon because the position of the sun is below the horizon. This reason is reinforced by the international term that DIP is the height of the sun below the horizon. The term DIP refers to the Sun depression angle, which means the depth of the sun. In determining the time of Fajr, the appearance of Fajr as sadiq is one of the indicators. This is the actual Fajr which indicates that the dawn has entered the position of the sun's height of about -20̊ below the horizon in the east [17]. This position is called DIP, in this study DIP is used as a reference in determining the beginning of prayer times.

D. Polynomial Equations

Polynomial is one of the mathematical functions that involve multiplication, exponents, and variables. To find the equation root of the function, it is necessary to find the value of the variable that has a function value of 0 (f(x) = 0. The following is the basic form of polynomial equations.

$$Y = a0 + a1x^1 + a2x^2 + a3x^3 + \cdots + anx^n \quad (1)$$

Where:

a is a constant value

n is the degree or order

x is the value of the variable

The root of the polynomial equation is the value of the x variable which has a value of f(x) = 0. So, if the value of x is included in the equation the result is 0. For polynomials in the form of a quadratic or third-order, this can be done analytically, but if the polynomial degree is more than three very difficult to find by analytical means [18].

The equation is centered using a center tab stop. Be sure that the symbols in your equation have been defined before or immediately following the equation. Use "(1)," not "Eq. (1)" or "equation (1)," except at the beginning of a sentence: "Equation (1) is ..."

E. Methodology

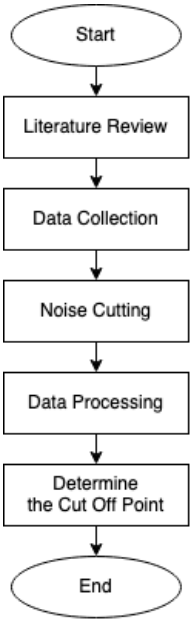

Figure 2. Methodology

This research began by learning digital image processing material. After that, it was continued by learning and experimenting using drones as a tool for data collection in the form of images. The data collected was 212 images to obtain maximum results. After collecting data, the process of cutting images with a lot of noise was carried out. After the noise was removed from the images, the image data was then processed using image j software.

In this process, the standard deviation value was obtained. After that, the dip value was calculated by entering the coordinates of the data collection location in the NOAA formula developed by ISRN UHAMKA. After that, a table was created. Therefore, a graph can be calculated using the ABC formula in MATLAB to determine the cut-off point as the beginning of dawn determinant. The dip value in this study was used as a standard comparison as a reference in the future.

Results and Discussion

The data was retrieved at a drone flight altitude of 30 meters and taken every 15 seconds with a supply of 3 batteries. Each battery can last for ± 20 minutes and produce 213 images data. The following are the results of the data obtained. The data processed is the image data with a range of once per minute.

Table 1. Data Processing Results

No	Photo ID	Standart Dev.	Time	DIP (deg)
1	171	23.906	4:31:15	-21.66
2	173	24.116	4:32:15	-21.41
3	177	24.468	4:33:15	-21.16
4	181	24.629	4:34:15	-20.91
5	185	24.906	4:35:15	-20.66
6	189	24.877	4:36:15	-20.41

7	193	24.867	4:37:15	-20.17
8	197	24.739	4:38:15	-19.92
9	201	24.767	4:39:15	-19.67
10	205	25.153	4:40:15	-19.42
11	209	25.365	4:41:15	-19.17
12	213	25.015	4:42:15	-18.92
13	217	25.528	4:43:15	-18.67
14	221	24.432	4:44:15	-18.43
15	225	25.276	4:45:15	-18.18
16	229	25.339	4:46:15	-17.93
17	233	24.96	4:47:15	-17.68
18	237	25.138	4:48:15	-17.43
19	239	25.248	4:52:15	-16.44
20	245	24.878	4:53:15	-16.19
21	249	24.615	4:54:15	-15.94
22	253	25.112	4:55:15	-15.69
23	257	25.038	4:56:15	-15.44
24	261	25.227	4:57:15	-15.19
25	265	25.177	4:58:15	-14.95
26	269	25.159	4:59:15	-14.7
27	273	25.43	5:00:15	-14.45
28	277	24.887	5:01:15	-14.2
29	281	25.389	5:02:15	-13.95
30	285	25.143	5:03:15	-13.7
31	289	25.362	5:04:15	-13.45
32	293	25.383	5:05:15	-13.21
33	297	25.219	5:06:15	-12.96
34	301	25.54	5:07:15	-12.71
35	305	25.483	5:08:15	-12.46
36	309	25.433	5:09:15	-12.21
37	311	25.813	5:10:15	-11.96
38	312	25.483	5:13:15	-11.22
39	316	25.668	5:14:15	-10.97
40	320	25.392	5:15:15	-10.72
41	324	25.329	5:16:15	-10.47
42	328	25.954	5:17:15	-10.22
43	332	25.724	5:18:16	-9.97
44	336	26.354	5:19:17	-9.72
45	340	26.637	5:20:18	-9.47
46	344	27.537	5:21:19	-9.22
47	348	28.449	5:22:19	-8.97
48	352	29.208	5:23:20	-8.73
49	356	31.818	5:24:21	-8.48
50	360	34.286	5:25:22	-8.23
51	364	37.431	5:26:23	-7.98

52	368	40.506	5:27:24	-7.73
53	372	45.023	5:28:25	-7.48
54	376	48.346	5:29:26	-7.23
55	380	53.613	5:30:27	-6.98
56	382	58.51	5:31:28	-6.73

After becoming numerical data, the data was plotted into a graph and then analyzed in the form of graphic data to determine the cut-off point. The graph displays the time value and the standard deviation value. So that it shows the brightness of the sky that is getting brighter marked by the increasing blue line that can be seen in Figure 3 below.

Figure 3. Graph of sky brightness approximated by polynomial

The graph was then brought together using the polynomial 5 equation. It is shown in the figure by a red dotted line. So, the equation is depicted as in the Polynomial Equations below.

$$Y = 6E + 09x^5 - 7E + 09x^4 + 3E + 09x^3 - 6E + 08x^2 + 6E + 07x - 2E + 06 \quad (2)$$

The next step was to find the cut-off point using the MATLAB program formula as shown in Figure 4 below:

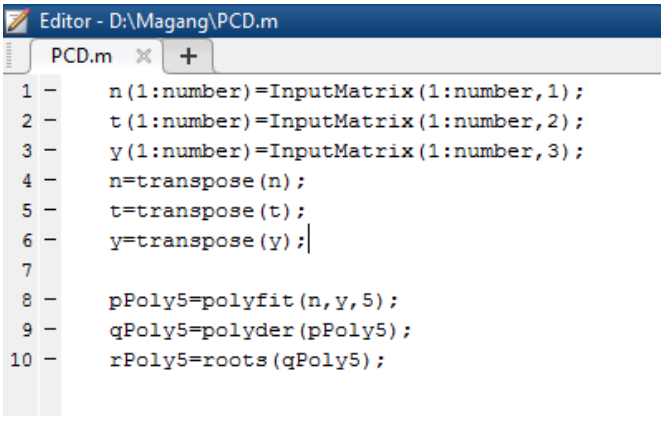

Figure 4. MATLAB Program Display

The next step was entering the MATLAB command window. Then, fill in the number as the initiation of the amount of data input in the program. After that, fill in the input matrix as the initiation to bring up the table. Enter excels data as much as 56 data matrix table. Then, run the program in the editor menu. Thus, the result obtained was 29.432, which are rounded up to 29. This number shows the number of the first appearances of the dawn as sadiq, which can be seen in table 1. So, it can be used to determine the beginning of the fajr time.

29	281	25.389	5:02:15	-13.95

Figure 5. Time of Appearance of fajr as sadiq

Meanwhile, the fajr time set by the government on the Ministry of Religion website shows the fajr time as shown in Figure 6.

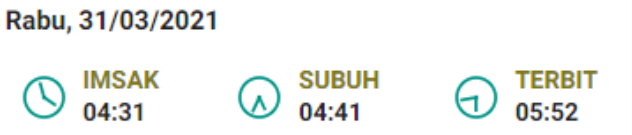

Figure 6. Government Version of Fajr Time

One of this research aims was as an additional reference for further research. In particular, for the government to review and conduct research again regarding the early entry of fajr time in Indonesia using sophisticated equipment. Therefore, the results are relevant to the existing technological advances to improve the quality of Muslims' prayers.

Conclusion

From the results of the polynomial equations obtained, it can be concluded that the determination of the cut-off point is at 05:02:15 which is 21 minutes later than the time set by the government. The appearance of the dawn as sadiq is when the sun at a dip of -13.95°.

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