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Predicting Times of Partial Solar Eclipse Event based on the Lens Flare Feature in Sequence of Images taken from Smartphone Camera by means of Sketch Filter

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Abstract

To predict times in a collection of events and the duration of the partial solar eclipse which occurred on 20th April 2023 at Bandung city, West Java province of Indonesia can be accomplished by just a collection of photograph pictures. The pictures are taken from a smartphone camera with sketch filter capability. By analyzing the boundary of the lens flare feature on the series of recorded pictures after pre-processing, the size and the locations of the overlapped regions between the sun and the moon can be identified and analyzed chronologically. The movement trajectory in a curve shape of the overlapped region centers can be obtained by extrapolating three center of the overlapped regions as the three points anchor that can be used to predict the start and end times also the peak time of the solar eclipse event

Keywords

Partial solar eclipse, lens flare, sketch filter on camera, three points anchor of extrapolation

Introduction

There are many researchers presenting their paper related to the sketch filter. Jiang, B. and Liu, S. presented a framework for automatically image sketching naturally using two-layer steps algorithm, sketch extraction and rendering [1]. Lu, J., Zhang, Z. and Chen, H. also used a two-layer of the sketch filter algorithm for estimating entropy in the data plane [2]. Khayan, A. and Khoenkaw, P. used automatic pencil sketch landscapes for generating images from photographs [3]. Klum et.al. presented sketch based face recognition for comparing the forensic and composite sketches to be used in investigating the suspects in criminal activities [4]. Peng, C. et.al. presented a multiple representations-based face sketch of photosynthesis as an important role in law enforcement and digital entertainment [5]. Stephane, M and Charlotte, P. proposed the primal sketch of image series with edge preserving filtering application to change detection of multitemporal image series [6]. Wan, W. and Lee, H.J. proposed face sketch synthesis with joint training model to improve the sketch synthesis performance by concatenating the high-pass information of the training sketch patches with photo patches together when calculating the reconstruction weight [7]. Zhang, X. et.al. solved the problem of sketch generation for sketch-based image retrieval by transforming photos from raw pixels to pseudo-sketches that fills the gap between these two domains [8]. Galea, C. and Farrugia, R. proposed a method which extracts multi-scale local binary pattern descriptors from overlapping patches of Log-Gabor-filtered images to obtain cross-modality templates for each photo and sketch [9].

There are many researchers presenting lens flare phenomena to be used for any purpose. Nussberger et.al. discussed robust tracking in images with lens flare feature that can be used by civil airspace in detecting, tracking and avoiding the aerial objects [10]. Sassoon, E. and Treibitz, T. discussed the implication of the stray light or flare caused by internal reflections between optical elements in interference-based hyperspectral cameras [11]. Zheng, Z. et.al. discussed a strategy of monitoring the level of optic system flare in the lithographic scanner in the lithography process [12]. In this paper the lens flare phenomenon is used as the valuable data instead of is avoided.

There are also researchers discussing the partial solar eclipse phenomenon, such as proposed by Thamyl, S.V. et.al. that proposed the quasi periodic echoes induced by a partial solar eclipse [13]. Fukami, T., Higashi, R. and Nagano, I. discussed the observation of the MF broadcasting wave intensities on the solar eclipse [14]. Uryadov, V.P. et.al. presented the result of observations of the ionosphere response to a partial solar eclipse on 11.08.2008 according to data from a network oblique sounding path in the Eurasian Region [15]. Maji, S., Chakrabarti, S. and Chakrabarti, S.K. and Mondal, S.K. reported the results of their monitoring of NWC transmitter from about 80 km away from Kolkata city of India during the partial solar eclipse of 15th January 2010.

Methods

There are two major steps, (1) the preparation and analyzation steps and (2) the calculation and interpretation steps. The first major step can be broken down into three minor steps. The first one (1a) is the step to capture the lens flare phenomenon on recorded photograph images taken from smartphone cameras which have the sketch filter capability during the partial solar eclipse event. The second step (1b) is to do pre-processing to have the objects, the sun and the overlapped region of the moon on the sun, be on a normalized scale. The last step (1c) is to pinpoint the objects and detect the center of the overlapped region for all images in sequence. The purpose of the first step is to have the boundary of the sun and the overlapped region with the moon be identified by using the sketch filter capability of the smartphone camera. The purpose of the second step is to have the chosen images of the sun and the overlapped region with the moon in sequence recorded with the same size that can be reproduced as the sequence of partial solar eclipse events from time to time, so the shift of the overlapped region can be figured out chronologically. Finally, the second major step can be broken down into two minor steps. The first one (2a) is the step to choose three centers of overlapped regions inside the sun as three points anchor and based on these anchors, a curve can be drawn through the three points and extrapolated to the edge of the sun boundary. So the start and end times of the solar eclipse event or the duration of eclipse event can be calculated based on the distances equivalence between two points with known time in the next step (2b).

Results

As the example result of step-1b, an image taken at 09:44 is chosen and displayed in Figure-1.

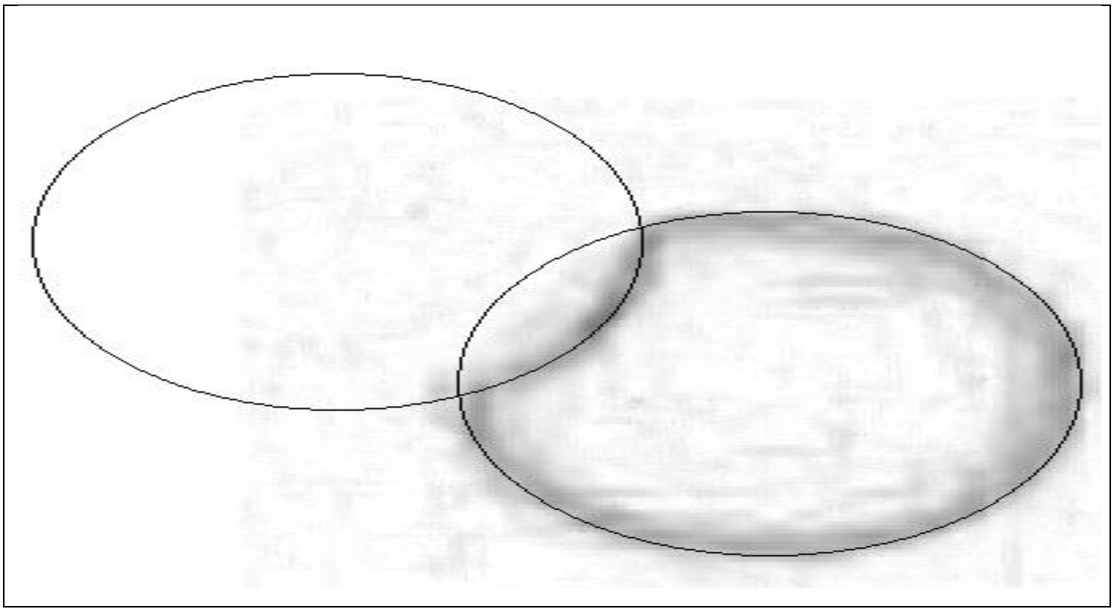

Figure-1. The example of lens flare feature of a photograph taken at: 09:44 is chosen, the boundary of objects is represented by two circles (the sun at right-side and the moon at left-side)

As the result example of step-1c, the same image as displayed in Figure-1 is chosen, but with additional information as the center of overlapped region as indicated by two crossed lines that can be seen in Figure-2.

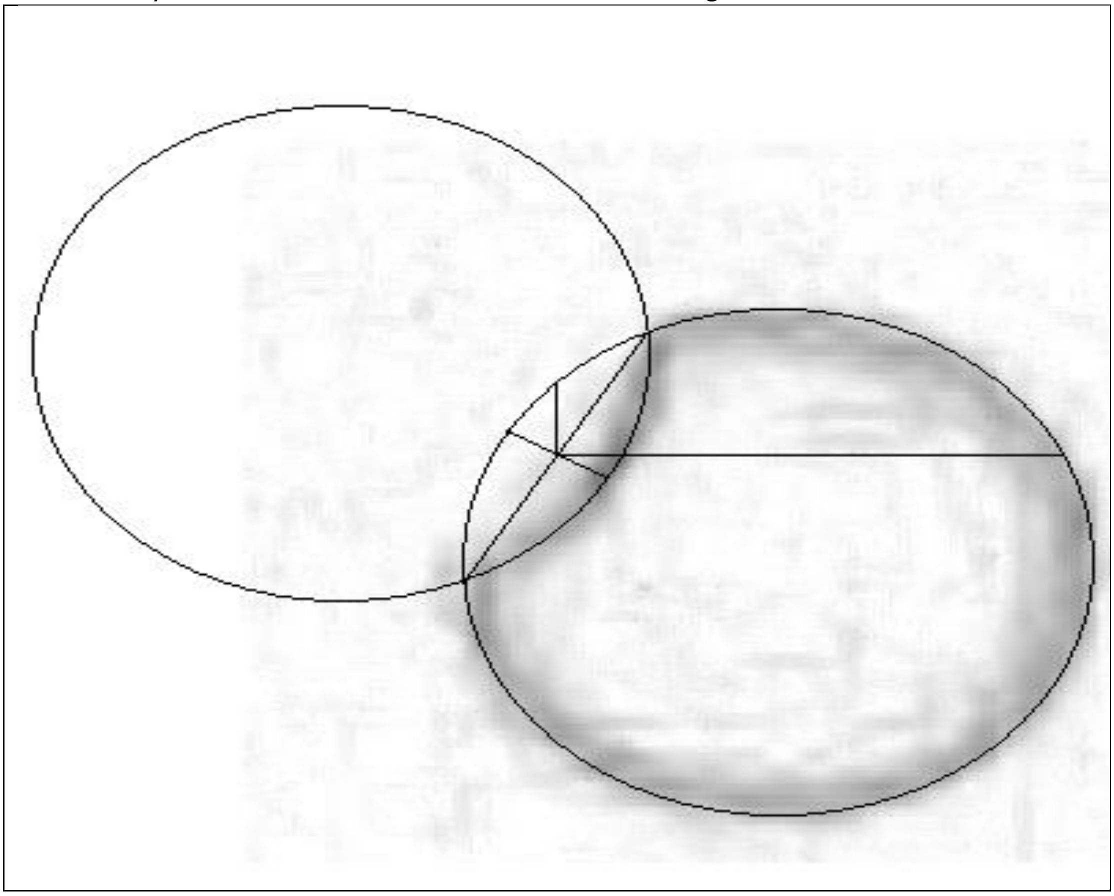

Figure-2. The center of overlapped region is indicated by two crossed lines of the image as the same image as displayed in Figure-1

The series of images (divided into two figures) as the whole result of step-1c are all displayed in Figure-3 and Figure-4 respectively at the Appendix. The three points anchor (A, B and C) is picked from the images labelled by the time at 09:41:22, 10:32:00 and 10:59:43 respectively. Shift point A and C into an overlapped region with point B inside after the boundary of the sun in which point A (left) and point C (right) inside are in line with the boundary of the sun in which point B (middle) inside (step-2a). The distance between point A and B (B-A) are 57 pixels that are equivalent to 3038 seconds, or one pixel equals 53.3 seconds. Point D as the first extrapolation result of the curve through the three points anchor has a distance 70 pixels from point B or equals to 3731 seconds. Point E as the second extrapolation result of the curve through the three points anchor has a distance 100 pixels from point B or equals to 5330 seconds. So the duration of the solar eclipse can be predicted as the equivalent of (3731+5330) pixels or 2 hours, 31 minutes and 1 second. The start of the eclipse event (D) is 1 hour, 2 minutes and 11 seconds before the time of point B, so the start time of the solar eclipse can be predicted to have happened at 09:29:49. The end eclipse event is 1 hour, 28 minutes and 50 seconds. So the end time of the solar eclipse can be predicted to happen at 12:00:50. The peak eclipse event is in half of the predicted duration or 4530.5 pixels or equals 1 hour, 15 minutes and 31 seconds after the start time, so the peak time of the solar eclipse can be predicted to happen at 10:45:30. The results of step-2a and 2b are displayed in Figure-5 (all calculations and the in line three pairs of images) at the Appendix. Additionally, the prediction summary that compared to the astronomical calculation [17] is summarized in table-1 at the Appendix. As long as the series of images of partial solar eclipse is taken from Amateur smartphone camera with the sketch filter capability, so the accuracy of start time, peak time and end time of solar eclipse predictions that are less than 5% is still reasonable and acceptable (see table-1).

Conclusion

The lens flare feature on a series of the recorded pictures taken from a camera with a sketch filter on it can be used to figure out the boundary of each pair of the sun and the moon on a partial solar eclipse event from time to time. By extrapolating the three chosen centers of overlapped region between the sun and the moon as three points anchor, the start, the peak and the end times of the partial solar eclipse and also the duration of solar eclipse event can be calculated and predicted.

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Appendix

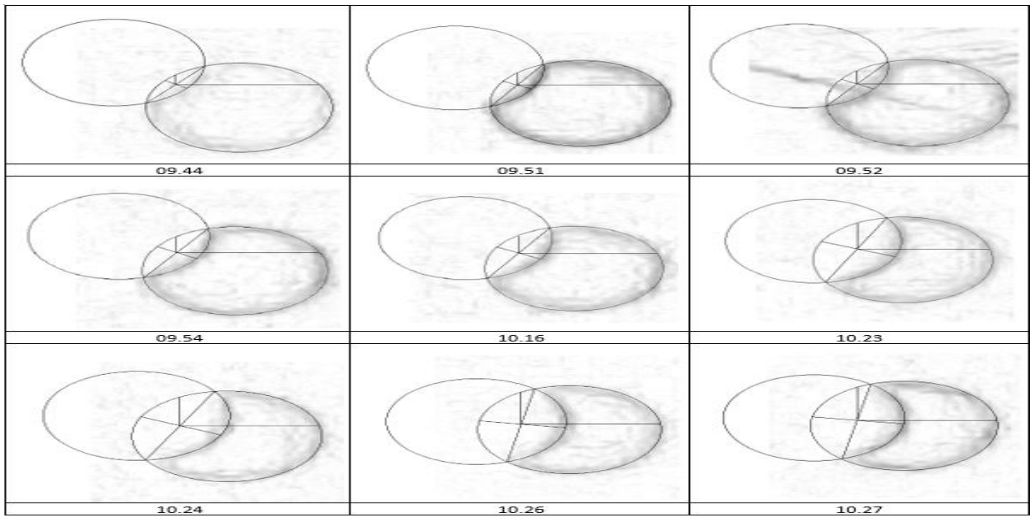

Figure-3 The first 9 images as the result of step-1c are displayed in sequence according to the time of photograph taken chronologically

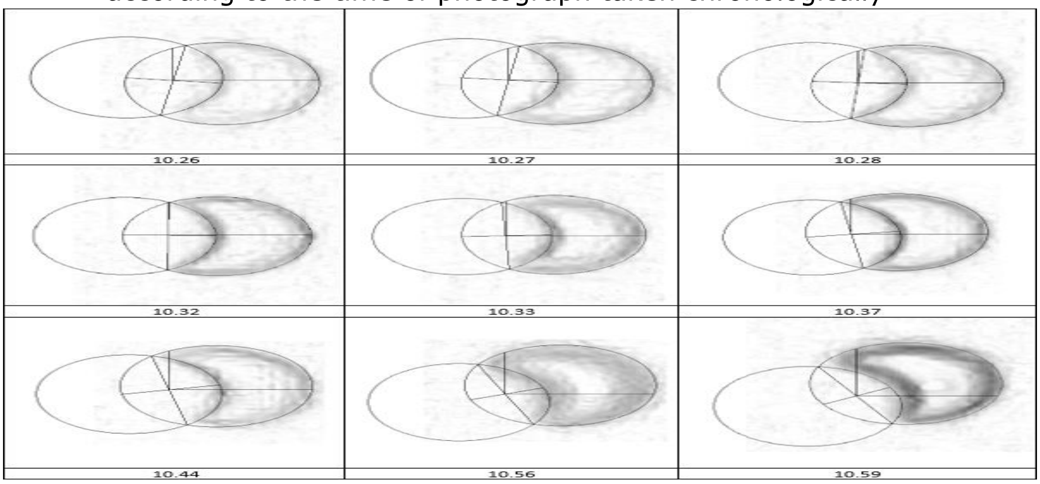

Figure-4. The second 9 images as the result of step-1c are displayed in sequence according to the time of photograph taken chronologically after the first 9 images in Figure-3

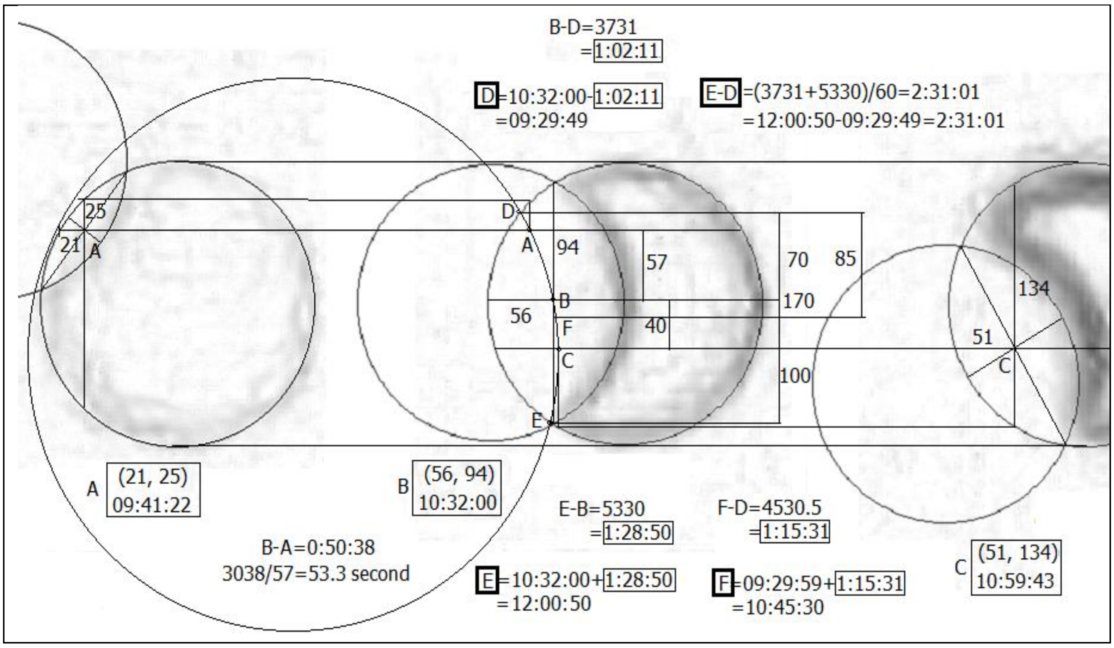

Figure-5. The extrapolation curve through point A, B and C (have known time) as three points anchor is crossed the edge of the sun boundary at point D and E (step-2a). The start time (at point D), the peak time (at point F) and the end time (at point E) of the partial solar eclipse event are calculated based on the equivalence distance (pixels) with the time (B-A: 3038 seconds divided by 57 pixels is 57.3 seconds)

Location: Bandung city of West Java Province, Indonesia

Latitude: South 06:56:01.5

Longitude: East 107:35:21.0

Table-1Prediction summary of the partial solar eclipse proposed by methods of this paper compared to the Astronomical calculation [17]

Solar Eclipse	Astronomical	Prediction (*)	Error	Seconds	Percentage	Description
Start time	9:27:00	9:29:49	0:20:49	169	1.79%	Too late
Peak time	10:45:00	10:45:30	0:00:30	30	0.32%	Too late
End time	12:08:00	12:00:50	0:07:10	430	4.56%	Too early
Duration	2:37:00	2:31:01	0:05:59	359	3.81%	Too short
(*) based on the sketch filter of smartphone camera and extrapolation of curve through 3 points of anchor						