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A Framework for Remote Monitoring System

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Abstract. Remote monitoring system becomes an important facility to support observation activities for various natural disasters. In many incidents of natural disaster such as volcano eruptions, the available monitoring systems installed closely to disaster area were damaged due to extreme condition raised by the event. The temperature of disaster site could suddenly increase to hundred degrees of Celsius, drowned in a water flood or even trapped in a toxic heating gas. Therefore it is important to have observation facility that is installed far away from disaster area. This research is an exploratory study to develop the framework for remote monitoring system. It includes hardware requirement and algorithm definition that cover system lenses and a set of image processing algorithm. The framework delivers a promising preliminary result towards the effort for remote monitoring system development.

1. Introduction

The last decade becomes the witness of natural disasters hitting Indonesia continuously. Floods, landslides, hurricanes, earthquakes, volcanic eruptions, forest fires, even tsunami wave came and went. Various sources noted that the total losses caused by natural disasters has reached the value of trillions of rupiah and thousands of deaths [1,2,3,4,5,6]. In addition to being influenced by natural factors, the damage also influenced by the unpreparedness of anticipating and managing natural disasters. It is closely related to the lack of early detection and observation facilities that has been installed and operated. Many cases demonstrate the absence of early detection facilities and amenities observation led to substantial material losses and claimed many casualties, like the tsunami at Aceh in 2004 [2,3] and at Cilacap in 2006 [4].

For facilities that have available observations, some cases even show damage to the equipment installed in the disaster area, such as when the eruption of Mount Kelud in 2007 [7]. Damage to the tool is primarily due to the extreme conditions of the disaster area such as the emergence of natural gas heat as well as the surface temperature of the earth. Therefore, the facility of early detection and observation that installed at a considerable distance from the disaster site yet delivers a good observation result become indispensable.

Meanwhile, the need for remote facility of monitoring system is increasing by nowadays. This is triggered by the magnitude of the benefits that can be generated by this facility, primarily as a tool for observing catastrophic incident or natural phenomena. This system could be used to reveal a variety of natural phenomena that need timely and long-range observation [8,9]. Such natural phenomena are often found in Indonesia, for instances are the migration of groups of birds crossing the oceans and the development of a variety of wildlife, or even the happening of various natural disasters which have claimed many casualties as described above.

2. Motivation

The Indonesian archipelago, located between the edge three plates of the earth namely the Pacific, Eurasia, and Australia plate. This country has also about 60 volcanoes that are still active, 17,000 islands, vast forests, and inhabited by diverse flora and fauna [15]. The geographic conditions make the region of Indonesia has a rich collection of flora and fauna, has a nice view, but is susceptible to natural disasters such as volcanic eruptions, forest fires, hurricanes, tsunamis, earthquakes, and others. Therefore, in relation to the exploration of natural resources and the efforts to minimize vary losses which can be caused by these natural disasters, the facility that can be used to monitor a variety of natural phenomena in Indonesia is urgently required. The system must be able to be used to observe terrestrial objects over long distances considering many natural phenomena that cannot be monitored from close range.

Nowadays various attempts have been made by researchers to build digital monitoring system such as afforded by Yao et al. [10,12] and Shirvaikar [16]. However, the existing monitoring system is capabe to only monitor terrestrial object in the order of hundreds of meters with blurred output quality and has narrow view angle. When it is compared with the distance required to monitor natural disaster such as volcano eruption, the existing condition is still far below the expectation. Although some systems have been built to reach the object in longer distance in the field of astronomy, such as the Hubble and several large observatories [17], such systems is not intended to observe terrestrial object in detail. Therefore research activities to establish remote monitoring system with a capability to reach terrestrial objects in distant with good detail quality are indispensable.

3. Related Work

Remote monitoring system is an application of imaging that aims to retrieve data from a distant event in the form of pictures or visual data. Some factors that affect the performance of these systems have widely been known by researchers such as the focus, exposure, and enlargement of images [18]. To monitor an object in close range, focus, lighting, and image magnification can be handled with ease. So to produce good quality of output for any objects of interest that are located closely to the monitoring facility is trivial. But not for distant objects, since objects that are located in distant would have small size when it is viewed from a monitoring point. Besides, the amount of intensities of the constituent components from a distant object is also relatively small compared to the objects that are closely located [11]. This leads to the difficulties to manage focus, exposure and image magnification for distant objects. Therefore, it is not surprising that a lot of effort to build a remotely digital monitoring system facing problems for recording visual data [12,16,19].

Various additional methods have also been proposed by researchers to solve the above problems, such as digital enlargement [13,14], parameter calibration image recording [16,19], and image restoration [12]. Nevertheless, the result of these methods still contain many weaknesses such as less sharpness of the output, increasing noise in visual data, and last but not least increasing complexity of the system. Meanwhile, Lintu and Magnor [11] has a unique approach towards solving this problem. The monitoring results that are unfavorable to distant objects is replaced by a set of images that are stored and have been available in the database. This method seems to become a breakthrough in the field of remote monitoring system, especially when the approach is associated with learning distant objects, for instance in the field of astronomy to study the structure of the galaxies. However, this approach is not appropriate to be implemented for terrestrial objects due to limitation of the system that is unable to display the output in real time, particularly when the object to be monitored constantly changing in timely basis. Few examples of these events are the activities to monitor natural events such as the migration of wild life animals or the happening of natural disasters.

4. Framework Development

Development of a framework for remote monitoring system has been conducted by considering the following aspects:

4.1. Data Acquisition

The parameter used to acquire visual data from real objects is the focus, magnification (zoom), lighting, and sensor size. The focus is used to collect all the light from a real object to the observation point. Focus is governed by a system of lenses. Enlargement is used to increase the size of captured images. Enlargement is affected by the longest focal distance divided by the shortest focal distance that can be reached by the lens system. The greater the result of this division, the stronger the magnification can be achieved. Lighting unit is used to ensure that captured objects emit enough light to be shaped into a digital image. In practice lighting unit is regulated by two mechanisms, namely the aperture size and the shutter speed. Aperture is the size of the hole that passes light to the lens system. The larger the hole, lighter intensities would be passed to a set of light sensor to shape the image. Meanwhile the shutter speed is the speed of opening and closing the curtain on the aperture. The faster a shutter is operated would generate dimmer digital image due to less light passed the lenses system. Sensor is a device used to capture and convert light into digital data in the form of images. The size of sensor affects the smoothness of image. Larger sensor would produce more delicate and higher resolution image.

4.2. Image Quality

To measure the quality of images quantitatively can be done by forming a histogram and see the spread of pixel values contained in an image. Values measured using this method is the value of color distribution, where a good digital image will show a clear difference in the distribution of colors for the main object and the background. In addition, a digital image quality can also be measured using a light intensity parameter, namely the amount of incoming light energy at the time the object is recorded. This is apparent from the degree of brightness of the image. To perform the measurement of light intensity of a digital image is done by changing the condition of the image into a single color, usually done by changing the color to gray level or referred to the grayscale image. Another way is by measuring the spatial resolution of the image, which measures the number of pixels making up the digital image. More number of pixels contained in digital image would show more detailed condition of real objects.

4.3. Image Zooming

Efforts to increase the size of digital image have been made by researchers such as th eresearch conducted by Morse and Schwartzwald [14], Yao et. al [12] and Sajjad et al [13]. Morse and Schwartzwald perform digital zoom using interpolation method by applying the level set to return the pixel value into its original condition. This method has only been tested on a low magnification, which is two to four times zooming and therefore it does not meet the need to enlarge the remote object which is at a distance of hundreds to thousands meters. Digital image magnification for long distances up to hundreds of meters is made by Yao et al [12]. This is done by arranging the optic device in hardware. However, the system displays blurred and trembling output. Other effort as performed by Sajjad et al [13] is only capable of displaying a mechanism with small magnification levels, i.e. four times magnification and has a shortage for full-color image enlargement.

4.4. Framework Design

Design framework that is done in this activity are shown in Figure 1, which consists of two stages as follows: The first stage is the data acquisition phase, which begins with preparing the platform for producing digital images mainly taken from a distance of hundreds to thousands of meters. Then the results of data acquisition would shape the characteristics of the developed remote monitoring system by comparing with the digital image taken from a short distance. The second stage is the main part of the study, namely by processing and enhancement of digital image from a distance using a variety of digital image processing algorithms for the purpose of enlarging the size of the image, so that objects acquired from hundreds to thousands of meters away from he observations point can be displayed properly. The first step that must be done is to determine the distribution of the color using the histogram to determine the difference between the existences of the main object with the background. This process if followed by the sharpening process of the main object by increasing the contrast value of the digital image. This is done by the interpolation process to enlarge the dimensions of the main object and the filtering process to clarify the edges of the main object. Result of the developed framework is depicted in Figure 1.

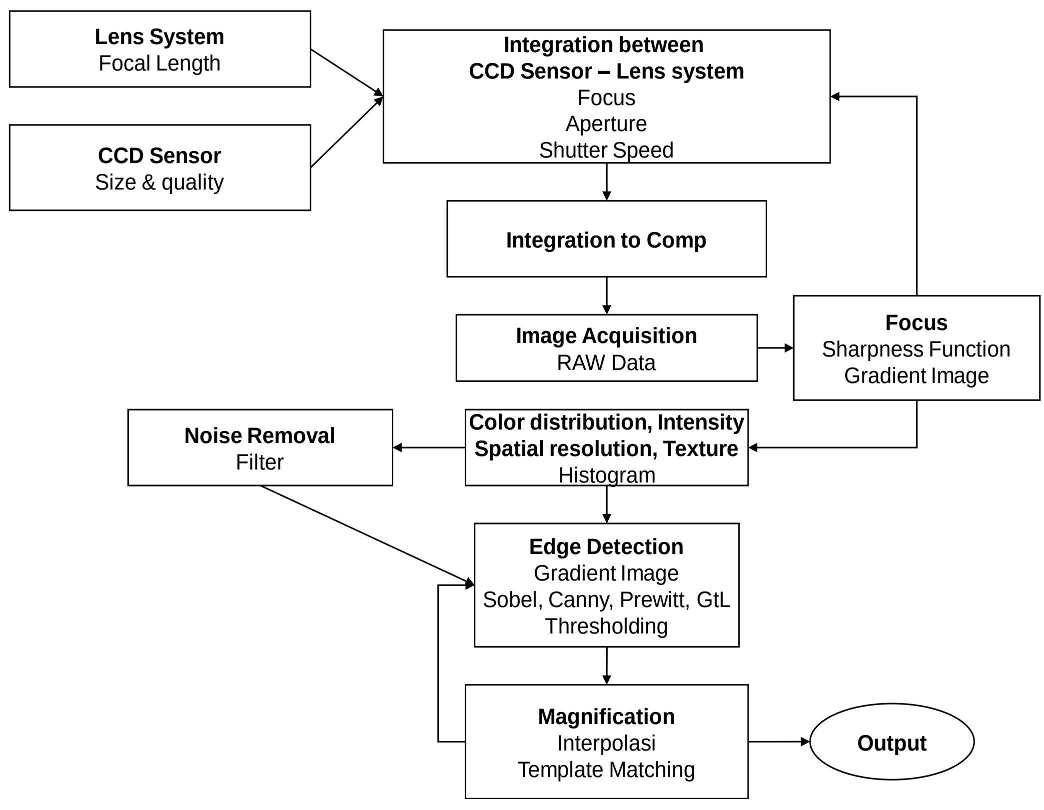
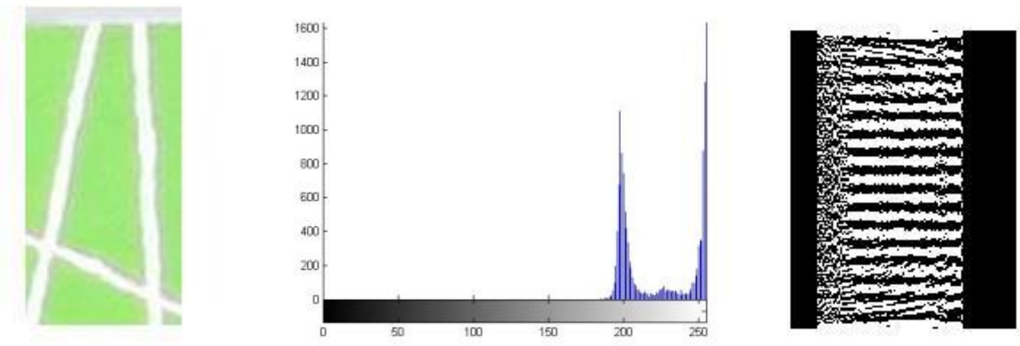


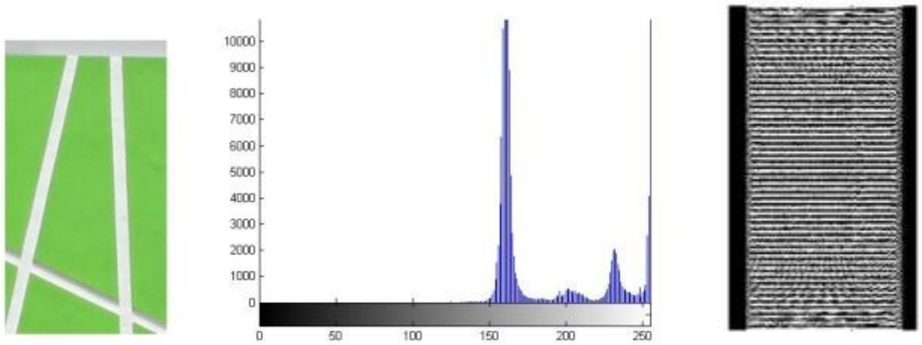
Figure 1. Developed framework for remote monitoring system.

5. Experiment & Discussion

Few experiments have been conducted to a partial component of the framework proposed above. The intention is to reveal any obstacle restricting the framework from reality. By employing a half top part of the framework for capturing distance objects compared to its close counterpart, some facts can be disclosed such as illustrated in Figure 2. Experimental results depicted in Figure 2 show the difference presentation of object captured from a long range and from a common distance of pocket camera. The differences include histogram and frequency domain presentations, in which some components are missing from the picture obtained from a distance. These facts disclose the cause why distance object lost its detail compared to its short range counterpart.



(A)



(B)

Figure 2. Experimental results. (A) Distance object (B) Short range object

6. Conclusion

The framework to build remote monitoring system has been developed in this study. It consist of two major stages namely lenses system and image processing. The first stage is to acquire digital image captured from real objects using three well-known parameters i.e. focus, aperture and shutter speed that are produced from integrating the focal length of lenses system and the size as well as the quality of image sensor. This stage is done in an image capturing device that equipped with lenses system. Result of captured image is then supplied to image processing to precede image with a set of algorithm which include focus sharpening, noise removal using a set of digital filters, detection of object boundary based on edge detections and image magnification algorithm based on interpolation. The algorithms also include histogram equalization and detection of spatial resolution in order to support the optimal focus obtained from distant object. The framework produced by this study become a promising preliminary result to further developed remote monitoring system based on visual data processing.

References

[1] WALHI. Pemerintah Diminta Lakukan Terobosan dalam Mengelola Bencana. Wahana Lingkungan Hidup Indonesia (WALHI), www.walhi.or.id, 28 Desember 2007.

[2] Tempo Interaktif. Total Kerugian Aceh dan Sumut Sekitar Rp 42,7 Triliun. Majalah Tempo Interaktif, www.tempointeraktif.com, 19 Januari 2005.

[3] Tempo Interaktif. Data Depkes, Korban Jiwa Tsunami 70-80 Ribu. Majalah Tempo Interaktif, www.tempointeraktif.com, 31 Desember 2004.

[4] Suara Merdeka. Depsos Catat 419 Tewas, Kerugian Tsunami Cilacap Rp 11 Miliar. Surat Kabar Harian Suara Merdeka, www.suaramerdeka.com, 20 Juli 2006.
[5] TVOne. Pengungsi Bencana Merapi Capai 283 Ribu Jiwa. Dapat diakses di website Televisi Nasional TVOne, nusantara.tvone.co.id, 7 November 2010.
[6] Tempo Interaktif. Korban Meninggal Merapi 109 Orang. Dapat diakses website Majalah Tempo Interaktif, www.tempointeraktif.com, 5 November 2010.
[7] Liputan6. CCTV Pemantau Gunung Kelud Tak Berfungsi. Liputan6 SCTV, www.liputan6.com, 4 Oktober 2007.
[8] BridLife. (2006). Monitoring of Wild Birds. BirdLife International, www.birdlife.org, 11 April 2006.
[9] Colozza, A; Doke, J.L. (2005). High-Altitude, Long-Endurance Airships for Coastal Monitoring. National Aeronautics and Space Administration, NASA Glenn Research Center, NASA/TM-2005-213427, gltrs.grc.nasa.gov, February 2005.
[10] Yao, Y; Abidi, B.R.; Abidi, M.A. Auto Focussing in Extreme Zoom Monitoring: A System Approach with Application to Faces. 2nd International Symposium on Visual Computing, Lake Tahoe, NV, November 2006.
[11] Lintu, A.; Magnor, M. An Augmented Reality System for Astronomical Observations. Proceedings of the IEEE conference on Virtual Reality 2006.
[12] Yao, Y; Abidi, B.R.; Abidi, M.A. Extreme Zoom Monitoring: System Design and Image Restoration. Journal of Multimedia, Vol. 2, No. 1, February 2007.
[13] Sajjad, M.; Khattak, N.; Jafri, N. Image Magnification Using Adaptive Interpolation by Pixel Level Data-Dependent Geometrical Shapes. World Academy of Science, Engineering and Technology, 2007.
[14] Morse, B.S.; Schwartzwald, D. Image Magnification using Level-Set Reconstruction. Proceedings of the 2001 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 2001.
[15] Wikipedia. Indonesia. Wikipedia, The Free Encyclopedia, en.wikipedia.org, 24 September 2006.
[16] Shirvaikar MV. An optimal measure for camera focus and exposure. Proceedings of the IEEE SSST 2004.
[17] NASA. Great Observatories – Beyond Einstein. NASA, http://universe.nasa.gov/program/observatories, 2007.
[18] Li, M.; Lavest, J.M. Some Aspects of Zoom Lens Camera Calibration. Technical Report ISRN KTH/NA/P—95/03—SE, Dept of Numerical Analysys and Computing Science, KTH (Royal Institute of Technology, February 1995.
[19] Vatani, N.N.; Roberts, J. Automatic Camera Exposure Control. Online Repository of en.scientificcommons.org, 2007.

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