INTELLIGENTPHOTO: A DESIGN FOR PHOTO ENHANCEMENT AND HUMAN IDENTIFICATION BY HISTOGRAM EQUALIZATION, ENHANCING FILTERS, AND HAAR-CASCADES

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ABSTRACT

Flickr and Instagram are known to be an online crowd- sourced photo sharing applications which people can share ex- periences with others. SmartPhoto is such a framework that was developed for this purpose. In the example of post-disaster re- covery first responders survey the damage by taking pictures and then transfer them back to the rescue center. A problem with this system is how to abolish the redundancy and to find the most indicative photos containing human. SmartPhoto measure the utility of the crowdsourced photos based on the metadata of the photos which is accessible geometrical and geographical infor- mation. But this system did not address the problem with low quality images. If we enhance the low quality photos there is a 50% chance that the photos will contain any human features and by identifying them they can be easily find. The proposed system called Intelligent Photo addresses this problem by first measur- ing the quality of the photos by checking the amount of blurriness and noisiness. It is based on by applying Laplacian kernel to the photos. The system then uses techniques known as Histogram Equalization to enhance the dark photos and perform other en- hancing operations like noise reduction, smoothing, de-blurring, and edge enhancement to the low quality photos using wiener fil- ter, median filter and smoothing filter. Max utility and Min selec- tion algorithm are applied to find the most indicative photos and to abolish the redundancy in photos. Feature Feature matching is done to the selected photos by applying Haar-cascades. Panora- mas of the photos are constructed and it is send to rescue center for further action. This system is applicable to post-earthquake recovery, map service provider etc.

Index Terms*- Smartphone, photos, metadata, Histogram Equalization, Enhancing Filters, and Haar-Cascades.*

1 INTRODUCTION

Mobile computing is human-computer interaction by which a computer is expected to be transported during normal usage, which allows for transmission of data, voice and video. Mo- bile computing involves mobile communication, mobile hard- ware, and mobile software. Communication issues include ad hoc networks and infrastructure networks as well as communi- cation properties, protocols, data formats and concrete technolo- gies. Hardware includes mobile devices or device components. Mobile software deals with the characteristics and requirements of mobile applications. In mobile computing, a set of distributed computing systems or service provider servers participate, con- nect, and synchronize through mobile communication protocols. It provides decentralized (distributed) computations on diversi- fied devices, systems, and networks, which are mobile, synchro- nized, and interconnected via mobile communication standards and protocols. Today smartphones not only change the way peo- ple communicate with each other, but also the way they interact with the world.

The popularity of online photo sharing services such as Flickr and Instagram indicates that people are willing to take photos and share experiences with others. The major challenges faced by these applications is how to characterize the quality (usefulness) of crowdsourced photos in a way that is both meaningful and resource friendly. Existing solutions from description based techniques either categorize photos based on user defined tags, or prioritize them by the GPS location. Tagging each photo manually is not convenient and may discourage public participa- tion. GPS location itself may not be sufficient to reveal the real point of interest. Even at the same location, smartphones fac- ing different directions will have different views. To solve this problem a system called IntelligentPhoto is developed. It mea- sures the utility of the crowdsourced photos based on the meta- data which is accessible geometrical and geographical informa- tion. From the metadata, we can deduce the location and how the photo is taken.

Photos can be of low quality due to various reasons. Over- exposure or under-exposure causes photos to be too bright or too dark; camera movement and shutter speed affect how severe the image is blurred; the quality of lens and digital sensors is also important. These factors can only be analyzed by image pro- cessing. Thus, before photo selection, some efficient image pro- cessing techniques may be applied at the server end to filter and enhance the low quality photos. Efficient algorithms are applied to the enhanced and high quality photos to select the one that has high utility (how many aspects are covered) and to remove redundancy. Feature matching is done to the selected photos to detect the humans and panorama of the photos is built for make it easy for the rescue center.

2 BACKGROUND AND RELATEDWORK

The resource-aware framework, called SmartPhoto [1], to optimize the selection of crowdsourced photos based on the ac- cessible metadata of the smartphone including GPS location, phone orientation, etc. didn't address the low quality photos and human detection.

A picture delivery service called PhotoNet[2] relies on pic- ture prioritization scheme, called CAP (Content-Aware Prioriti- zation) that aims to maximize delivered content diversity. By maximizing diversity, the network has a better chance at giving the sink the big picture quicker, as opposed to delivering lots of pictorial coverage of more populated locales and none on more isolated ones. PhotoNet is motivated by the needs of disaster- response applications, where a group of survivors and first re- sponders may survey damage and send images to a rescue center in the absence of a functional communication infrastructure.

In Information processing for live photo mosaic with a group of wireless image sensors[3] the basic problem is how to charac- terize the usefulness of the image data and how to optimize the network to achieve better quality of information.

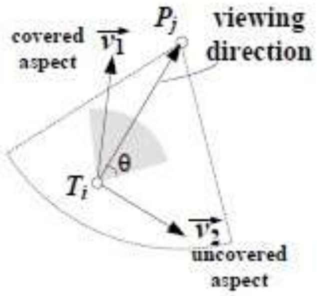
A System based on Web-GIS for Post-Disaster Recovery Management [4] addresses the data management challenges of the post Tsunami recovery process in a single district of Sri Lanka. It proposes a web-based GIS system to assist the post-Tsunami recovery process. The data components needed to pro- vide timely information for decision makers were identified from the ambiguous subject domain of the massive-scaled disaster. It facilitates the user to access interactive maps and query informa- tion through the maps via a standard web browser.

3 METADATA AND PHOTO UTILITY

A Photo metadata includes details relevant to the photo it- self as well as information about its production. Metadata is generated automatically by the device capturing the photo. It is an accessible geographical and geometrical information obtained from the smartphone. The metadata used in the proposed work are angle in which the photo is taken which is depended on the device that captures, bearing angle which is the angle between the device and the object to which it focuses to capture, photo identity number and the device IMEI number to which the photo has been captured.

A photo utility indicates how many aspects are covered. The utility is calculated based on the metadata, which can be prac- tically obtained via various embedded sensors in most off-the- shelf smartphones. Photos can be taken at different viewpoints cover different aspects of the target. The total utility depends on how many aspects can be covered and how they are covered. For a target T_i and a photo P_j , T_i is said to be covered by P_j if P_j's range includes T_i. An aspect $\dot{v}$ of Ti is covered if the angle between $\hat{v}$ and $\dot{T_iP_j}$ is smaller or equal to a predefined angle θ called effective angle. Here $\dot{T_iP_j}$ is the viewing direction of the camera towards the target when the photo is taken. Further, the utility of a photo Pj can be defined based on how many aspects of Ti are covered by this photo. As shown in figure target T_i is covered by photo P_j . Its aspect $\dot{v}_1$ is covered by P_j but aspect $\dot{v}_2$ is not.

FIGURE 1. An aspect is covered if it is close to the viewing direction



4 PROPOSED WORK

The proposed work uses the following methods and algo- rithms:

4.1 METHODS USED

(a) **Histogram Equalization:** The goal of histogram equaliza- tion[6] is to distribute the gray levels within an image so that every gray level is equally likely to occur. Histogram equal- ization will increase the brightness and contrast of a dark and low contrast images. It makes features observable that was not visible in the original image.

(b) **Enhancing Filters:** Three enhancing filters are used. They are Wiener filter, Median filter and Smoothing filter.The most important technique for removal of blur in images due to linear motion or unfocussed optics is the Wiener filter. The median filter is normally used to reduce noise in an im- age, somewhat like the mean filter. However, it often does a better job than the mean filter of preserving useful detail in the image. The filter replaces each pixel of the original with the median of neighboring pixel values. Smoothing filters, which may be used image smoothing and noise removal.

(c) **Max-Utility Algorithm:** Its purpose is to select the photos that have high utility. It works as a multi-round selection process. In each round, the weighted contribution (utility) of every unselected photo is calculated. The photo with the most contribution to the total utility is selected. If there is more than one photo with the most contribution, the one with the lowest index is selected. Once a photo is selected, it will be removed from the selection. The elements (sub-intervals) covered by the selected photo will be removed from future consideration. The selection process runs until B photos have been selected or every aspect of all targets has been covered, whichever comes first.

(d) **Min-Selection Algorithm:** Its purpose is to remove redun- dancy and only keep the minimum selection of photos that satisfies the coverage requirement. The algorithm begins by selecting the photo that covers the most number of sub- intervals. Once a photo is selected, it will not be removed. The sub-intervals covered will not be considered in the fu- ture. Photos are selected one by one based on how many new sub-intervals can be covered. Each time, the photo cov- ering the most number of new sub-intervals is selected. Ties can be broken arbitrarily, by giving priority to the one with smaller index. The process stops if all sub-intervals is cov- ered or no more photos can be selected (i.e., either photos are all selected or no more benefit can be achieved.

(e) **Haar-cascades:** Haar-like features are digital image features used in object recognition. OpenCV already contains many pre-trained classifiers in XML form.

4.2 SYSTEM ARCHITECTURE

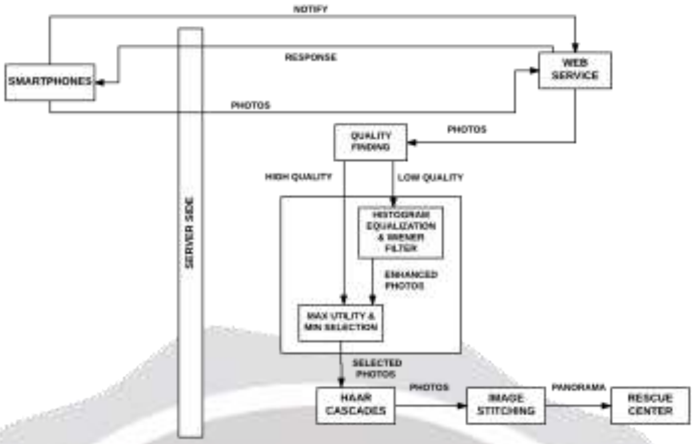


FIGURE 2. System Architecture

In the proposed system called IntelligentPhoto, the smart- phones first send a notification to the server about the disaster. The notification is send through an application running in the smartphones. The server can be notified through a text message, capture the photos and uploaded to the server with the help of this application. When the server gets the notification from the smartphones it sends reply message indicating that the server is ready to accept photos from the smartphones. The smartphones then capture the photos of the place in which the disaster has happened and sends it to the server. In the first stage, the server detects the amount of blurriness and noisiness in the received photos by using Laplacian kernel as shown in figure 3:

$$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

FIGURE 3. Laplacian Kernel

The blurriness and noisiness is detected by convolving the image with the laplacian kernel and taking the variance (i.e. stan- dard deviation squared) of the response. If the variance falls be- low a pre-defined threshold, then the image is considered to have blurriness and noisiness (i.e. low quality), otherwise, it doesn’t (i.e. high quality).

In the second stage, all the low quality photos are enhanced by using histogram equalization, and filters such as wiener filter, median filter. The Max-utility and Min-selection algorithms are performed to the enhanced photos and the high quality photos in the third stage. Feature matching is done to the output of the third stage using Haar-cascades. The photos containing humans is detected and marked in the fourth stage. Object Detection us- ing Haar feature-based cascade classifiers is an effective object detection method proposed by Paul Viola and Michael Jones. It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images.

The photos that contain human features are stitched together to get a panorama and is send to the rescue center for further action. If no human feature is detected the process stops. Figure 3 shows the identification of human in Japan earthquake disaster.

FIGURE 4. Japan disaster

5 CONCLUSION

Post-disaster recovery planning is defined as developing a set of strategies to assist a community in rebuilding after a disas- ter occurs. The photos of the place taken after the disaster are not only meant to publish in any social media but can also be useful for the identification of humans that were a victim of the disaster. IntelligentPhoto is a new system which is helpful in post-disaster recovery by using the captured photos of the disaster place. “A photo is worth a thousand words” is an English idiom. It refers to the notion that a complex idea can be conveyed with just a single still image or that an image of a subject conveys its meaning or essence more effectively than a description does.

The proposed system makes use the photos of the disaster place captured by the smartphones to detect the humans. The enhancing phase of this system helps to intensify or improve the quality of the dark and low quality photos so that there is a 50% chance that the enhanced photos will contain any human features.Max utility and Min selection algorithm are applied to find the most indicative photos and to abolish the redundancy in photos. Finally, the panorama of the selected photos that contains hu- mans are constructed and is send to the rescue center for further action.

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