August 24, 2016

IMAGE ACQUISITION AND PROCESSING FOR INTELLIGENCE ANALYSIS

Matthew Wood
Patrick Dunagan
John Clark
Kristina Bohl

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Recommended Citation
Wood, Matthew; Dunagan, Patrick; Clark, John; and Bohl, Kristina, "IMAGE ACQUISITION AND PROCESSING FOR INTELLIGENCE ANALYSIS", Technical Disclosure Commons, (August 24, 2016)
http://www.tdcommons.org/dpubs_series/248

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IMAGE ACQUISITION AND PROCESSING FOR INTELLIGENCE ANALYSIS

Introduction

The U.S. Government as well as other international governments need data to better operate the multitude of functions that they are each chartered to provide. The U.S. Government alone has very large military and intelligence components with annual budgets of approximately $500B and $50B, respectively.

Summary

Satellite image acquisition is well known in the art. Many companies provide commercial satellite imagery. Existing imaging systems also allow the determination of polygons representing places on Earth from satellite and other imagery. Utilization of such imagery can aid generally in intelligence analysis and, more specifically, economic resource analysis, counter-terrorism, and counter-proliferation. The present disclosure can also provide intelligence analysts with a capability to monitor relevant physical activity across all of the global locations that could be relevant to security threats. Micro and macroeconomic trends uncovered by analysis of various activities, including commodity stocks/flows or shipping container activity could provide context for foreign or domestic threats, fill gaps in an intelligence thesis, or corroborate other sources of data.

Detailed Description

Described are systems, methods, computer programs, and user interfaces for image location, acquisition, analysis, and data correlation. Results obtained via image analysis are correlated to non-spatial information useful for intelligence analysis. Broadly, imagery can be used for economic resource analysis, including determination of significant economic changes and patterns related to problems to determine implications of such problems or enable required
action pertaining to the same. Imagery can also be used to determine economic changes and patterns correlated to local stability and economic health to forecast risks to and effects of counter-terrorism efforts in the impacted regions. Imagery can further be utilized to monitor sites of known activity related to proliferation/deproliferation of nuclear material or weaponization and determine the implications of the activity or enable required action.

The geographical coordinates of features on Earth, for example a particular location related to intelligence analysis can be mapped to textual descriptions. From these mappings, a polygon of interest on the surface of the Earth is determined. The polygon of interest's dimensions and coordinates control an image acquisition system. This system finds relevant and timely images in an image database and/or controls devices to acquire new images of the area. With one or more images of the polygon of interest available, various image enhancement techniques can be performed. Image enhancements can be performed to increase human and/or machine perception and discrimination of items of interest from the background.

Enhanced images, can then be presented to human workers to perform the visual analysis. The resulting counts are processed by analytic and statistical processes. These processes incorporate the results from many different images, and/or many results from the same image counted by different workers. The processes may include filtering functions to improve the resulting data.

Results of the processing can be correlated with non-spatial data, for example intelligence analysis data. Over time these correlations allow the results of this analysis to be used in predicting the non-spatial data. For example, utilization of imagery can identify significant economic changes and patterns related to problems or correlated to local stability and economic
health, and can be used to monitor sites of known activity related to proliferation/deproliferation of nuclear material or weaponization.

In some embodiments of this system, feedback from the image acquisition, image analysis, and non-spatial correlation is used to improve the data collected. For example, feedback may be used to refine the dimensions of the polygons of interest, the quality of the imagery, and the accuracy of the image analysis.

FIG. 1 shows a block diagram of one example of an imaging system 100, according to one embodiment. Input control parameters 105 specify the operation of the system. These parameters include textual non-spatial descriptions of areas of interest on Earth. Examples of non-spatial descriptions include “Nuclear Reactor.” Other control parameters may include the type of data to be collected (e.g., exhaust plumes), time and date ranges for image collection, the frequency of derived data measurement, or requirements for confidence scores of derived data.

The location search subsystem 110 determines polygons of features of interest on the Earth. The geographical coordinates of features on Earth, for example an intelligence analysis location, are mapped to textual descriptions. The geographical coordinates may be obtained from geographical databases or prior imagery of the site, for example. The textual descriptions may, for example, be Intelligence Site in Russia. From these mappings, a polygon of interest on the surface of the Earth is determined.

The location search subsystem 110 can also be configured to receive feedback 169 from the non-spatial correlation subsystem 140. This may be the case where the non-spatial correlation subsystem 140 determines that additional information needs to be obtained by the location search subsystem 110. For example, the non-spatial correlation subsystem 140 may determine that the correlation between the count at a given location and the relevant data is
inconsistent, suggesting a need for more or different data that can be obtained by location search subsystem 110. The feedback provided to the location search subsystem 110 may include an updated search location, thereby resulting in different locations being searched for use in obtaining results.

The polygons of interest can be passed 115 to the image acquisition subsystem 120. The image acquisition subsystem 120 determines the quality and appropriateness of the polygons based on real images. For example, the image acquisition subsystem 120 may determine that a polygon is enlarged, shifted or refined relative to the real images. This polygon discrepancy information may be provided as feedback 167 to the location search subsystem 110 to improve the quality and appropriateness of polygons determined by the location search subsystem 110.

The image acquisition subsystem 120 can also use the spatial information describing the polygons of interest and the other control parameters to acquire an image, or set of images, that satisfy the control parameters for each polygon of interest. In some cases, image data is accessed from an existing image archive 150. Additionally, if needed, these images are sourced from image archives, including a social image archive. In other cases, image data is obtained from an image collection subsystem 160, such as a satellite or satellite network, array of security cameras, drones, or other purpose built image acquisition systems. Images may be acquired from either or both of the image archives 150 and image collection 160 depending on which images are the most economical and appropriate for the task.

In some cases, feedback information about the quality and alignment of the imagery is passed back 166 to the image acquisition subsystem 120. Based on this feedback, the image acquisition subsystem 120 can acquire more imagery. The image acquisition subsystem 110 is also configured to receive feedback 168 from the non-spatial correlation subsystem 140. The
feedback may be used to alter the acquisition of images. For example the feedback may be used to change the frequency or time of day of image acquisition.

The acquired images can be sent to the image analysis subsystem 130. The image analysis subsystem 130 evaluates the images, enhances and prepares the images, presents the images to the human workers with a task specific user interface, statistically processes the results, and passes those results to the non-spatial correlation subsystem 140.

The image analysis subsystem 130 can include a number of methods for improving accuracy and throughput in image analysis. The capabilities of the image analysis subsystem 130 are described with respect to the example of intelligence analysis. However, the principles discussed are general and can be applied to many different image analysis tasks. Image enhancement and analysis can be performed with automated systems and/or human-in-the-loop systems. In some cases, the image analysis subsystem 130 receives feedback information about the accuracy and adequacy of its results from the non-spatial correlation subsystem 140. In these cases, the data is modified, or the image analysis is re-performed according to the feedback information.

The non-spatial correlation subsystem 140 can receive result data from the image analysis subsystem 130, and calculate temporal correlation between that data and intelligence analysis. For example, intelligence analysis can more particularly include economic resource analysis, counter-terrorism, and counter-proliferation analyses. The data can add value to intelligence analysis because such data is physically observable, and can relate to remote and/or inaccessible locations. In addition, data freshness or rate of change can be important to such analysis.
The non-spatial correlation subsystem 140 can collect correlation data over time. The collected data is used to create a prediction of future metrics based on previously collected correlations between image analysis data and other data. The defense and intelligence community are responsible for addressing and monitoring key national security issues around the world. Recently, the defense and intelligence community have been largely focused on counter-terrorism and counter-proliferation, but have never stopped considering stability and risks globally. Local economic activity (and activity in general) can be an important factor in every one of these issues. The intelligence analysis described herein can help provide solutions or awareness of these important issues.

Users of the present disclosure can include individuals who spend time analyzing national security problems. Such users can include intelligence analysts studying foreign military spending, military planners tracking the local atmospherics of a defined operating area, civil affairs teams analyzing options for infrastructure investment in a foreign country, or strategists trying to observe economic influences or effects of foreign policy. Each one of these roles will have multiple problems being solved at a given moment in time and the specific problems and their priority will regularly change based on current events and changes in policy. However, the ability to analyze major economic indicators over time will add value to nearly every problem they are trying to solve. Ultimately, such users want to better inform national security decisions to mitigate risk and increase success.
Figures

FIGURE 1
Abstract

Described are systems, methods, computer programs, and user interfaces for image location, acquisition, analysis, and data correlation. Results obtained via image analysis are correlated to non-spatial information useful for intelligence analysis. Broadly, imagery can be used for economic resource analysis, including determination of significant economic changes and patterns related to problems to determine implications of such problems or enable required action pertaining to the same. Imagery can also be used to determine economic changes and patterns correlated to local stability and economic health to forecast risks to and effects of counter-terrorism efforts in the impacted regions. Imagery can further be utilized to monitor sites of known activity related to proliferation/deplication of nuclear material or weaponization and determine the implications of the activity or enable required action.

Keywords associated with the present disclosure include: image acquisition, satellite imagery drone imagery, intelligence analysis, economic resource analysis, counter-terrorism, counter-proliferation.