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A virtual professional community to support effective use of remotely sensed imagery

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ABSTRACT
This paper introduces an idea of establishing the GeoTruth Virtual Professional Community (VPC) for Image Analysis in Remote Sensing - a collaborative framework for professionals, using ground truth terrestrial photographs for interpretation and analysis of satellite and aerial imagery. The proposed utility-driven community is initially formed by members involved in developing an open-source GeoTruth Engine – a collection of Web-based geo-data media tools, serving as a community-open participatory mechanism for collection, storage, distribution and analysis of geographically referenced landscape photographs and corresponding metadata. The paper investigates conceptual issues of collaborative networks related to establishing and evolving the GeoTruth VPC, describes basic life cycle development and operational principles, outlines possible implementation strategies for the GeoTruth framework, and finally elaborates on corresponding copyright and legal issues.
Keywords: *Remote Sensing, Virtual Professional Community, Participatory Mechanisms, Open Source Software*

1 INTRODUCTION

Many researchers worldwide use remotely-sensed imagery in their projects, both in social and natural sciences; however, users often encounter difficulties working with satellite images and aerial photographs, since image interpretation requires experience and skills. The best way to acquire these skills is to go to the field, identify your location on an overhead image, observe the landscape, and find corresponding features in the image.

In many cases, terrestrial photographs taken from the ground with conventional cameras can serve as a replacement for field observations. If the coordinates of a terrestrial photograph are known, the position of a photographer can be located on an overhead image, and the users can use conventional terrestrial photographs as ground truth to establish the visual link between an object and its representation in an overhead image without travelling to an actual field location.

There have been few attempts to create repositories of sample objects but they either represent images acquired by a particular sensor without ground truth (Remote Sensing Guides… 2006), or provide ground truth photographs which characterize very specific objects (i.e., specific types of plants) in a limited area (Zion National Park… 2006; Ochi and Takagi 1996). Any repository of this type will always have certain limits, because the worldwide compilation of feature identification keys and ground truth data is an extraordinarily large task for any single project or organization, however users could compile such repositories by themselves. Many of them have had, and will have field trips in which they have taken terrestrial photographs of different landscapes, geographic objects and phenomena; many of them also use GPS. If such geographically referenced and annotated photographs are collected, stored and distributed using some Web-based open participatory mechanism, professional users can quickly form a collaborative framework, or in other words, a Virtual Professional Community (VPC).

Relationships in network-based communities are driven by utilitarian needs and are often of short duration, and professional communities are no exception. A member's initial requirement for knowledge may eventually be transformed into a reciprocal role, in which the member both provides and receives information. Member participation in VPC can vary from passive to highly active. Members can form small groups with interests in particular areas of study with more strong ties among the members. The life of a utility-driven VPC, especially utilising particular web-based tools or services, depends on the usability of such a mechanism. Copyright and legal issues stemming from the use and sharing of geospatial data are of high importance in rapidly developing communication networks.

In this paper, we summarize general principles, functions and policies of VPC, and outline specific issues related to the design, establishment and functioning of professional communities and corresponding participatory mechanisms for professional collaboration in the area of interpretation and analysis of aerial and satellite imagery.

2 GEOTRUTH VIRTUAL PROFESSIONAL COMMUNITY

During the last decade, the amount of activity in cyberspace has grown in an explosive manner. The World Wide Web and other telecommunication technologies have opened up new possibilities for collaboration. People form Virtual Communities (VC) over different communication

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networks, each of which is driven by a particular interest or professional need to access and mediate knowledge and information remotely.

One way to facilitate the accumulation of knowledge and applied skills is establishment of a Virtual Professional Community. A Virtual Professional Community represents a combination of the concepts of a virtual community (Rheingold 1993) and a professional community. Professional communities ("communities of practice") provide environments for professionals to share the body of knowledge of their professions such as similar working cultures, perceptions of problems, problem-solving techniques, and professional values and behaviour (Katzy and Ma 2002). Professional communities may be public or member-initiated (Porter 2004).

Quite often, Virtual Professional Communities are a manifestation of collaborative networks that bring together audiences on specific topics such as product application or product development, and this is the method that we propose for the establishment and functioning of the GeoTruth VPC. The GeoTruth VPC is initially formed by members involved in designing and development of a Web-based media data engine - the GeoTruth Engine. Once prototyped and tested, this engine could serve as a community-open participatory mechanism to collect, store and disseminate landscape photographs among members of the community.

Preliminary analysis of the various characteristics of virtual communities (Porter 2004) allows us to propose the following attributes for the GeoTruth VPC:

- Goal: To accumulate and share knowledge, skills and new approaches for effective use of remotely-sensed images;
- Objectives: To create, develop and maintain a repository of geographically referenced and annotated landscape photographs according to specified metadata standards;
- Primary audience: Researchers, organizations, students, and project managers, both in social and natural sciences (e.g., environmental specialists, foresters, biologists), who use remotely-sensed imagery;
- Places and spaces: The community's "space" covers the whole globe; the community's "place" is to be useful for researchers across the many disciplines that use space imagery; and the socio-cultural "space" is the opportunity to meet and communicate without prejudice;
- Population interaction structure: Network-based community members are geographically dispersed and focus on the functional benefits of the community such as terrestrial imagery acquisition, collaboration in landscape knowledge sharing and related problem solving;
- Driving motivations: The main motivations are to search for information and new techniques, and to collaborate with many colleagues in different parts of the world;
- Degree of organization: A high level of interaction usually is not the norm in VPC's and may not occur without the intentional efforts of a moderator. The GeoTruth community can exercise "technological control" over access to preserve the quality of the imagery information, but there also has to be some system of control over unwanted behaviour. The stressful ties in such a community are likely to have low frequency. The balance among privacy, functionality needs, security, content etc. should be maintained;
- Psychological sense of community (PSOC): The Remote Sensing community will likely have low level of PSOC (Forster 2004), but members of the community still need to have feelings of belonging, trust, expected learning, recognition and obligation which can be created by introducing roles, protocols, policies and/or norms for the VPC;
- Profit model: The GeoTruth VPC is proposed as a non-profit community;
- Implementation platform: An asynchronous platform is most appropriate where the community can access a Web GUI for downloading and uploading images and metadata, discussing issues in forums, and using e-mail;
- Main technical requirements: The major subsystems of GeoTruth engine are a strong distributed repository; an information warehouse; a user-friendly web-based interface; and analysis tools.
- Possible challenges: The VPC has to be intellectually accessible; users have to share only what they know to be true; the lack of a code of conduct may be an issue.

3 GEOTRUTH VPC: LIFE CYCLE DEVELOPMENT AND OPERATIONAL PRINCIPLES

A Virtual Professional Community cannot emerge spontaneously, and needs to be nurtured during its creation and development until it is able to sustain itself. Most researchers adopt five stages of group dynamics to the life cycle of a professional community development (Palloff and Pratt 1999; Preece 2000; Katzy and Ma 2002). We adapted the group dynamics concept for the creation of the GeoTruth VPC, and discuss operational principles for each phase of development.

Phase 1: *Initiation*

The idea of the GeoTruth VPC originated with Remote Sensing professionals residing in three countries, and the ideas were shared amongst the initial members of the professional community. Members of a multidisciplinary group (representing the fields of Remote Sensing, GIS, Information Technology, Computer Science and Physiology) formed team that developed a vision for the GeoTruth VPC and assessed potential Remote Sensing community and user needs. During this phase, the team exchanged opinions with domain experts and potential users; analyzed public web sites; investigated RS academic associations and participated in professional groups' mailing lists (which may have an impact on the GeoTruth VPC) and relevant literature; and carried out preliminary data interpretation and methodological case studies.

Phase 2: *Strategic planning: assessment of community and user needs*

The core team defines processes for how the community will operate; it includes community values, standards, an organizing structure, and a sustainability model.

Values: The strategic objectives of the GeoTruth community are to develop an open access participatory mechanism as a set of tools that, from a quality point of view, will support users worldwide in accumulating and sharing knowledge, skills and new approaches for effective use of remotely-sensed images, and will save user and money by reducing number of field trips and making them more efficient.

Standards: The community policies, describing the requirements and access procedures, are articulated in a public website that is open for anybody to use, but with technological quality control over information contribution. This online community requires newcomers to demonstrate some level of "knowledge" for *entering* new information. A system of "community" controls over unwanted behaviour is also established, which regulates interactions between facilitators and users, and users themselves.

Organizational structure: Moderators will encourage communication, collaboration among members, and will assist new members in joining the community. The moderation roles include:

- Maintenance of online forums;
- Providing technical help;
- Controlling the input of images and their metadata;
- Defining methodology;
- Entering data (raster and vector base map layers);
- Maintaining software and hardware;
- Developing polices upgrade and support;
- Sharing of knowledge with VPC users; and
- Organising meetings to help cultivate trust among the participants

Sustainability model: Development of the GeoTruth VPC at the implementation and nurturing stages could be mostly funded through research and industrial foundations as well as being supported by individual members. The GeoTruth Engine contents and source code will be open to public at the implementation stage. Functioning of the GeoTruth VPC at the operational stage has to be self-sustainable.

Phase 3: *Technical implementation of online environment*

The technical implementation of GeoTruth community represents the conclusion of the previous two phases. Principles of usability of the virtual environment and the social interactions that goes on within it have been taken into consideration in the design and implementation of the GeoTruth mechanism. The following design dimensions of "usability" and "sociability" are considered (Preece 2000):

Table 1. Preece's design issues for online community

USABILITY	**SOCIABILITY**
Interaction Dialogue	Membership Policy
Navigation	Codes of Conduct
Registration	Security
Representation of Users	Privacy
Message Format	Copyright
Archives	Free Speech
Support Tools	Moderators

Several of Kim's "social scaffolding" principles (Kim, 2000) have been also adopted for the system design and implementation: building flexible, extensible gathering places; creating meaningful and evolving member profiles; encouraging appropriate etiquette; promoting cyclic events and facilitating member-run subgroups.

Technical implementation implies the design, implementation and testing of a prototype of the GeoTruth Engine online platform, and consecutively the refining its sociability and usability (Goodfellow 2003).

In this project, we use a rapid prototyping methodology for development of the GeoTruth. *Prototyping* is a way of quickly developing an incomplete working system from a design model in order to test various aspects of a design, illustrate ideas or features, and gather early user feedback (Stephen *et al.* 2006; Grimm 1998; Crinnion 1991). Prototyping is often treated as an integral part of the software engineering process, which reduces project risk and cost, testing and implementation time, and improves the software quality; usually it requires several iterations to create a complete working system.

Phase 4: *Welcoming and nurturing the community*

At this point, the community starts to operate with a defined structure and processes. A Community Committee will be established to promote the GeoTruth Engine, and it will interact with the available members. Critical success factors in this phase are the development of clear and visible community purposes, membership benefits, and structures and policies (Goodfellow 2003). The efficiency of the management activities, technological tools and methodology are verified by using users' feedback and by analysing the possible deviations from the strategic plan.

Phase 5: *Operation, evolution management, support and adaptation*

In this stage, the GeoTruth repository will be populated with information and the number of members will have reached a critical mass. The community may have established collaboration and partnership with other professional communities, related to Remote Sensing, GISciences and Geospatial Technologies. The community also needs to balance privacy, functionality needs and content. Monitoring of community activities, evaluation of its results and achievements and its adaptation to new requirements and needs has to be carried out by the Community Committee and the community itself.

4 IMPLEMENTATION STRATEGIES FOR GEOTRUTH ENGINE

The GeoTruth Engine can be developed as an open source or proprietary system, and can be implemented using client-server solutions using standard internet browser, specifically designed web-enabled standalone platforms, or a hybrid approach.

Open Source strategy. If an Open Source strategy is chosen, the GeoTruth engine has to be developed in accordance with Licensing Models that are approved by the Open Source Initiative (OSI), which is a non-profit corporation that is dedicated to managing and promoting Open Source projects. There are a number of different Open Source license types that can be found on the OSI web site. From these, the GNU General Public License (GPL), which was created "to be of the greatest possible use to the public" (http://www.opensource.org/licenses/gpl-license.php), is the most appropriate for the GeoTruth implementation strategy.

The GNU GPL license provides the opportunity to invite system architects, designers, developers, and programmers from the research, education and public communities into the project without restrictions. The GeoTruth project can be registered on SourceForge (www.sourceforge.net), which is an online Open Source repository hosting more than 100,000 projects. SourceForge operates as a "centralized resource for managing projects, issues, communications, and code" (http://sourceforge.net/docs/about). It also provides access to the GeoTruth project to the Open Source community and the general public in all project phases, and promotes the research and results of the project.

Apart from a fully independent Open Source project, GeoTruth can be implemented in the frame of an existing Open Source project, for example NASA's World Wind. This will lead to adoption of the framework's license policy.

The second choice of development is a *proprietary strategy*, which can be implemented as an entirely proprietary project, or as a third-party co-operation. The latter may require third-party licensing. For example, Google Earth engine-based implementations allow the integration of a third-party plug-ins and extensions through and Application Programming Interface (API), but does not provide access to the engine's source code.

A typical *Web-enabled standalone platform* requires licensed software installed on the user's computer, which is an obvious limitation for such an approach. Platforms such as Goggle Earth, GeoLink, and TopoFusion provide their clients with the ability to retrieve geospatial information and data from different online services.

Alternately, *Web-service internet-browser solutions* usually do not require any specific software apart from a standard Internet browser, which makes this approach extremely attractive for many users, especially those involved in travelling. Examples of such platforms are Google Maps, ArcWeb Services, and Yahoo! Maps. Open access, the sharing and distribution of terrestrial photographs amongst professionals in GIS and Remote Sensing, which are the core ideas of GeoTruth, can be quite naturally implemented using such an approach and, in fact, many people already share their photos using geotagging.

Geotagging is a form of geocoding, in which geographical identification metadata are added to various media such as websites, RSS feeds, or images. This metadata usually contains spatial coordinates (often in the form of latitude and longitude), and may also include the altitude and place names. Geotagging a photograph allows it to be associated with a geographical location.

A number of spatially enabled web-services allow the user to link terrestrial photograph to maps or satellite imagery, among of them the general-purpose services such as Flickr, Global Photo Track, WikiMapia. Many proprietary geotagging services do not allow plug-ins and extensions. Being originally developed as non-profit alternatives to Google Maps, many of them simply copy the main concept of the prototype, but are lacking in service, features and options.

The real strength of GeoTruth is in delivering a completely new meaning to web-based photo geotagging – from curiosity of browsing casual photographs to professional use of landscape presentation and analysis. This could be very powerful mechanism for many research and educational applications. As GeoTruth uses a very distinctive feature, such geotagging, other web mapping services might be interested in co-operation and can open their "core" for integration with GeoTruth engine to enrich their services and attract GIS, Remote Sensing and other professionals, who use satellite imagery in their studies and projects.

5 LEGAL AND AUTHORSHIP ISSUES IN GEOTRUTH

Two key legal issues need to be addressed in the system. These are the determination of ownership and copyright issues surrounding photographs that are submitted to the system, and the management and protection of the system from vandalism.

Ownership and copyright issues are fairly straightforward. There are really only two options -- the ownership and copyright are retained by the owner, or they are assumed by the GeoTruth team when photographs are submitted to the system. The first option is used by the Flickr photo sharing website (Flickr… 2008); the second is used by the World-Wide Media Exchange (WWMX) site (http://wwmx.org/TermsOfUse.aspx). Flickr allows individuals to assign a Creative Commons license (http://creativecommons.org/) to each of their photographs, in which copyright is retained, but permission is granted for limited, non-commercial personal use (http://www.flickr.com/terms.gne?legacy=1). This is a better option than having the GeoTruth team assume copyright, since it allows contributors to retain control over their work, and does not discourage contributions in any way.

Although the system is intended to facilitate open participation by members of the public and the remote sensing community, the system will not be self-managing. Required ongoing maintenance includes the performance of backups, examination of new entries, and the prevention of, and repairs to the system due to vandalism. Recent experience within the Wikipedia community-open encyclopaedia project has shown that vandalism and the deliberate distortion of facts does occur (Reuters … 2005). The interesting side of this is that there is a significant degree of self-policing among users/contributors. Thus, Wikipedia contributors rapidly correct entries made by vandals, often within minutes (Arrington 2005).

With the GeoTruth website, vandalism can be reduced by allowing open contribution, but limited editing and replacement. Once an image has been submitted and approved by a moderator, access will then be restricted. This will help to prevent content from being destroyed. The moderator's job will be to ensure that only appropriate images are submitted to the site, to ensure that copyrighted material is not submitted, and to make sure that changes to the site are legitimate. The moderator will also be able to respond to any claims of copyright infringement by removing the images in question from the site until the copyright of the material is established.

6 CONCLUSIONS AND FURTHER RESEARCH

The concept of GeoTruth goes far beyond an ordinary data repository. Such a mechanism should inspire users to actively participate in Community Life and encourage sharing not only the data, but also knowledge. The basic principles, functions and policies of participatory mechanisms for professional collaboration in the Remote Sensing community, studied in the paper, must still be tested during the establishment and nurturing of the GeoTruth Virtual Community.

Future research will focus on the detailed development of the GeoTruth concept. This will include a thorough analysis of the types of data to be used and their specifications, the development of a methodology and techniques for field data collection, and the analysis of possible platforms and Web tools for the GeoTruth engine. The idea of the GeoTruth community needs to be disseminated by informing members of relevant online professional societies, publishing in scientific journals and professional magazines, and carrying out workshops and presentations. This strategy could expand the professional community, enrich the image repository and excite users of remotely sensed imagery to exercise and enhance the GeoTruth participatory mechanism.

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