Design and Implementation of Digital Map Products Contributing GIS Perspective based on Cloud Computing

Jinsuk Kang

Abstract—**In this paper, we describe an augmented reality system for defense technologies and present a novel approach to a Collaboration Interaction Model (CIM) combining context-aware and mobile augmented reality devices. This model is aware of a user's context through user-centric integration and inference of contextual information in geo-cloud space. Based on the user's context, the model filters the content relevant to the user and overlays the filtered content over the associated physical entities. In addition, CIM generates the community according to the relationship between the entities and enables a user to selectively share personalized content with other mobile users.**

Index Terms—**Augmented reality, context-aware, eneral object recognition, geo - cloud**

I. INTRODUCTION

Augmented Reality (AR) refers to a live direct or indirect view of a physical environment in which elements in that environment are augmented by virtual computer-generated imagery. It is distinct from virtual reality, which refers to a wholly computer-simulated immersive environment. To do this, geo-cloud computing wants to explore methods of presenting 2D and 3D virtual objects that represent targets, aerospace and defense [1], [2].

Mobile devices such as personal digital assistants (PDAs) and smart phones help people to traverse the divide between physical and digital space. These devices enable users to access information from remote servers about their current physical location. Such developments form part of a more general trend that is pushing physical and digital environments closer and closer together [3], [4]. Also, as computers increase in power and decrease in size, wearable, and pervasive computing applications are rapidly becoming feasible, providing people constant access to online resources anywhere. This new flexibility makes new kinds of applications possible to exploit a person's surrounding context. Mobile AR presents a particularly powerful user interface (UI) to context-aware computing environments. AR systems integrate virtual information into a person's physical environment so that he or she will perceive that information as existing in their surroundings. Mobile augmented reality systems provide this service without constraining the individual’s whereabouts to a specially equipped area. Ideally, they work virtually anywhere, adding a palpable layer of information to any environment whenever desired. By doing so, they hold the potential to revolutionize the way in which information is presented to people. Computer-presented material is directly integrated with the real world surrounding the freely roaming person, who can interact with it to display related information, to pose and resolve queries, and to collaborate with other people. The world becomes the user interface [5]. Compared to virtual environments, which simulate a whole virtual world, Mobile AR applications try to include virtual objects in the real environment. In order to augment a virtual object into the current environment, a system has to be aware of the current context. Animd Dey’s [6] defined its meaning and said in simple words; context is every piece of information about the environment that is needed by the system to perform its tasks. This kind of information could be considered as implicit input for the system, not visible to the user. We propose a unified framework of general object recognition and tracking for a service mobile phone to work in indoor and outdoor environments. To solve object variations, we propose a modified local Zernike moment which is tolerant of various environmental changes such as illumination changes and pose changes. The recognized object can be tracked using Lie group methodologies to simplify representation and computation of a motion. An initial 3D CAD model alignment is performed using the homography computed in the process of general object recognition. It can also be used as a training environment by taking advantage of the AR properties of imagination, interaction, and immersion.

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II. GENERAL OBJECT RECOGNITION AND TRACKING

Our approach utilizes mobile device platforms such as PDA and Ultra Mobile Personal Computer (UMPC) platforms. Mobile devices add mobility and functionality to users as a practical form of wearable computing. Since mobile devices are now very easy to acquire and use, we utilize mobile devices as an interaction tool. A notable feature of today's mobile device is a built-in camera. The increased functionality and popular acceptance of mobile cameras is that it gives users a sense of control of time and moment by taking and keeping pictures of memorable moments. We further enhance this idea to design our smart object controller. Fig. 1 shows the overall architecture of a camera-based context-aware smart object controller system.

A. Recognition and Tracking

Fig. 2 shows the proposed system of 3D object recognition by combining feature matching with tracking. The system consists of three components: the model DB generation, object recognition and tracking. In model generation, four points of an image model are pre-selected corresponding to the 3D CAD model points. By performing object recognition using local Zernike moments, we can obtain a homography between the image model and the input scene. By transforming the image model points using this homography, we can establish correspondences between the input scene feature point and the 3D CAD feature points. Using these correspondences, we can estimate the initial pose of the recognized object. Then we perform object tracking using the Lie group SE (3) in real-time.

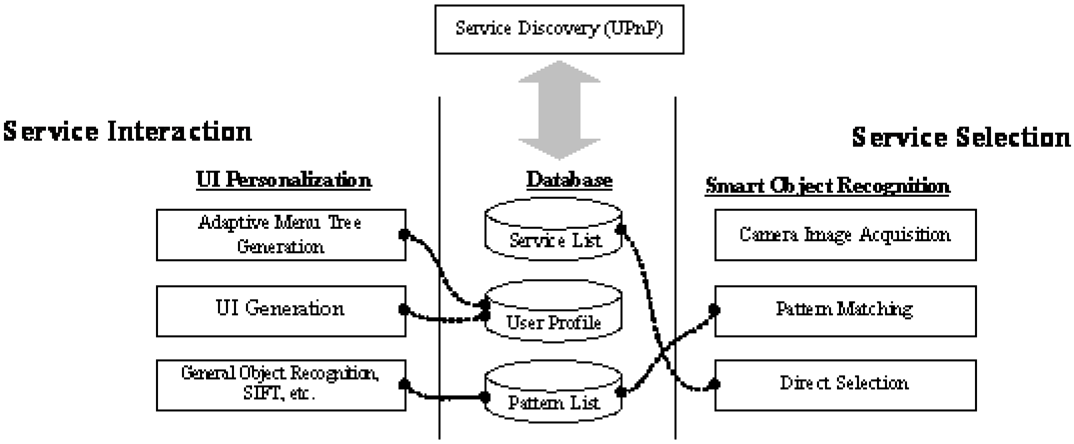


Fig. 1. Architecture of context-aware smart object controller

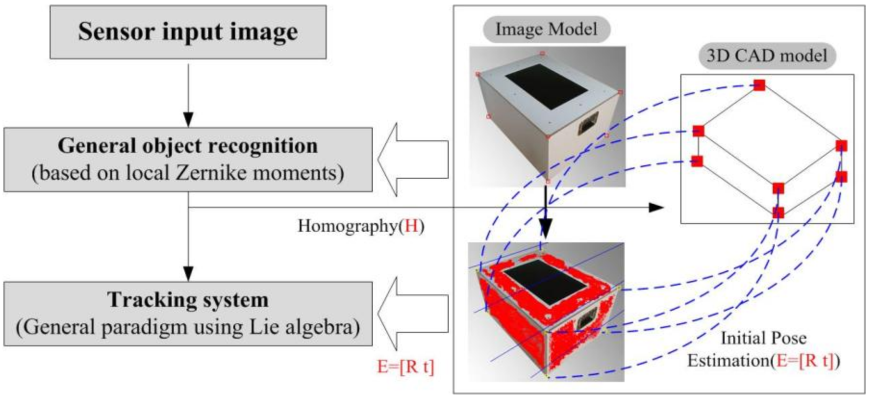


Fig. 2. Proposed recognition and tracking system

B. General Object Recognition

The object recognition system has two parts: robust feature extraction and feature matching. Fig. 3 shows the overall system of object recognition. In the off-line process, Zernike moments [7] are calculated around interest points detected from the scale space of the image model and are stored in a database. We can recognize an object by probabilistic voting of these Zernike moments in on-line process. The locality of the Zernike moment provides some robustness to occlusion and background clutter. We verify the recognition by aligning model features to the input scene. In this process, the homography between the image model and input scene is calculated. We determine the success of the recognition by the percentage of the outlier. The outlier is determined from the distance between scene feature position and transformed model feature position by homography.

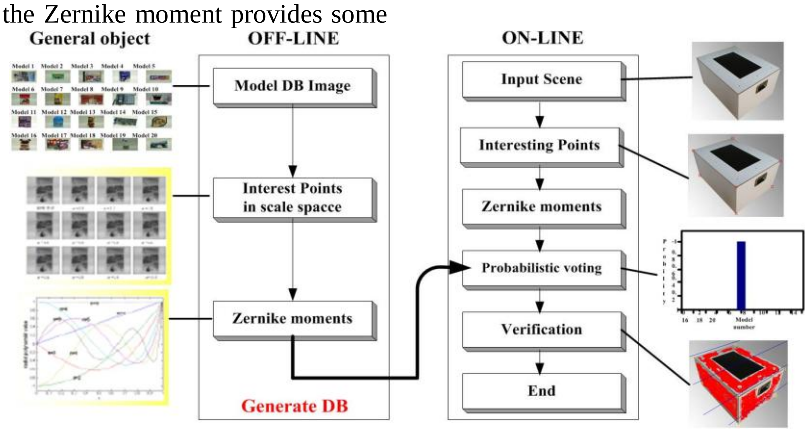
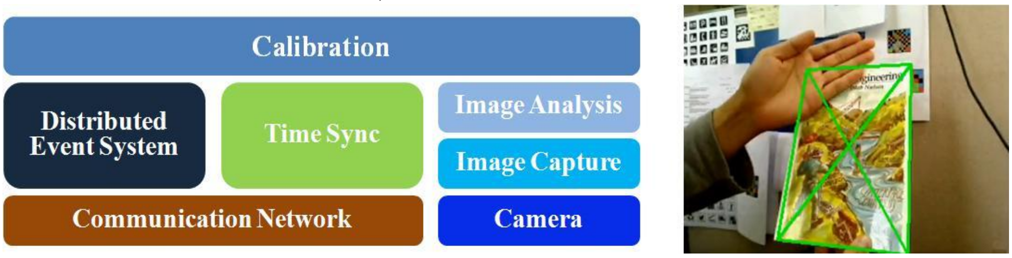


Fig. 3. The proposed general object recognition system

III. Mapping to Context Management Systems

A. Camera Calibration on Mobile-phone

Mobile phone camera calibration provides us with information about the intrinsic and extrinsic parameters of a camera. The intrinsic parameters are parameters that describe the camera's internals including the focal length, the distortion coefficients of the camera's lens, and the principal point (which is usually the center of image). The extrinsic parameters define the position and orientation of the camera relative to some world coordinate frame. While the intrinsic parameters of a camera vary from camera to camera, they need only be found once per camera. The extrinsic parameters of a camera are view-dependent.



(a) (b)

Fig. 4. Camera calibration on mobile phone, (a) Overview of facet's architecture, (b) Highlighted book cover calibration object detected with point correspondences

A common technique used to calibrate a camera is to find a number of image-world point correspondences. An object of known geometry such as a book cover pattern is detected in image space. In fact, the book cover pattern as in Fig. 4 is the most common calibration object used today. Mobile phone camera lens contains some amount of distortion. The distortion present can be described by radial and tangential distortion coefficients. These coefficients are used to rectify distorted images by undistorting acquired images. These undistorted images from the input to our CV system. Undistorting a point (x, y) results in a point (x', y'). This undistortion procedure is applied to each point of an acquired image. Where, $r^2 = x^2 + y^2$, k_1, k_2 are radial distortion coefficients and p_1, p_2 are tangential distortion coefficients. k_1, k_2, p_1, and p_2 are determined during camera calibration.

$$x' = x(1 + k_1r^2 + k_2r^4) + 2p_1xy + p_2(r^2 + 2x^2)$$
$$y' = y(1 + k_1r^2 + k_2r^4) + p_1(r^2 + 2y^2) + 2p_2xy \quad (1)$$

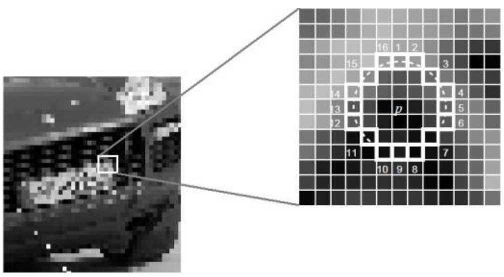


Fig. 5. 12-point segment test corner detection in an image patch. The highlighted squares are the pixels used in the corner detection. The pixel at p is the centre of a candidate corner. The arc is indicated by the dashed line passes through 12 contiguous pixels which are brighter than p by more than the threshold

We present here the FAST (Features from Accelerated Segment Test) feature detector. This is sufficiently fast that it allows on-line operation of the label placement system. A test is performed for a feature at a pixel *p* by examining a circle of 16 pixels (a Bresenham circle of Radius 3) surrounding *p*. A feature is detected at *p* if the intensities of at least 12 contiguous pixels are all above or all below the intensity of *p* by some threshold *t*. This is illustrated in Fig. 5. The test for this condition can be optimized by examining pixels 1 and 9, then 5 and 13, to reject candidate pixels more quickly, since a feature can only exist if three of these of these test points are all above or below the intensity of *p* by the threshold. With this optimization the algorithm examines on average 3.8 pixels per location on a sample video sequence.

B. Technique geo-cloud for Database

The server component has – in addition to the data queried form the Augmented World Model (AWM) – access to a database of general object recognition templates that implement different techniques, as depicted in the bottom of Fig. 6. Each individual general object recognition template available through the Database has four functional parts:

- Part 1 : A function to query the template for appropriateness to visualize a specific data type by providing the corresponding data schema.
- Part 2 : Processor to handle raw data objects, provided by the utilized federation.
- Part 3 : The implementation of the actual general object recognition technique.
- Part 4 : I/O routines to transmit or receive all required data of the template's general object recognition.

Therefore general object recognitions are represented as partial scene graphs. The preprocessed intermediate data, transmitted to the client, can therefore be raw data objects, standard scene-graph nodes, extended scene-graph nodes, or images streams. For the integration of a new general object recognition a template plug-in which implements the technique has to be made available on the server and, if intermediate object recognition data should be transmitted, on the client side. If a specific general object recognition technique is only available on the server side, then the clients cannot process the technique's intermediate data and the server system reverts to basic image-stream transmission.

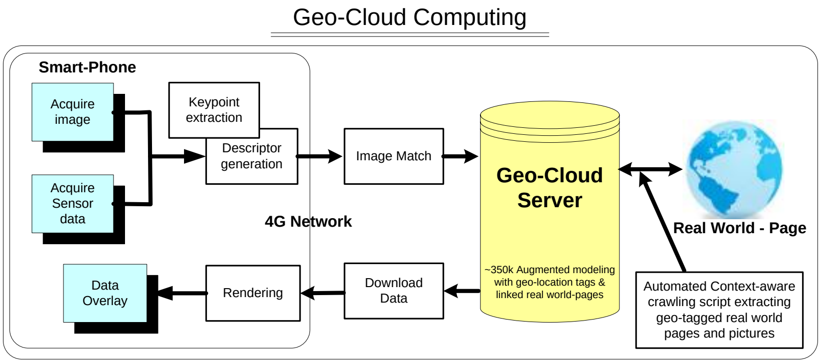


Fig. 6. Overview of the communication and preprocessing infrastructure to support data processing for mobile devices, implementing general object recognitions

IV. Experimental Scenarios, Results and Evaluation

This section extends the scope for implementation of user interfaces. Inspired by the strengths and weaknesses of the aforementioned work, and according to the recommendations we presented in the introduction, we developed a new interface for interaction with hand-held computers. In order to favor good visualization we opted for a system where the screen is never occluded by the users' hand. Consequently, users can concentrate on their data without being perturbed by physical objects. Moreover, we particularly wanted to ensure that users were not constrained to move the hand-held computer for interactions and they could choose and maintain the optimal viewing angle to the screen. In our system, user interactions involve movements behind the hand-held computer. The development of mobility and communication technologies makes it possible to access information anywhere at any time. Being aware of the great demand for information delivery on the virtual representation of real world, many 3D cities have been created either by companies like Google, Microsoft. Integrating the Global Positioning System (GPS) with the Inertial Navigation System (INS) has become indispensable for providing precise and continuous positioning information. In our system, we employ MotionNode [9], a high quality sensor, to compute miniature pose parameters. One accelerometer, one gyroscope, and one magnetometer contribute data for each of the three axes. A work-flow of estimating position, velocity, and attitude in Inertial Measurement Units (IMU) is illustrated in Fig. 7(a). Fig. 7(b) shows the overall concept and processing steps, which will be illustrated in more detail later. In short, the feasibility of real-time image processing is due to simple sensor geometry and limited complexity of the imagery collected.

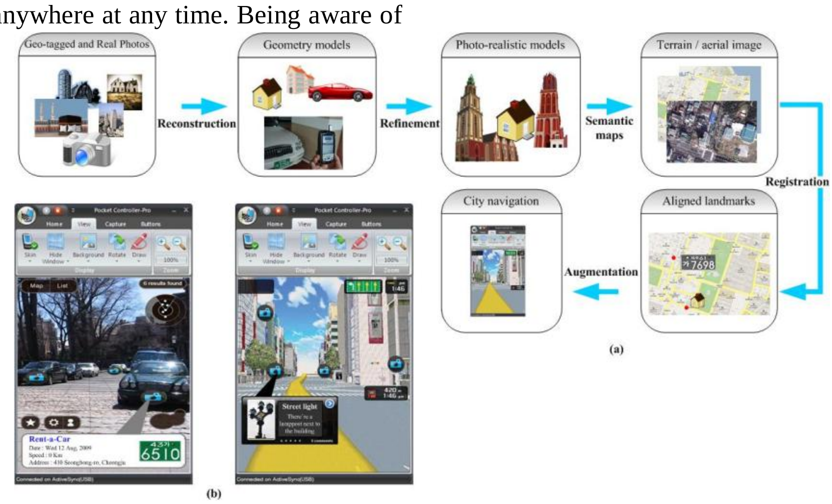


Fig. 7. Concept for recognition from informative local descriptors, (a) Workflow of the fine-scale directional guidance using the concept of augmented reality, (b) Experiment using the mobile device of a target object and general object recognition of cadastral information service for the 2D/3D map decision

This paper presents a hybrid solution to mirror world navigation. Integration of GPS and INS could provide accurate location information in the world coordinate system. The client used a PDA with a built-in IEEE 802.11 networking(iPAQ 5550), an attached mobile camera (Photosmart Mobile Camera) with a 320×240 resolution and an expansion pack with a 4.66 GB PC card hard-drive to store the application content. The resulting mobile package weighs approximately 400g with a battery life of approximately 2 hours. We anticipated that the application could be ported to a camera phone with little difficulty. In order to assess the feasibility of automated line extraction with 3D positioning and real-time usage, a rich set of potential image processing functions was developed in a Visual Embedded C 4.0 programming environment.

V. Conclusion and Future Works

The proposed general object recognition approach makes use of a context-aware framework to efficiently interpret and analyze heterogeneous context-based data queried from a federated data source. In addition to the hierarchicallydefined data type, the system also considers further context aspects to select and configure general object recognitions deployed to the clients, like a geo-referenced position, viewing direction, user preferences, client hardware, total amount of data, data entities within the current view, and much more. The open system thereby generalizes popular geo-mashup systems [10, 11] in a way multiple arbitrary data sources can be displayed via a generic data-visualization system, with respect to arbitrary context aspects, not just a geo-spatial position. Also, augmented reality smart phones now provide computation power, cameras, motion sensors, data connectivity, good displays, and most importantly are ubiquitous and easy to use when actively moving. The key tasks of near real-time image recognition and real-time tracking have been demonstrated on smart phones. And modeling the real world to support them on a large scale is becoming feasible. Camera phones are also ideal computational photography platforms, providing easy programming access to researchers and more versatile I/O capabilities than traditional digital cameras. The presented application shows the advantages and flexibility of the system to support mobile users with different qualifications, different aims, and different hardware in inspecting and understanding huge amounts of data. Mobile context-aware presentations of various kinds of data enable future applications that support interactive high-quality general object recognition adequate for a user's current context.

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