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Augmented Reality, an Emerging Technology and its View Management Problem.

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Abstract: *This paper talks about the emerging augmented reality technology, which has become popular in recent times due to availability of smartphones. Augmented reality applications need to annotate real world objects with information. Labelling is the most intuitive technique to achieve this goal. But labelling sometimes causes overlapping and occlusion amongst labels and objects. This causes ambiguity. This paper reviews two interactive system of view management to address the problems.*

Keywords: *Augmented reality, Virtual reality, View management, Point of interest (POI), Annotation, Label, Layout.*

I. Introduction

Augmented reality is a technology through which a user's real world view can be altered by superimposing computer generated virtual texts and images on the users viewing screen in real time. It is an emerging technology and has found applications in various fields such as medicine, tourism, defense, arts etc. This technology has gained popularity in recent times due to the availability of smartphones which contain the required hardware to support augmented reality.

Most applications make use of labels to provide digital information to the user in context of their real time environment. These labels annotate real world buildings and places with textual information. The digital information is registered based on geographical locations (Point of interest) with corresponding GPS position. These POI's are projected on the screen with the help of labels.

As the number of POI's in the frame increase, number of labels increase. This often leads to labels occluding important real world objects and other labels. As a result, the view of the user is hampered. Furthermore, augmented reality environments are dynamic, due to which the labels must be coherent with the frame. Jumping labels are undesirable. They distract the user and hamper the view.

The decision of where to place the labels so that readability is increased and the view of the user is not hampered, is the problem of view management. View management refers to the layout decisions that determine spatial relationships among the 2D annotations in the view plane. Researchers have come up with several techniques to solve the problem of view management.

In this paper, we discuss two techniques. First, Image-Driven View Management [1]. Second, Dynamic Labeling Management [2].

II. Augmented Reality- The concept

a. Definition

Augmented reality technology consist of the following building blocks [3]:

Real world.

Real time.

Computer Graphics.

Seamless integration of the graphics in real world.

An AR enabled device.

Keeping these building blocks in mind, a formal definition of augmented reality is:

Augmented Reality (AR) is a real-time device mediated perception of a real-world environment that is closely or seamlessly integrated with computer generated sensory objects [3].

It is important to understand the difference between virtual reality and augmented reality. They both form the part of mixed reality. In virtual reality, real world objects augment the virtual environment and in augmented reality, virtual objects augment the real time environment.

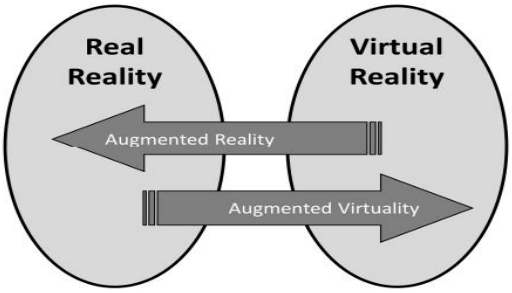

Figure 1 Conceptual model of the relationships between the Real (Physical) Reality and Virtual Reality.

b. Classification

Based on the five natural powers of human sense of sight, taste, hearing, touch and smell. Augmented reality can be classified as

Visual augmented reality. (Sight)

Haptic augmented reality. (Touch)

Gustatory augmented reality. (Taste)

Olfactory augmented reality. (Smell)

Audio augmented reality. (Hearing)

The classifications of AR are evolving. The main types of AR in the context of their conceptual evolution are

Marker augmented reality. (Recognition based AR)

An AR marker is an image or a view of real-world objects that provides a unique pattern that can be captured by an AR camera and recognized by AR software [3].

The AR software recognizes the marker and calculates the correct position for placement of the graphic. This graphic is then embedded in real time near the marker.

Marker less augmented reality. (Location based AR)

In marker less AR, objects in real world are tracked without the use of markers. . It places graphics in real time based on the position (the latitude, longitude and altitude) of the AR object in the real world environment. [3]

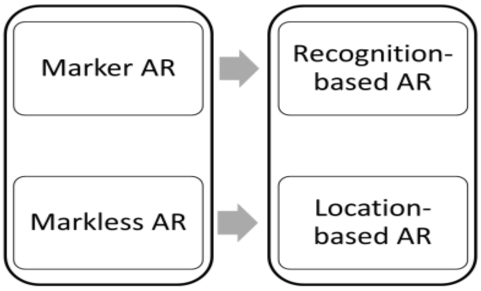

Figure 2 The evolution of the conceptual model of Augmented Reality.

III. View Management in AR

View management refers to the layout decisions that determine spatial relationships among the 2D annotations in the view plane.[1] Researchers have come up with several techniques to solve the problem of view management. In this paper, we discuss two such techniques.

a. Image-Driven View Management

Image driven view management technique takes into consideration the layout (point based placement or labeling) of a label along with its representation (visual style) to increase readability. It makes use of the pixel based approach for placement of labels and considers an extensive list of aspects for placing labels based on the real time content. [1]

This technique focuses on unambiguity, aesthetics, readability and frame-coherence of labels. It is a hybrid technique that combines a layout algorithm with adaptive rendering. The approach adopted analyses the image to determine the placement of labels. It takes care of the following [1]

1. Labels should not overlap important real world objects.

2. Labels should be rendered in a way that they easily relate to their corresponding POI's.

3. Labels should be readable over the background.

3. Labels should be coherent to the frame.

i. Image Based Layout

The layout technique uses information from the image to determine position of the labels. The goal is to avoid occluding important real world objects.

To identify important areas in the image, saliency algorithm is used along with edge analysis. Saliency algorithm produces an intensity image (saliency map) where the grey levels represents the importance of information in the image. The edge analysis produces an edge map. Taken together, the salient information and the edge information encode the pixel positions where labels should be placed.

To implement optimization, Greedy algorithm is used. Greedy algorithm sequentially optimizes each label and evaluates the objective function of each. The minimum value among the candidate positions is selected as the position of the label. The algorithm sorts out the labels from left to right and in depth from closest to farthest. It iterates for each label, for different positions in the space and minimizes the objective function. [1]

To handle image motion and dynamic content in the image, the layout algorithm is executed at low frequency after initially placing all labels. To avoid jumping labels, each label is locally tested for changes of the saliency or edges information and re-computation is avoided as needed.

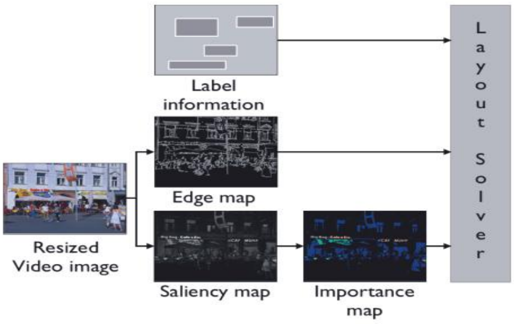

Figure 3 Image analysis for our layout algorithm: the image is resized, saliency map and edges map are computed. A threshold is applied to the saliency image.

ii. Adaptive Representation

Leader lines

When moving labels further away from their anchor position, leader lines are required to link them. Users must be able to distinguish the leader line from the background for which the contrast between the colour of the line and the surrounding pixels should be high. The contrast is achieved by following the process of computing an average of the lightness of the pixels surrounding the leader line and modifying the colour of the leader line to yield a contrast. [1]

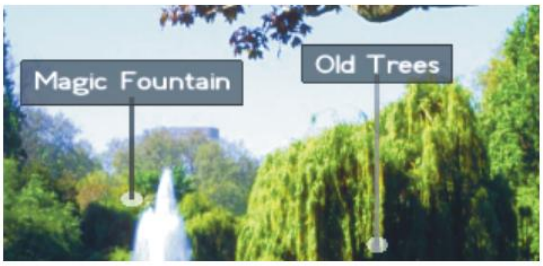

Figure 4 Colour of leader lines are adapted to background.

Anchor

Anchor points help the user in identifying the real position of the POI (if the POI is in front or behind the object present in the view). The inner radius of the anchor encode the distance. If a POI is close to the user, the ring will be a full disk, if the POI is far from the user, the ring will converge to a circle. The opacity is modulated by encoding its value in function of the distance to the viewer. Hence, close POIs are opaque, while distant POI are transparent. To determine the radius, distance of the POIs are rescaled from the user's viewpoint to a normalized range. [1]

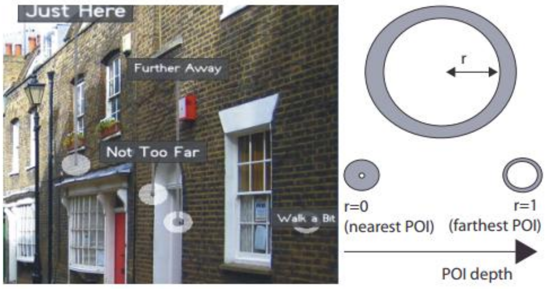

Figure 5 Anchor Ring concept and example with POIs at different distance.

Background and text

When the label overlays a dark or bright area of a video image, the readability is impaired. Hence active rendering styles for the labels is adopted. A separated technique, which works in HLS (hue, saturation and lightness) colour space and allows to adapt lightness or saturation of a label background or of its content is adopted.[1]

Three approaches can be used

1. Global approach: It computes the average lightness over the entire image and modifies the lightness of the label background to have a contrast difference above a certain threshold.

2. Local approach: considers only the computation of the average lightness in the neighbourhood of each label's background, and contrast modifications are applied separately for each label.

3. Salient relative approach: considers the average lightness of the salient regions, so the labels can be more prominent with respect to the saliency information on the image.[1]

iii. Context and Temporal coherence (Consistency)

To achieve temporal coherence, label movement caused by jitter introduced by unsteadily holding the device is minimized. Label movement is also avoided there are only small dynamic changes in the scene. An inertial sensor is used to determine the yaw magnitude of the current rotational camera motion.[1]

The Algorithm avoids placement of labels on detailed features or visually prominent elements (people, cars, visual signs, and complex facades) and places labels in uniform areas (sky, ground area, grass). For urban facades, labels are generally moved between windows and reliably avoid overlaying shop signs. The saliency map computation is also efficient for filtering highly repetitive textures. The edge map computation generates a large number of lines for complex scenes with trees or complex building structures. Therefore a small weight factor for the edges map is used in the objective function.

b. Dynamic Labelling Management

In dynamic labelling management, layout decision of the labels are based on users' desired constraints. The goal of this technique is to place label efficiently to avoid ambiguity. Occlusion problem are solved in two directions:[2]

Labels are rearranged to explore more available positions.

Information filtering is used to reduce number of labels. Irrelevant information for the user is eliminated.

This technique combines three sub-techniques:[2]

View driven filtering technique to reduce number of labels.

Adaptive labelling technique to optimize placement.

Fast label searching to instantly respond to user's inquiry.

Hence this technique integrates label placement algorithm and information filtering.

i. View Driven Label Filtering

Properties of an object can be categorized as Objective and subjective. The filtering function helps determine the elimination of labels. View driven filtering technique has the following characteristics [2]

Level of details for objects vary with their distance from viewer. Details consist of colour, size and contents shown on them. Example if the text of a label is "Reserve Bank of India" can be abbreviated to "RBI" when the viewer moves away from it.

Hardware automatically clips the object outside the view frustum but their labels have to be clipped manually.

To indicate the priority of objects, system strengthens the contrast of label display. Label size become larger as priority increases. Other factors that influence the priority are distance from user, object size and user focused.

Objects with same feature are bounded into a single group such that only one label is needed for all objects in the group.[2]

Objective properties:[2]

Label context: Stores the text associated with the label (different text for different distance level)

Group index: Indicates the group to which this object belongs.

Position: Stores the bounding box of the projection of each object on the 2D screen.

Size: Stores the minimal and maximum size of the visible label.

Transparency: Property used to improve label display if overlapping cannot be avoided.

Subjective properties:[2]

Priority: Each object is assigned a priority that helps in filtering.

Focus region: This property represents the user-focused region which helps in filtering labels outside of the region.

Filtering technique reduces the data redundancy and display efficiency is enhanced.

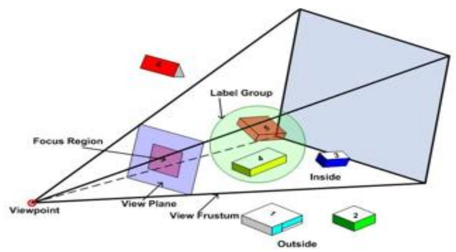

Figure 6 Only objects/groups of objects that lie inside the focus region are labelled.

ii. Adaptive Label Placement

This system calculates the bounding box of the projection for each object and then determines a rational area to place the corresponding label. There are two placement schemes

Internal labelling: Places label inside the bounding box.

External labelling; Places label outside the bounding box. An arrow is used to connect the label and associated object.[2]

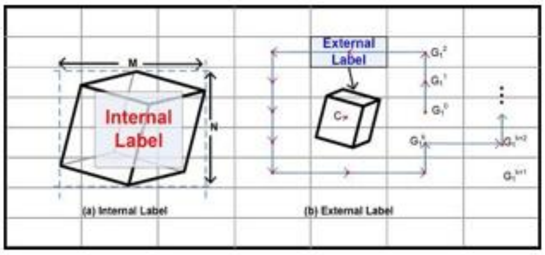

Figure 7 Internal and External labelling.

iii. Label Searching

Labels give users extra information related to the environment but excessive information usually make users confused even if all labels are well displayed. Hence this system supports fast label searching. The interface of label searching is an input box. Users may input some keywords and the system will use a coloured arrow to show the direction of the inquired label.[2]

iv. Dynamic Labelling

Users can navigate the environment with the assistance of dynamic labelling and structured label searching facility.[2]

IV. Conclusion

Augmented reality annotates real world with valuable information for the user. Placement of this information on the view screen of user must be monitored such that the view is enhanced and not hampered. This is taken care of by the view management techniques talked about in the paper. The first technique combines a layout algorithm with adaptive rendering. The second technique integrates label placement with label filtering. Both take care of dynamic label placement. All these features make these algorithms effective.

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