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Creating a City Administration System (CAS) using Virtual Reality in an Immersive Collaborative Environment (ICE)

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Current problems in administration of a city are found to be decentralized and non-interactive for an effective city management. This usually will result in inconsistencies of decision-making, inefficient services and slow response to a particular action. City administration often spends more money, time and human resource because of these problems. This research demonstrates our research and development of creating a City Administration System (CAS) to solve the problems stated above. The task of the system is to use information, multimedia and graphical technologies to form a database in which the city administrators can monitor, understand and manage an entire city from a central location. The key technology behind the success of the overall system uses virtual reality and immersive collaborative environment (ICE). This system employs emerging computer based real-time interactive technologies that are expected to ensure effective decision-making process, improved communication, and collaboration, error reduction, (Rafi and Karboulonis, 2000) between multi disciplinary users and approaches. This multi perspective approach allows planners, engineers, urban designers, architects, local authorities, environmentalists and general public to search, understand, process and anticipate the impact of a particular situation in the new city. It is hoped that the CAS will benefit city administrators to give them a tool that gives them the ability to understand, plan, and manage the business of running the city.

Keywords: *City Administration System (CAS); Virtual Reality; Immersive Collaborative Environment (ICE); Database.*

Introduction

There has been numerous attempts in Malaysia to computerise the city administration and planning activities such as traffic monitoring, maintenance of infrastructure, enforcing zoning bylaws, approval of new development and controlling mass gatherings. The fact is that a system designed for city administration and planning can be very diverse and complex is because of the abundance of information that is to be processed as well as the varied methods and procedures that must be followed even for simple tasks. Moreover, decisions are usually made after cross-referencing a multitude of documents, laws, needs and unresolved issues, making it a very tedious and daunting task.

What we need is a simple system that has a structure and can be interacted upon by various components and people of the city administration. CAS (City Administration System) aims to be just that. It has a fully graphical input using Virtual Reality

technology and GIS system, making interaction to the city interesting and effective. It also has a hierarchical structure for all databases within the systems that are governed by 3 types of database i.e. static, dynamic and active. The output can then be in the form of approval or decision by city administrators and of course the commencement of specific tasks for the city.

Problems of City Administration without CAS

The traditional way of administering a city is by divisional rule. For a major city, there must be at least a dozen divisions that preside over and has authority over various aspects of the city. These divisions (such as architectural and planning, engineering and technical, utility control, transportation, maintenance and so on) report to at least 2 major departments such as Administrative and Development.

Administrative department will maintain and operate existing facilities in the city. This includes collecting rentals and taxes, taking care of landscapes and amenities and informing other various authorities for the need of maintenance and upgrade of infrastructure such as electrical supply and roads. On the other hand, Development department concentrates on what will happen in the future as well as current unresolved issues and find ways to find solutions. This will normally include vetting for proposals for new development, relocation of squatters and conservation of historical identities.

The problem with this structure is that most of the time these tasks overlap one another and inter-relational problems occur which are very difficult to solve. For example, a new fly-over is needed, and this will affect some squatter's land. In addition, this fly-over will block the scenic view of a historical structure. In this problem alone, many other divisions will be involved including both of the departments. Solving a simple problem such as this normally will take a long time and decisions made usually will be biased towards some of the divisions.

Mistakes made from the decision are usually costly and irreversible. These non-centralized and non-collaborative ways of dealing with city administration are ineffective, inconsistent, inefficient and slow. CAS is designed so that the whole city can be viewed; interacted with and different parties will be able to 'see' potential problems before decisions can be made (figure 1 and 2).

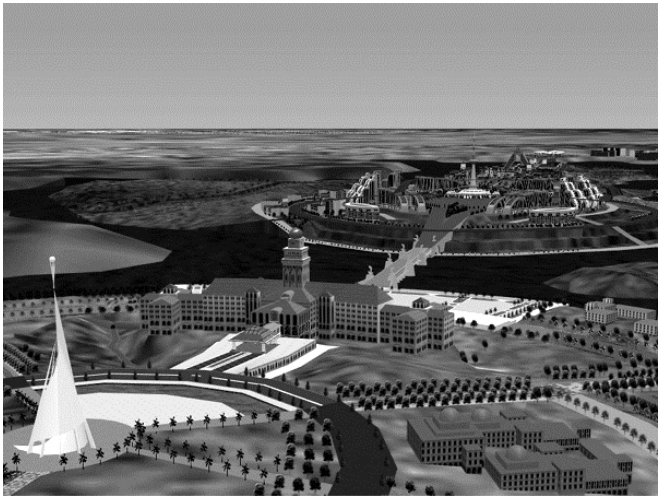

Figure 1. An aerial view shot of Putrajaya, Malaysia real-time virtual model to be developed in CAS.

City Administration System (CAS) Framework

The framework of CAS is divided into 3 parts namely input, process and output. The input is where each division interfaces with CAS and update data regarding its jurisdictions and actions. This is done via the division's network portal through their Intranet terminal or Wireless Application Protocol (WAP) enabled devices. For example, engineering and technical division sends a team to install a drainage section, and upon completion and inspection, the lead engineer can use a WAP hand-phone to "sign" his team's work. This will update CAS with the latest information in its database together with the physical aspects of the drain such as length, capacity, connections and date of installation. Input systems are designed to be hierarchical. All divisions are at the same level with specific tasks under them. These subtasks that overlap with other divisions' subtasks are inter-linked. An update of any shared items in the subtasks is to be "signed" by all affected divisions.

For the process, a structured database system is designed for CAS. The database consists of 3 types i.e. Static database, Active database and Dynamic database. Static database is for fixed items such as length of a drain, type of pavement tiles or name of a road. Of course the static database can also change but the changes are inconsequential to the other databases. Active database changes according to relative changes to other databases linked to it. An example of data in an active database is road closures for a parade. This closure will affect traffic path and direction at the point of closure. A temporary path linking points of diversion can be constructed via input. Dynamic database changes over time. The drain constructed above will need maintenance periodically and time for maintenance can be set and reminders will be sent to a particular division for attention.

The output of CAS is via Immersive Collaborative Environment (ICE). This is the most challenging part. All inputs and processes will then be updated into ICE in real-time. ICE is often used by the Administrative and Development department to monitor and control the whole city. These departments sit on a higher hierarchy level than divisions and may revert any decisions made from the level below them. ICE is divided into 2D and 3D graphics created using Digital Elevation Model (DEM) of stereo satellite imagery.

Figure 2. A ground shot of Putrajaya, Malaysia real-time virtual model to be developed in CAS.

These graphics are overlaid with GIS data of the terrain such as roads, train tracks, boundaries and zoning. The GIS data is connected to the process database and status of each data can be accessed in ICE interactively. As Ayres (1998) says, open database systems will make our GISs more efficient and therefore will increase their usefulness, as well as increasing the market value of such systems. The Virtual Reality technology used in ICE will enable decision-makers to see and understand a given scenario before making a crucial decision.

CAS: Given Scenarios

New Development Proposal

There is a proposal to develop a piece of land in the city. The proposal includes a 12 floors office tower, a shopping arcade and pedestrian malls. It also proposes to reconstruct an old road that cuts through the land into a highway and divert the original road path to go through a series of nodes in the complex before joining an existing highway at the periphery of the land.

When the architect submitted the plans and models for approval, a 3D model that sits on a geo-referenced terrain is created (and charged to the developer). The Architectural and Planning division inputs the 3D model into the city's ICE model and creates databases for process. These databases are then connected to GIS data such as linking the new highway to the old road and recalibrate the traffic path, flow and capacity through the new highway. It also creates a separate layer for the existing model of the land for reference.

In ICE, the Administration department officers can flythrough and walkthrough or view at any angle of the proposal in real-time. They can also check the process data such as shadow casting at various times of the day as well as pedestrian and traffic circulation in and around the complex at peak times. The impact of the development can be felt in ICE and recommendations can then be suggested. The transaction with CAS is then recorded and portions of it are then multi-cast to related divisions for further recommendations. The final approval can then be given after taking into consideration the views of all parties within the collaborative system.

Flood Crisis

Handling an emergency situation within a city administration is another example of CAS capabilities. Imagine a flood crisis. There is heavy downpour continuously for 4 hours and water level in a section of the city rises to over 1 meter. With water level sensors placed at strategic positions of the river, the emergency division is able to track and monitor rises of water at different parts of the city in real-time. City administration officers are also sent to worst hit areas for better understanding of the situation and offered assistance to trapped and helpless people. With either WAP devices or radio communications, the latest information is transferred to CAS via these officers. Research in this area especially 'hydroinformatics' has been demonstrated by Srdanovic, Jovanovic and Lekic (1998) using GIS technology to control flood. What is more important because it provides a natural environment where various collections of data can be managed, analysed and displayed based on the situation.

All these information will then be layered to the ICE system. The city administrators can then use the ICE system and collaboratively discuss and decide the course of action to be taken and what type of facilities is to be provided to the rescue workers. Humanitarian aids can then be channeled to the flood victims depending on the number of victims and their conditions. Highway bulletin boards and radio broadcasts will inform the masses of road cutoffs and diversion in order to avoid the public entering the flood areas. Meanwhile, gates to specific flood drains will be opened either manually or remotely to divert overflow water and monitor for possible blockage.

Crisis handling like flood requires a high degree of efficiency in decision making and with CAS, the most important data can be accessed easily and quickly for better understanding of the situation.

Haphazard handling of emergency situation can result in higher death toll and unwanted loss of properties.

Maintenance of the City

In the process framework, maintenance of the city primarily depends on Dynamic database (change over time). For a GIS data for example, a particular road, dynamic database should be set to include items like; garbage collection, road repairs, landscape pruning, light fixture repairs, advertising board updates and so on. Whenever there is a need for a particular job, the CAS will then inform the affected divisions of the task and open the line to update the status. When the task is completed, the line will be closed until the next maintenance job is needed.

Administrators can then check the status for the whole city for maintenance upkeep and may also be able to determine whether a particular division is understaffed or inefficient for their tasks. Although maintenance may not be the most important agenda for CAS, it can lead to serious implications such as outbreak of diseases, bad roads that cause serious accidents and trees that grow until they damage electrical lines or phone lines.

Conclusion

Future cities require effective communication, fast updates, effective decision making that goes beyond traditional management and control. Because of the competitive edge, digital demand, convergence of technology and complexity of design, the role of city administrator should be global and ready to attend to customer needs at any time and place. The use of virtual reality as a tool with the right visuals, structured databases, and interactive levels allow individual, professional, and designers to search, cross-reference, avoid redundancy of work, predict, understand, manage, and anticipate the impact of any situation in a city. The ability to assign and update (automatically) the correct information via network (or WAP) to specific stage of the city scenario makes VR an effective tool that stimulate creativity and critical thinking in city administration. This would be the biggest challenge for the direction of the research. Above all the city administrator designers could be better informed when they are aware of people's real needs, how people lived in the past and how they live in different parts of the world.

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