# Gamified Information Systems: Toward an Efficient Delivery of Information

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## *ABSTRACT*

*Video games can be viewed as one of the most efficient information delivery platform. Playing a game means consuming game information and making decision in a fraction of a second. There are principles behind this efficiency. Firstly, information is provided in a visual manner utilizing human preconscious information processing power. Secondly, information is provided in an intuitive form eliminating abstract layers of information processing. Thirdly, information is provided in context making it effortless to obtain appropriate information for the task at hand. These principles could be applied to an information system in order to improve the system efficiency. To demonstrate the concept, a gamified information system has been developed using conventional game technology.*

## 1.0 INTRODUCTION

Video games have become an important part of the modern culture. The demographic of game players has expanded to all ages and genders [1]. Regardless of the demographical difference, game players have similar experiences that playing games is very engaging or even addictive. It could be said that video games have touched the essence of human psyche that is common to all people. A game player can play a game continuously for countless of hours despite the fact that playing a game is a very demanding task. Most of the time, a player is forced to consume game information and make decision in a fraction of a second. The amount of information that a game player has consumed during hours of gameplay is enormous, while the player does not even realize that he/she has accomplished a magnificent task. From this perspective, video games can be viewed as one of the most efficient information delivery platform.

### 1.1 Game Information

In order to play a game, a player needs to know the current state of the game that he/she is playing. For example, in order to make a decision for the next move in a chess game, a player needs to know all current positions of both one's own and opponent pieces. This information about the current state of the game, or "game information", needs to be communicated to the player through some means and, typically, video games communicate most of game information in graphical form. In fact, graphics in games could be viewed as visual representation of game information.

## 2.0 LITERATURE REVIEW

The use of game design elements in non-gaming context, Gamification, is a new research field. The term "Gamification" started to be used in 2008 and gained a widespread adoption in the second half of 2010 [2]. Currently, the majority of works are focusing on engagement aspect of video games as this approach has been embraced by professional community[1]. Recently, the success of FoldIt project, where the protein structure involved in the reproduction of HIV has been solved by game players [3], spark interest in researchers to the possibility of using video games as a crowd sourcing platform to solve difficult problems. A good overview of the gamification and its related research fields can be found from the works of Deterding et al. [2] [4].

Although this work is under an umbrella of "Gamification", it is quite different from other works as it focuses on different aspect of video games. To the best knowledge of the authors, this is the first work that addresses the efficiency aspect of video games, and the first work that derives principles behind this efficiency. Apart from an academic context, a demo project in SAP Gamification Cup, "Gamified Manufacturing" [5], appears to be similar to this work. However, it emphasize on only one concept, the visualization of information using virtual reality.

# 3.0 UNDERLYING PRINCIPLES

The reason for the efficiency of video games in delivering information comes from the nature of the game industry itself. Video game is an interactive entertainment and, in this industry, engaging user experience is vital to the success of the product. Video games usually achieve this goal by immersing a player in a game's world, and video games usually maintain this highly immersive experience through the timely interaction between the game system and the player. This normally means that the game should be able to provide game information in the form that could be consumed by the player under a very strict time limit. Furthermore, since video game is an entertainment application, the process of consuming game information should also be pleasurable to the player.

These requirements force game designer to provide game information in the easiest way for human to consume, and game companies who fail to meet these requirements would be driven out of business easily. It could be said that this efficiency has been developed through Darwinian "survival-of-the-fittest" law. From this perspective, three design principles that lie behind this efficiency have been identified, which are Visual, Intuitive, and Contextual principles (VIC principles).

## 3.1 First Principle: Visual

In video games, most game information is provided in a visual manner. This approach utilizes human preconscious information processing power. The efficiency of this approach can be observed easily by a simple comparison provided in Figure 1.

[1] See the Gamification Summit website at http://www.gsummit.com

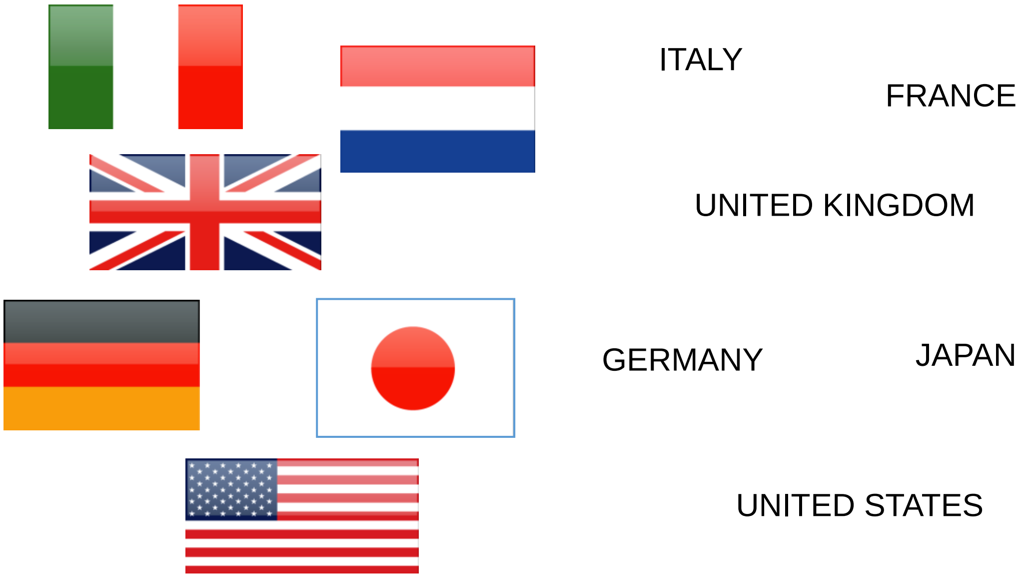


**Figure 1: Country information in visual form (left) and non-visual form (right).**

From Figure 1, it can be seen that we can obtain country information through the flag images faster than through texts. This happens because human vision system has the highest capacity for processing information, and most importantly, it is preconscious [6] [7]. This preconscious processing is very efficient since it is an automatic processing that does not require conscious thought, which is the source of inefficiency [8].

Utilizing preconscious processing also gives additional advantages. Firstly, it implies that the conscious processing power has been preserved, and could be used for more important tasks. Secondly, it implies that the result of this process would be very consistent or, in other words, less prone to error since it is a pattern that has already been chunk up in the brain [3][9]. For an example, it is more probable that people would make a mistake between the names “United Kingdom” and “United States” than it would be between the flags of those two countries.

Furthermore, visual approach also allows us to pack large amount of information in one single image [6]. This advantage could be seen from the example shown in Figure 2, where one image of the game’s battlefield screenshot could represent a substantial amount of data. In fact, the popular phrase "a picture is worth a thousand words" could be rephrased as “a picture is worth a thousand data”.


| Name | Group | Action | Status | Position |
|---|---|---|---|---|
| Carrier 1 | Ally | Fire | Alive | … |
| Carrier 2 | Ally | Fire | Alive | … |
| Carrier 3 | Ally | Fire | Alive | … |
| Carrier 4 | Ally | Fire | Alive | … |
| Carrier 5 | Ally | Move | Alive | … |
| Colossus 1 | Ally | Fire | Alive | … |
| Colossus 2 | Ally | Move | Dead | … |
| Colossus 3 | Ally | Fire | Alive | … |
| Colossus 4 | Ally | Move | Alive | … |
| Hybrid Destroyer 1 | Enemy | Fire | Alive | … |
| Hybrid Destroyer 2 | Enemy | Move | Exploding | … |
| Hybrid Destroyer 3 | Enemy | Fire | Alive | … |
| … | … | … | … | … |

**Figure 2: A battlefield screenshot from "StarCraft II: Wings of Liberty from Blizzard Entertainment" (above) and its equivalent information (below).**

Therefore, it seems that the usages of graphics in video games are not simply a coincidence, or it is designated only for aesthetic/luxury purpose, as it can be seen that graphics is a very efficient mean for conveying information.

## 1.1 Second Principle: Intuitive

Video games typically provide information in intuitive forms, which help eliminating abstract layers of information processing. A good comparison between intuitive and non-intuitive information can be seen from the comparison between user interfaces of the two games shown in Figure 3.


**Figure 3: An intuitive user interface in "Diablo III from Blizzard Entertainment" (left) and non-intuitive user interface in "Final Fantasy II from Square" (right).**

In the game "Final Fantasy II", information about weapon equipment is presented in abstract forms, which are short words such as "RHand", "LHand", etc. The game uses these short words to represent parts of the body that could equip weapons. However, this information is not in a form that can be understood directly, and would require our abstract thinking capability to interpret the information. Unfortunately, abstract thinking involves conscious thought, which is not efficient. In contrast, in the game "Diablo III", the same information is presented in a form that is familiar and natural to the player using an image of human body. This form of information can be processed automatically and unconsciously since the player would already have the chunk routine in his/her brain that could process this kind of information.

However, the question still remain "How could information be presented in an intuitive way?". In order to answer this question, we need to understand more clearly of what does it mean to be intuitive. The first difficulty arises from the fact that intuitive is subjective. What is intuitive to one may not be intuitive to the others. For an example, an iPhone in the hand of a grandparent who born during World War II would become a useless device that is too complicated to use. While the same iPhone in the hand of a teenager who born in digital era would be a great gadget that is easy and intuitive to use.

From this example, it can be seen that information would become intuitive when it is in a form that is familiar to the target user group. The usage of human body in the game "Diablo III" is a good example in this respect since all game players would be familiar with human body. Also, another good example of an object that would be familiar to all game players is our world since we all born and live in it. So, it is not surprising that most video games have utilized it by creating their own virtual worlds and presenting game information through that.

Thus, it comes to the second question "Where does familiarity comes from?". The answer would come from our past experiences since we would be familiar with things that we already have experiences with. A common example would be an experience when you drive a car back home. Normally, when you drive a car back home using the same route every day, eventually, you would be able to drive a car back home without thinking of where to make a turn. This ability means that you have successfully built an autopilot mode for your way back home, or in other words, the way back home has already become intuitive for you.

Therefore, it can be seen that through repetition almost everything could become intuitive. The advantage of this intuitive information processing is that it would lift a burden out of your conscious thought; however, it also has a drawback that you should be aware of. Following the previous example of driving a car, if one day you want to stop by a grocery store before going back home and if you are not so conscious while you are driving, it is highly likely that you would end up in front of your home instead of the grocery store. This would happen because unconscious thought is a fixed pattern that is difficult to alter, which is the downside of unconscious processing.

To summarize the process of presenting information intuitively, firstly, it is important to identify the target user group; then, find out the common experiences that they share; and lastly, present information in the way that will be in accord with those common experiences.

## 3.2 Third Principle: Contextual

Video games usually provide information in context, which makes it effortless for the game player to obtain appropriate information for the task at hand. For an example, in a real-time strategy game "Starcraft II", a player plays a role of a military general engaging in a battlefield. In this context, the player needs to control his/her military units to fight against the enemies. Thus, everything that is happening in the battlefield would become crucial information to the player. To answer this need, the game let the player see battlefield information through a virtual camera that can fly over the whole battlefield. A sample battlefield screenshot is shown in Figure 4.


**Figure 4: A battlefield screenshot from "StarCraft II: Wings of Liberty"**

Furthermore, for strategic and tactic planning, geographical information of the whole battle field, along with information about the location of allied and enemies units are essential. The game let the player see this information through a mini-map at the bottom-left of the game interface. An enlarge image of a mini-map is shown in Figure 5.

**Figure 5: A mini-map screenshot from "StarCraft II: Wings of Liberty"**

From these examples, it can be seen that the game "Starcraft II" provides information that is highly relevant to the context, and all of the information is provided in only one single screen. In this manner, the player does not need to spend time finding any information, since all necessary information is already provided in front of him/her.

Additionally, when the task in the game has changed, video games usually change their interfaces in accord with the current task; and in cases that there are many tasks to do in one time, video games usually provide multiple interfaces that can be toggled using hot keys. In fact, game designers are forced to design game interfaces using a few possible clicks/keystrokes because video games usually have strict time limit. The game player normally needs to make a rapid decision during the gameplay continuously. If the player needs to spend time making several clicks/keystrokes, it would break the immersive quality of the game. Thus, game interfaces have evolved to become very efficient in order to meet this timing constraint.

### 3.3 VIC Principles

From VIC principles, it can be seen that video games try to push information out of conscious processing as much as possible. This is similar to the concept of CPU and GPU where graphics calculations are push out from CPU (conscious) into GPU (unconscious). This is reasonable since conscious thought are orders of magnitude slower and also more prone to error [9]. As a result, the delivering of game information has become very efficient.

Therefore, by applying VIC principles, it is possible to create an information system that would be both efficient and robust. Besides, this system would also allow the user to preserve his/her conscious processing power for more important tasks.

## 4.0 GAMIFIED INFORMATION SYSTEMS

Traditional information systems has its core in database management system (DBMS), which typically store data in text and table format. As it is natural for the systems to follow its data source, text and table have become prevailing formats in traditional information systems. Gamified Information Systems is a shift in perspective, where the presentation of information is not restricted to text and table style, but would follow principles derived from video games (VIC principles).

From a conceptual level shown in Figure 6, it can be seen that information systems and game systems are, in fact, similar. Information systems has data in a database and presents it through graphical user interface (GUI), while game systems has game information which is presented in graphical form. The concept of gamified information system has been developed through this perspective. In gamified information systems, data from a database would be provided to the user using the approaches that are commonly used in video game systems.

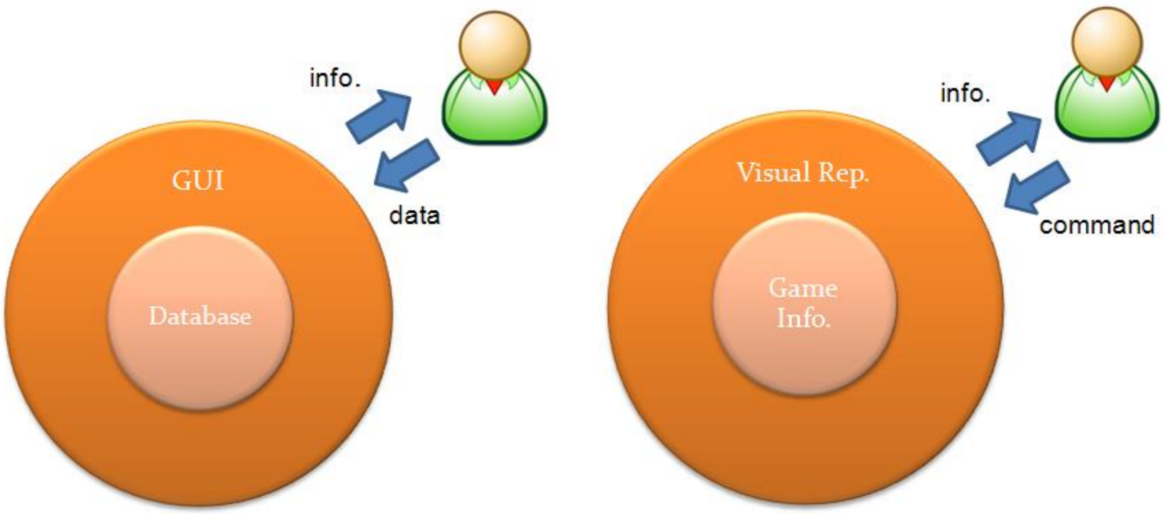


**Figure 6: A conceptual level of information systems (left) and video game systems (right)**

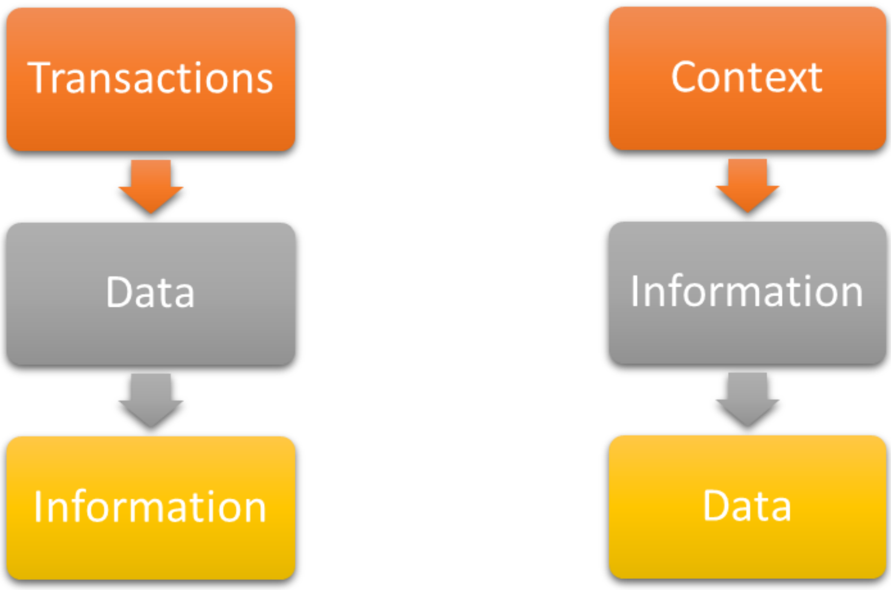


**Figure 7: Development approaches of traditional information systems (left) and gamified information systems (right)**

Besides, gamified information systems has another shift in perspective in its development approach. In traditional information systems, the development typically starts from business transactions; then, transaction data are captured and stored in a database; later, the transaction data are processed and turned into information; and finally, this information would be presented to the users through GUI. In gamified information systems, the development would start from the context of the systems; then, the context would inform the kinds of information that would be needed; and lastly, the required data would be determined from the needed information.

Nonetheless, it should be noted that there is a minor difference on the input of the systems. Traditional information systems normally has data as an input while video game systems normally has commands as an input. This implies that the concept of gamified information systems may not be appropriate for the information systems that have intensive data entry task.

## 5.0 A DEMONSTRATION OF THE CONCEPT

To demonstrate the concept presented in this paper, a gamified information system called "Virtual Terminal Information System (VTIS)" has been developed using conventional game technology. The objective of this gamified information system is to provide information to a terminal manager whose main responsibility is in the handling operations of containers in the terminal. In this context, the most important information is container information and container transportation equipment information.

Generally, the terminal manager need to monitor the whole container terminal, and also need to be able to obtain information that would be important in the handling operations of the containers. Following VIC principles, a virtual terminal has been created by replicating a container terminal into a 3D virtual world. Using this approach, a terminal manager would be able to monitor the whole terminal by navigating through the virtual terminal, and he/she could simply make a click on the associated 3D objects to obtain information. A sample screenshot of the system is shown in Figure 8.

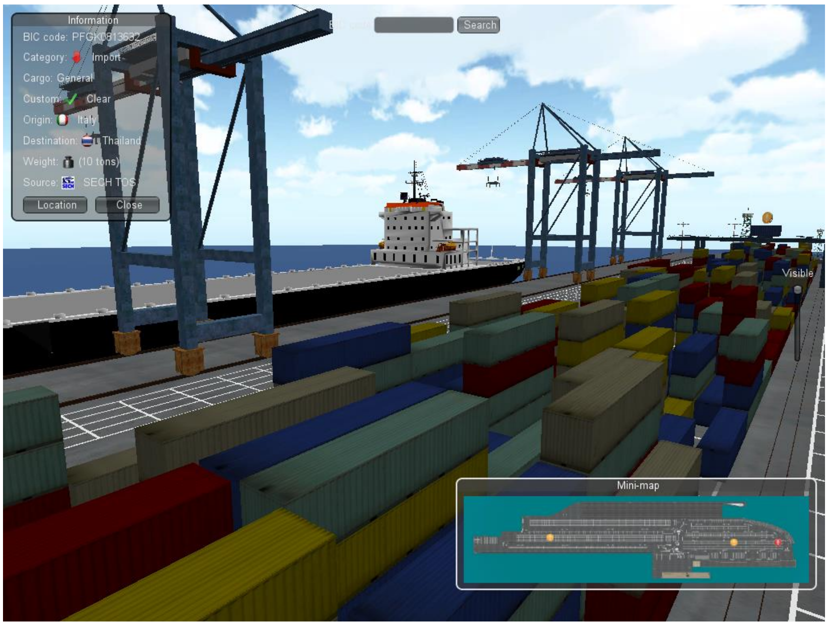


**Figure 8: A screenshot of the Virtual Terminal Information System (VTIS)**

## 5.1 Container Information

Users can obtain container information through the two user interfaces shown in Figure 9. The first interface is through the virtual terminal. In this approach, the user can see the location of all containers by navigating through the virtual terminal, and the user can click on the virtual container object in order to obtain detailed information of a particular container. An enlarge image of container information window is shown in Figure 10.

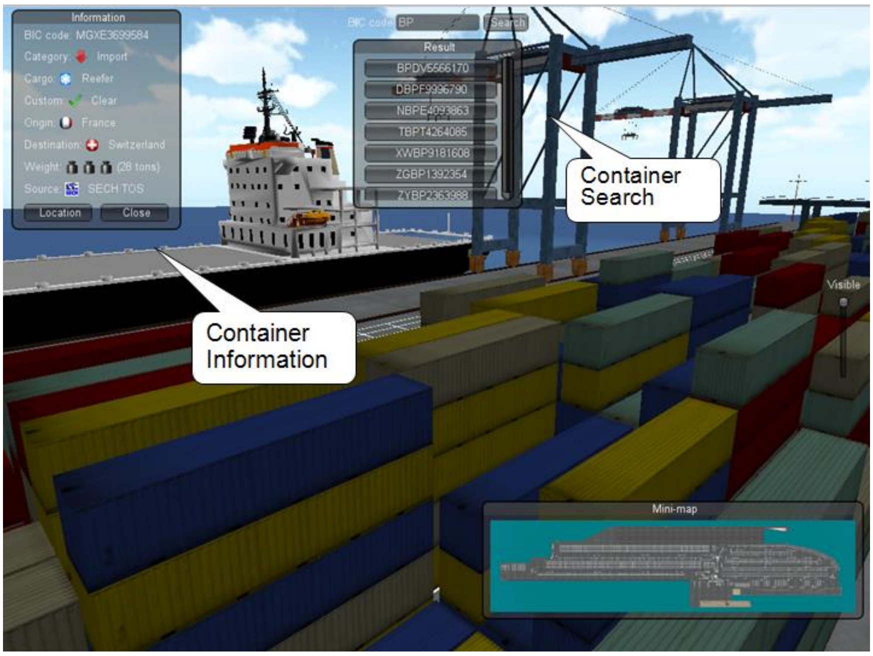


**Figure 9: Container information interfaces**

Following visual and intuitive principles, container information details are presented along with images that reflect the contents of the information. For an example, a country is presented along with its flag. This usage of information icons would significantly reduce the time the user would need to read the information while also improves the reading accuracy. Besides, these information icons are easy to implement, and fully compatible with traditional information systems.

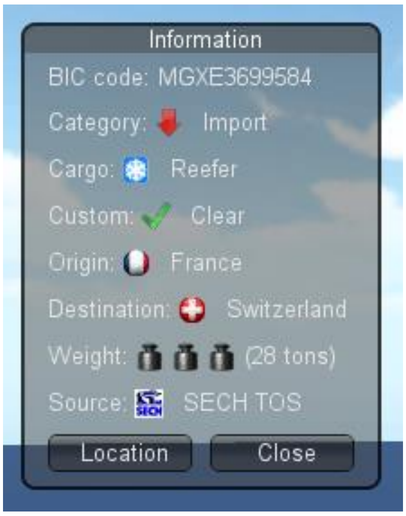


**Figure 10: Container information window**

The second interface is through the search box. Following contextual principle, the search box is placed in the main interface. An enlarge image of container search interface is shown in Figure 11.


**Figure 11: Container search interface**

In this interface, the user can enter a search key (BIC code) and obtain the list of containers that are matched with the key. Then, the user can click on an item in the list to obtain information of a particular container. In addition, the location of a container could also be located through "Location" button in container information window (Figure 10).

Lastly, it should be noted that, in this case, the search key is a text code. Therefore, using a simple text box is more appropriate than using graphics. The concept of gamified information systems does not mean that everything should be turned into graphics.

## 5.2 Container Transportation Equipment Information

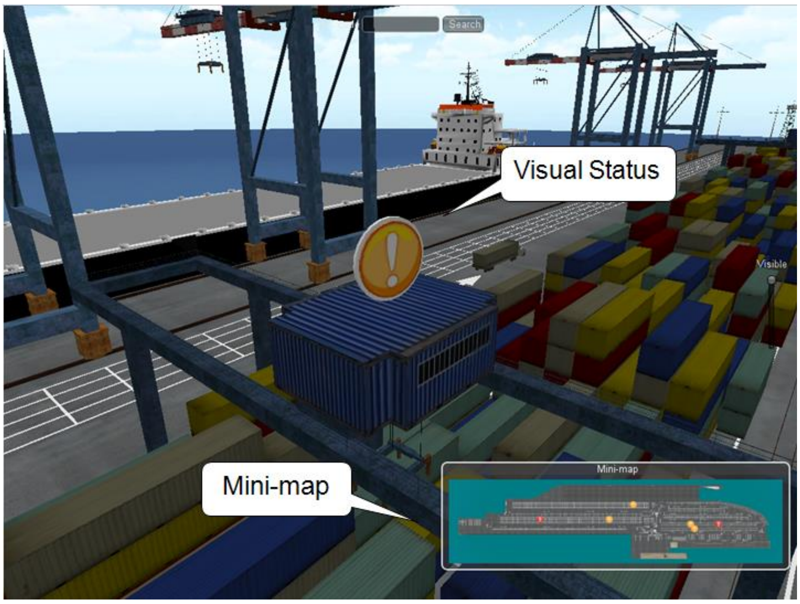


**Figure 12: Container transportation equipment information interfaces**

For container transportation equipment, a terminal manager normally concern about the equipment that are in troubles. Following VIC principles, this troubled equipment information is presented through two interfaces, which are visual status and mini-map. The screenshot of the interfaces is shown in Figure 12.

### 5.2.1 Visual Status

In visual status, the status of terminal equipment can be immediately seen through the virtual terminal as shown in Figure 13.

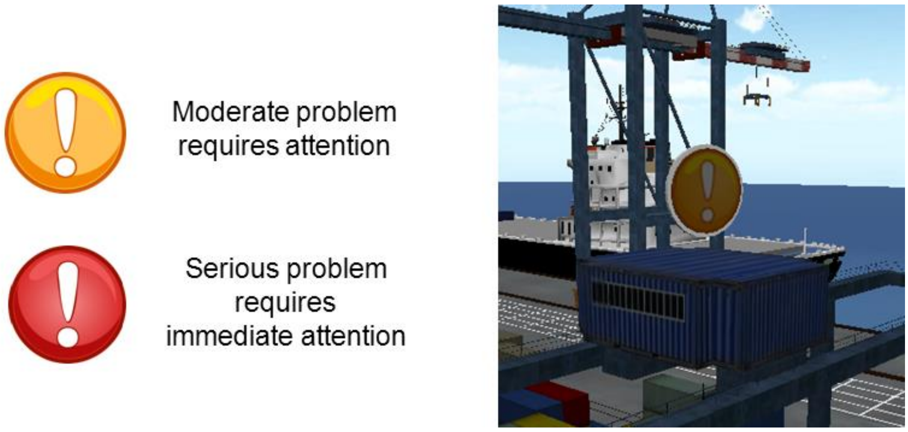


**Figure 13: Visual status of terminal equipment**

Above the troubled terminal equipment in the virtual terminal, a rotating icon is popped out, and the user could see this icon directly. A yellow icon indicates a moderate problem that would require an attention. A red icon indicates a serious problem that would require an immediate attention. These icons will disappear automatically after the system has acknowledged that the problems have been resolved.

### 5.2.2 Mini-map

Since a terminal manager is responsible for the whole area of the terminal, a mini-map would allow the terminal manager to see the whole terminal in one glance. Moreover, this mini-map also serves as a navigation tool where the user can jump to any location in the virtual terminal by simply making a click on the mini-map. An enlarge screenshot of a mini-map is shown in Figure 14.

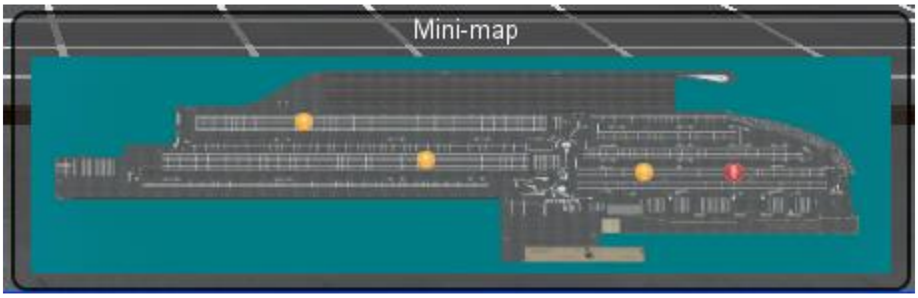


**Figure 14: A mini-map of a container terminal**

From the mini-map, the user can see the areas where the troubled terminal equipments are located through the colour icons, which follows the same meaning as in visual status. Then, the user can jump to the troubled area by making a click on the mini-map. This approach would allow the terminal manager to be able to perceive all the problems that are happening in the terminal immediately.

## 5.3 System Architecture

Virtual terminal information system uses client-server architecture. The server is responsible for receiving container information and container transportation equipment information from the terminal server (e.g. terminal operating system server), and distribute this information to all clients. The system architecture of virtual terminal information system is shown in Figure 15.

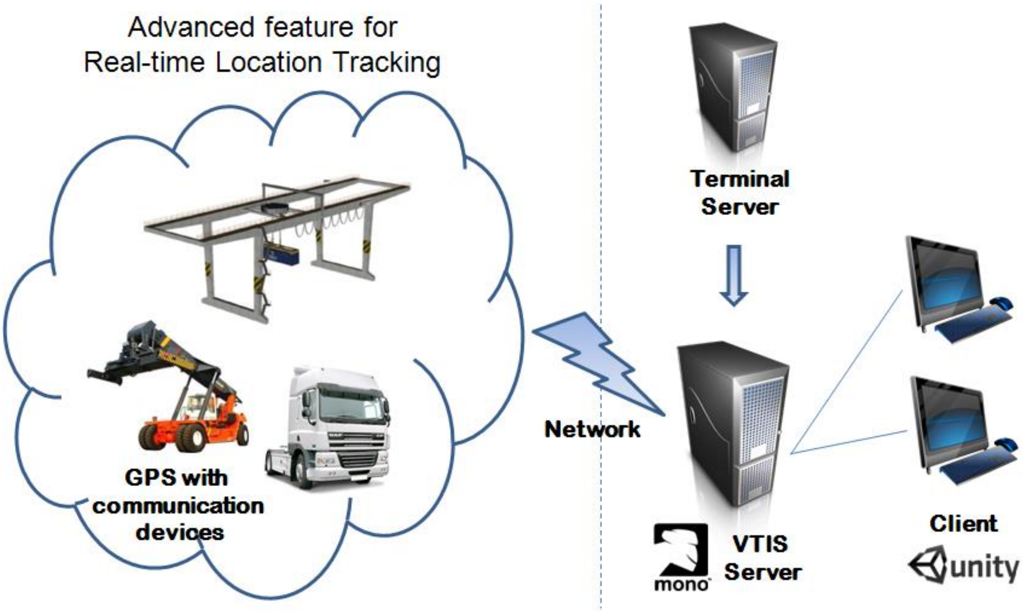


**Figure 15: The system architecture of the virtual terminal information system (VTIS)**

For the implementation, VTIS server is implemented in C# on Mono .NET Framework, and the client is implemented using Unity game engine. In addition, for an advanced feature, real-time location tracking, each container transportation equipment (e.g. cranes, tractors, reach stackers, etc.) must be installed with a GPS and a device for communicating GPS data to VTIS server.

## 6.0 CONCLUSION

Information systems and video game systems come from different backgrounds with different goals and purposes. Still, these two systems share the common task in delivering information to the users, and it has been shown that video game systems are very efficient in this aspect. This work has identified principles that are behind this efficiency, and has demonstrated that these principles can be applied to an information system in order to improve the system efficiency and reliability.

Lastly, it should be emphasized that the concept presented in this work could be applied in several domains, even though the demonstration has been implemented in business domain. One of the potentials could be the domains that concern primarily in the efficiency and reliability of the systems such as military and medical. In addition, the domain where the obtaining of information is a secondary task would also be an interesting one, as gamified information systems would allow the user to preserve his/her conscious processing power for the primary task. Automotive is a good example in this area since the primary task of this domain is driving while obtaining information is the secondary one.


### Acknowledgement

The authors especially thank Michel Donadon and Martina Stoppa for the 3D models which are used in the implementation of the gamified information system presented in this work. Also, the authors are grateful for the help of Asst. Prof. Francesco Bellotti, Asst. Prof. Riccardo Berta, and Danu Pranantha. Lastly, the authors would like to say thank you to Nordic Factory and various internet sources for icons/images which are used in this project.

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