

# Game Design Considerations When Using Non-touch Based Natural User Interface

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**Abstract.** In recent years, the advancement in gaming interface has paved ways for faster and more interactive gameplay. There is now an increasing trend of using Natural User Interface (NUI) for computer games. This has also brought forward new challenges in game design. When designing games using non-touch based NUI, it is not simply replacing existing interaction techniques with the NUI. Many considerations must be addressed to create the effective user experience when using NUI. In this paper, discussions of ten game design considerations have been presented. These ten design considerations can be classified into three main categories. Since the use of NUI is a new phenomenon in games, the design considerations presented in this paper are by no means exhaustive. However, the discussions provided in this paper can reveal potential areas for future research in the field of non-touch based NUI for games.

**Keywords:** Natural User Interface, game design consideration, user interface, interactive gameplay, non-touch based NUI.

## 1 Introduction

Game development backdrop is constantly evolving, swayed by the proliferation of gaming hardware interfaces. Current generation of computer games has shown a trend for gaming experiences that produce realistic and “natural” interaction techniques. This trend was started by Nintendo’s Wii video gaming console where the Wii Remote (or Wiimote) mimics a player’s physical action like swinging a sword, a golf club or a tennis racquet, in which the avatar that the player is controlling is also performing the same action in the game. This was followed by the recent trend and phenomenon, i.e. the introduction of a non- touch based Natural User Interface (NUI) device such as Microsoft Kinect. With a non-touch based NUI device, players are able to interact with/in games using their entire bodies, e.g. making a throwing gesture in a bowling ball game, a lashing gesture in such sword duel game etc. Such non-touch based NUI hardware [1] was able to impact the divergence of the gaming marketplace and at the same time game designers are posed with sub-sequent challenges in new game designs and metaphors. According to Nash [2], “The goal of these new

interfaces is simple: to reduce the entry barrier for everyone whilst still including traditional gamers”, and to accomplish this goal, new game design considerations must be addressed to accommodate non-touch based NUI.

Game design is an integral subset of game development. Adams [3] defines game design as the process of “imagining a game, defining the way it works, describing the elements that make up the game (conceptual, functional, artistic, etc.), and transmitting information about the game to the team who will build it.” Brathwaite and Schreiber [4] describe game design as the process of designing the content and rules of a game in the pre-production stage and the design of gameplay, environment, and storyline, characters during production stage. Using non-touch based NUI in games is not simply replacing existing interaction techniques. A lot of new considerations must be carefully thought out, planned and implemented, or otherwise the gameplay will suffer and, could cause frustration and dissatisfaction to the players. This paper discusses non-touch based Natural User Interface (NUI) and the factors that have to be considered by designers of games in designing games that uses this new trend of interface. Since the use of non-touch based NUI is a new phenomenon in games, the factors described in this paper are by no means exhaustive. They will evolve as more and more game developers embraces and utilizes NUI in their games. However, the factors outlined in this paper should give a good start for those considering the use of NUI in their games.

## 2 Natural User Interface (NUI)

According to Adams [3], the purpose of a User Interface (UI) is that it “creates the player’s experience, making the game visible, audible, and playable.” The role of UI is of primary importance because from the player’s interaction with the UI, he/she perceives whether the game is “satisfying or disappointing, elegant or graceless, fun or frustrating.” Adams further stated that since the UI is the intermediary element between the player and the internals of the game, the UI ‘knows’ all about any supported input and output hardware. The UI translates the player’s input and actions in the real world; via Windows, Icons, Menu, Pointing device (WIMP)-based or natural-based, into respective actions in the game world; passing on those actions to the core mechanics, and presents the internal data that the player needs in each situation in visible and audible forms. NUI allows a player to execute relatively natural motions, movements or gestures that they can quickly master and be able to manipulate on-screen content. The objective of NUI is to make the player feels “natural”. McMahan et al. [5] consider natural interaction techniques as “...those techniques that mimic real-world interaction by using body movements and actions that are similar to those used for the same task in the physical world.”

### 2.1 Types of Devices for Natural User Interface

Natural interaction can be experienced when interacting with hardware devices that allow player to control the UI directly. The first type consists of devices that allow for

direct manipulation via multi-touch screen of objects in 3D virtual environment (VE). Players can interact in multi-player 3D VEs using single or multi-touch surface hardware. Players interact with the device using their finger/s by touching, poking, prodding, sliding, pinching, spreading, tilting, shaking, or rotate the screen. These features can be found on hardware such as the Apple iPhone, iPod touch, iPad (Figure 1), and etc. The second type is devices that can control the player's motion using remote sensing hardware attached to the player. The devices are either held or attached to the player which translates body motions into game control signals. Common examples include the Nintendo Wiimote and Playstation Move (Figure 2) motion controllers. The third and final device type uses remote sensing features that are able to perform 3D spatial tracking of player's motion and gestures, where players interact in and control the elements of the 3D gaming world with their bodies. Without the player even touching any hardware interface, the NUI system can recognize images, gesture and speech, in various configurations. An example of this kind of device is the Microsoft Kinect (Figure 3) sensor.



**Fig. 1.** iPad [6]



**Fig. 2.** Wiimote & Move [7, 8]



**Fig. 3.** Kinect [9]

### **3 Game Design Considerations When Using Non-touch Based NUI**

Game design starts with an idea and is also often a modification on an existing concept [10, 11, 12]. The game designer usually produces an initial game design document containing the concept, gameplay, feature list, setting and story, target audience, requirements and schedule, staff and budget estimates [10]. Typically, the game design stage produces a documentation called the game design document that will be given to a game development team. The game development team, consisting of programmers, artists, and audio/sound designer who will then turned the game

design document into a working game. During the game development cycle, the work-in-progress game will undergo various iterations and testing. When designing games that are non-touch based NUI oriented, game designers have to make several and specific considerations to ensure players who purchased the game are entertained and satisfied with the gameplay. This paper provides a framework of game design considerations that can be separated into three main categories: user based analysis, function based analysis, and ambient based analysis. In this paper the following considerations have been identified that fall under these three main categories:

- 1) User based analysis
  - Target Audience
  - Genre
- 2) Function based analysis
  - Players' Perceived Playability
  - Gaming Space Requirement
  - Suitable Gestures
  - Gestural Control
  - Multi-Player/Single Player
- 3) Ambient based analysis
  - Speech Control & Audio Elements
  - Iconography
  - Types of Display Screen

All these considerations focus on implications to user experience that is one of the key objectives in game design. The following subsections discuss the game design considerations when using non-touch based NUI.

### 3.1 Target Audience

Game design is a market driven process. Game designers have to define the kind of experience they want to present and think about the audience who would enjoy that experience. Players purchase a particular genre because they like the type of challenges it offers. Adams [3] categorizes the type of audience for the game market as hard-core versus casual game players, men vs. women, adults vs. children, and girls vs. boys. Adams also discusses the issues that should be well thought-out and implemented to make game more accessible to players with impairments and players of other cultures. Adams further suggested for game designers to question themselves with the following, "Who am I trying to entertain" and once they have the answer to this, the following question follows: "Does this feature entertain a representative player from my target audience?"

When using a non-touch-based NUI for games, game designer must clearly define the target audience. Since current NUI based games tend to target the casual game

players, the game activities cannot be too physical and involve prolonged physical activities because these will quickly tire the players. Game activities should be designed to be in short bursts and yet entertaining, with short breaks in-between. Some examples of non-touch based NUI games are Dance Central, Game Party: In Motion, Your Shape Fitness Evolved, Kinect Sports, Kinect Adventures and Kinectimals.

### 3.2 Genre

Adams [3] defines genre as “a category of games characterized by a particular set of challenges, independent of the setting or game-world content.” The game idea may fall within one or several genres, and designers often experiment with mixing genres [10, 13]. The classic game genres and their related activities and challenges in the games are as summarized in Table 1.

**Table 1.** Summary of game genres and their related activities and challenges

Genre	Types of activities and challenges
Action games	Physical challenges
Real-time-strategy games	Strategic, tactical, and logistical challenges
Role-playing games	Tactical, logistical, exploration, and economic challenges
Real-world simulations (sports games and vehicle simulations)	Physical and tactical challenges
Construction and management games	Economic and conceptual challenges
Adventure games	Exploration and puzzle-solving challenges
Puzzle games	Logic and conceptual challenges

Referring to Table 1, when designing a game that uses non-touch based NUI, game designers should take into consideration the different types of activities and challenges associated with a specific game genre. Not all types of activities and challenges, and game genres are well suited for NUI as the primary interface. If activities and challenges in a specific game genre are not well designed, players will start losing focus and the gameplay will eventually starts to fall apart and be regarded as tiresome, not entertaining and boring.

For example in the strategy games genre, it is usually presented in a bird-eye-view (Figure 4). Using a point-select-command interaction technique a player usually takes control of constructing buildings, exploring the game area and commanding groups of miniature characters. Given the nature of strategy games being fast-paced, the combination of mouse-keyboard interaction technique is proven to be effective for this game genre. However, if a strategy game or any other types of game genre is to support non-touch based NUI, how would the game design be?



**Fig. 3.** Screenshots from the Command and Conquer [14], and Company of Heroes [15] RTS game

### 3.3 Players' Perceived Playability

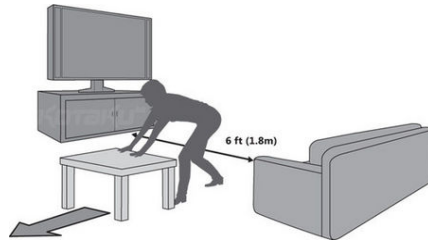
Despite any game genre, it is key that games are perceived as playable and that players feel that they are making progress when playing long games. According to Sweetser and Wyeth [16], natural interaction techniques affect the player's performance and his overall experience while playing a particular game. An important goal for a computer game is player's enjoyment. Player performance influences his enjoyment. Players will not continue to play game that they do not enjoy. Player performance is thus particularly important because players will experience anxiety if the challenge of a game proves much greater than their own ability to perform [17]. Gee [18] believed that games that people cannot learn to play and from which they do not get the enjoyment of learning would not sell.

Some games were designed to be fairly complex with a steep-learning curve of the controls and were meant for hard-core players. Casual players do not find games with complex control mechanisms to be entertaining and playable. If a game supports NUI, it should be designed in such a way that the control mechanisms feel natural and can almost immediately be mastered without long winded instructions or tutorials. With careful thoughts, planning and design, games that support NUI can be entertaining since NUI promotes the players to be a natural when interacting with games; the player is the controller.

### 3.4 Gaming Space Requirement

Gaming space requirement is another design consideration. Current non-touch based NUI games have a minimum gaming space requirement with some needing between 6 to 8 feet for optimal gaming experience (Figure 5). In relation to the space requirement, game designers should consider whether the player will be standing, sitting, moving, swinging their hands, stepping their feet etc. As most gaming activities tend to occur at home or in a private confined area, location is also another important factor to consider; whether the play area is in the living room, the bedroom,

or a dedicated game room; and whether these areas can comfortably accommodate the space requirement without too much rearrangement of existing items such as furniture that may be present. The number of players that can effectively occupy the gaming space should also be taken into consideration when designing games that supports non-touch based NUI.



**Fig. 4.** Gaming space requirement for a typical non-touch based NUI game (Totilo & Crecente, 2010)

### 3.5 Suitable Gestures

Suitable gestures that will be used when playing non-touch based NUI games should also be taken into account. The gestures performed should be appropriate to whether the game is played in a public setting or more of a private setting. The gestures should also be appropriate for the intended target audience such for adults or for children (Figure 6).



**Fig. 5.** Examples of gestures for non-touch based NUI games (Makaiookami, 2010; Leavey, 2010)

Nash [2] suggests on limiting the number of gestures that should be performed by the players and can be recognized by the NUI system at any one time. From Nash's user testing experience, he concludes that players can only remember a certain number of gestures and gesture shapes (e.g. circle, oval and zig-zag). To ensure a quick level of adaptability, the gestures and shapes need to be regularly repeated by the player, or at least there must be a non-invasive memory jogger system such as environment shapes or tracing shapes. Nash also posits that "gestures often work best in games where there is a good context for them, e.g. a wizard game such as in the Harry Potter series where you are casting gesture spells".

### 3.6 Gestural Control

“Gorilla Arm Syndrome” is often associated with touch-screen interface (Carmody, 2010; Boring et al 2009). According to Carmody (2010), the term “Gorilla arm” was coined by engineers circa 30 years ago and that “It’s the touch-screen equivalent of carpal-tunnel syndrome.” This syndrome was observed mostly with larger touch-screens where movements cause strain on the arm and shoulder after people do tasks with hands up in front of their bodies for long periods of time. Gestural control for non-touch based NUI games should be designed in such ways to avoid the “Gorilla arm” effects since front-end navigation is important and viable for gestural control. Nash [2] believes that “As more titles are released, some control systems are clearly more "usable" by a greater part of the gaming population than others. Development guidance started with handles and rails but seems to be polarizing between the pointers and 'hover' buttons system, and the arm sweep menus and swipe system. Interestingly, approximately 20% of players seem to have difficulty with the best gesture systems indicating that there is still much to learn in this area.

### 3.7 Multi 3 Player/Singles Player

Non-touch based NUI games should be designed for single player or multiplayer settings. With careful consideration during design, it is also possible to involve not only human-computer interactions but also human-human interactions among the players. Players should be able to naturally collaborate or compete with each other in the same virtual and physical space. The game should also be designed to be a spectator sport. As long as the bystanders stay out of camera view, they can watch the players play. The game should allow players and bystanders to switch places if the current players get tired. This will provide a continuous collaborative experience for a large and dynamic audience.

Laakso and Laakso (2006) developed a non-touch NUI system which they termed as “body-driven” games. Laakso and Laakso provide a design guideline for developing such multi-player games, where certain features should be present in these games. They include:

- Co-operation - Games should encourage players to co-operate in some form, either “team vs. team” or all working towards a common goal. A purely “all vs. all” games tend not to be as addictive in the long run.
- Simplicity - Games should not require the players to position themselves with precise accuracy or perform actions that require very tight timing.
- Intuitiveness - The control metaphors should have reference points to natural human actions.
- Neutrality - Player switches should not be an issue; players should be allowed to enter and leave during an on-going game.
- Scalability - Games should be playable with varying numbers of players, and if possible those numbers should be allowed to change during a game.
- Robustness - Both player approximation and gesture recognition should be simple and robust in order to work under varying conditions.



### 3.8 Speech Control and Audio Elements

NUI systems should have the ability to use voice commands and controls as one of the means to interact with games. Even though voice recognition technology has evolved significantly throughout the years, the synthesization of continuous natural human speech is far from perfect and cannot be effectively used in games. However, despite this limitation, meaningful single word, phrases and short sentences that have very less pronunciation variations can still be used in games as supporting or alternative method of interaction with games. Nash [2] suggests that game designers make sure that all active words or phrases are very different to one another, and then the system is only trying to identify a limited number of words or phrases. This is to avoid recognition errors because too many words and phrases results in much lower recognition confidence.

Audio elements in a game include sound effects, vibration, ambient sounds, music, dialog and voiceover narration. Adams [3] suggests the inclusion of a facility that allows player to adjust the volume level of music independently from the volume level of other audio effects – including turning one or the other off completely. Some players opt to only hear the sound effects and other sounds, thus turning off the music entirely.

Game designers should include and utilize audio elements and facilities available for a NUI system to ensure players have mostly realistic and authentic experience while playing the game and a memorable experience after playing the game. For example, sound effects correspond to the actions and events of the game world, such as the sound of gunfire or footsteps. While ambient sounds give the player aural feedback, for example, traffic sounds make the player feel that he is in an urban street or sounds of exotic birds inform him that he is in a jungle.

### 3.9 Iconography

Iconography is the study of identification, description and interpretation of the content of images. Since modern games are highly visually driven, the effectiveness of iconography is of vital importance. This is because the communication of the game, and the subsequent interpretation of the player of that communication, both rely heavily on iconography [2]. For example, icons convey meaningful and identifiable information in a very limited space, thus game designers should make them obvious and unambiguous [3]. Icons should be used for symbolic data that record a small number of possible options. Adams further suggests that icons should be made thematically appropriate that they look as if they belong in the game world. Nash [2] suggests that the effectiveness of the iconographical mechanisms should be tested exhaustively with a usability program. Nash further emphasizes that “the use of one graphic over another can save untold numbers of problems.” To support non-touch NUI based games, icons and buttons should be designed to accommodate effective control of the gameplay. One cannot simply use the standard mouse pointer with NUI. Players may perceived that there is no direct relationship between the mouse pointer

with the gestures they are performing e.g. the action of grabbing and throwing objects in the game world. A cursor icon that looks like a hand that has different hand animations will be more appropriate.

### 3.10 Types of Display Screen

Display screen for non-touch based NUI has great influence for players to experience maximum satisfaction and enjoyment when playing games. Game designers should always consider the types of display screen (e.g. a HDTV) the players may need to ensure optimal gameplay experience and enjoyment. Since current NUI technologies require players to be at a certain distance and sometime at a certain angle from the TV, NUI games require a large screen sized display no less than 32 inches. If the display screen is too small, the game elements on screen cannot be seen easily hence reducing the level of playability, involvement and immersion.

## 4 Conclusions

Natural User Interface or NUI has become at the forefront in human-computer interaction in the 21st century, and becoming a significant element of game interface. Non-touch based NUI is quickly becoming the trend of human-game interaction. Since its launch, the NUI Kinect sensor from Microsoft has sold more than 10 million units [1]. This number alone shows that NUI has a great potential not only for games but also for other types of computer application. NUI provides a more intuitive and natural way for players to focus more of game-playing and interaction with the game content. However, introducing a non-touch based NUI into games brings in new challenges for game designers. Using non-touch based NUI in games is not simply replacing existing interaction techniques. Game design considerations as described in this paper must be carefully thought out, planned and implemented, or otherwise the gameplay will suffer and could frustrate the players. As more and more games utilized non-touch based NUI, new considerations when designing games will emerge to counter the challenges that may arise.

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