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Voice Games: The History of Voice Interaction in Digital Games

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Abstract

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Title of the Publication: Voice Games: The History of Voice Interaction in Digital Games

Degree Title: Bachelor of Business Administration, Game Development Studies

Keywords: voice games, digital games, video games, speech recognition, voice commands, voice interaction

This thesis was commissioned by Doppio Games, a Lisbon-based game studio that makes conversational voice games for Amazon Alexa and Google Assistant. Doppio has released games such as *The Vortex* (2018) and *The 3% Challenge* (2019).

In recent years, voice interaction with computers has become part of everyday life. However, despite the fact that voice interaction mechanics have been used in games for several decades, the category of voice interaction games, or voice games in short, has remained relatively obscure. The purpose of the study was to research the history of voice interaction in digital games. The objective of this thesis is to describe a chronological history for voice games through a platform-focused approach while highlighting different design approaches to voice interaction.

Research findings point out that voice interaction has been experimented with in commercially published games and game systems starting from the 1980s. Games featuring voice interaction have appeared in waves, typically as a reaction to features made possible by new hardware. During the past decade, the field has become more fragmented. Voice games are now available on platforms such as mobile devices and virtual assistants. Similarly, traditional platforms such as consoles are keeping up by integrating more voice interaction features.

As a result of games escaping outside of traditional game platforms, voice interaction is now being implemented in a variety of games both by indie developers and more established developers. At the same time, new design approaches to voice interaction are experimented with. For platforms and developers, challenges to overcome in the future include coming up with fresh design approaches to voice interaction, integrating voice as a core game mechanic instead of as a substitute for existing control schemes, and taking into account players' privacy.

The complexity of voice interaction mechanics in games varies and is restricted by the platform's hardware and software capabilities. From this perspective, voice interaction in games typically falls into four categories: games where voice interaction is based on simple volume detection, games that require mimicking such as karaoke games through pitch and rhythm detection, games that feature voice commands through speech recognition, and conversational games that go beyond simple voice commands.

The study was carried out through the qualitative research method by conducting online literary research. Due to limitations of resources, it was not possible to include every game that has ever featured voice interaction or cover all the various design approaches that game developers have used.

Contents

Symbol list

Audio game

A type of game where the game's main output method is sound rather instead of graphics. In other words, the gameplay is facilitated through sound. Audio games can rely on voice interaction, in which case they are also voice games, or other methods of control, such as a traditional game controller.

Chatbot

A software that simulates human conversation by taking a user's written or auditory input, typically in the context of a specialized purpose. Chatbots work independently from a human operator and can be used, for example, to automate and personalize a customer service experience for a company or a brand.

Natural language processing

Abbreviated as NLP. A field related to artificial intelligence that aims to program computers to automatically process human natural language. Subtopics of NLP include machine translation of languages and question answering. NLP is used, for example, by chatbots and virtual assistants to process human input.

Natural language understanding

Abbreviated as NLU. Related to natural language processing but with a narrower purpose that focuses on machine reading comprehension of human natural language, which is unstructured data unlike the formalized syntax of computer languages. A subset of natural language processing.

Noise game

An emerging term used to refer to games that rely on non-verbal voice interaction, usually through volume detection. Common mechanics

	include the player having to create noise by blowing to the microphone or by screaming.
PAL region	Refers to nations that use the Phase Alternating Line (PAL) encoding system for analogue television. Most of Europe and Asia, Oceania, and parts of Africa and South America.
Speech recognition	Technology that captures and identifies words that are spoken and transcribes them to sets of digitally stored words. Answers the question "What is being said?"
Virtual assistant	Also referred to as digital assistant. A user-oriented software agent that uses various technologies to answer users' questions and perform tasks based on written or auditory commands. Some assistants respond with a synthesized voice. Examples include Amazon Alexa, Bixby, Cortana, Google Assistant, and Siri.
Voice command	A type of voice interaction that relies on verbal commands that are captured through speech recognition [2].
Voice game	An emerging term, short for voice interaction game. In a loose definition, the term encompasses games that feature any degree of voice interaction. In a stricter definition, it refers to games that rely on voice interaction as the primary method of player input.
Voice interaction	The use of voice to interact with technology, including games, whether verbally or non-verbally [2].

Voice-user interface	Abbreviated as VUI. In contrast to graphical user interface (GUI) that relies on visual cues, voice-user interface facilitates voice interaction between humans and computers through auditory cues. VUIs are used, for example, in virtual assistants.
Voice recognition	Technology that identifies the voice that is speaking. Correctly identifying the speaker can, for example, personalize an interaction and act as a security feature. Answers the question "Who is speaking?"

1 Introduction

This thesis is divided into three parts. The first chapter introduces the research problem and the approaches and methods chosen to conduct the research. In the second chapter, which makes up the bulk of thesis, the research questions are answered through a chronological narrative. Lastly, in the final chapter, the research findings are summarized, and the research project is discussed.

1.1 Statement of the Problem

While speech is a natural method of human communication, it was for many decades viewed as a futuristic interface for interacting with computers – let alone with games. The past decade has seen rapid technological advances in fields such as artificial intelligence, natural language processing, speech recognition, and cloud computing. The resulting commercial applications include smart and voice-enabled virtual assistants embedded within smart devices. These digital assistants serve as platforms for third-party apps and games while reaching millions of people. While having made voice interaction with computers an everyday affair, these platforms have also brought more awareness to a category of games that feature voice interaction.

While the wide range of smart devices and digital assistants of the past decade have contributed to the rising awareness of voice interaction both in and outside of games, the idea of using human voice as an input to a game is nothing new. In fact, it was first demonstrated almost five decades ago in the early 1970s. Starting from the 1980s, voice interaction has been experimented with in commercially published games and systems. Nevertheless, voice games as a category of games has remained relatively obscure while design approaches to speech-only and speech-first experiences are being experimented with. Consequently, this study aims to explore these two areas while serving as basis for further research.

1.2   Purpose of the Study

This study aims to research the history of voice interaction in digital games and highlight different design approaches to voice interaction. Research questions have been composed to achieve this goal.

1. What are examples of commercially published digital games that feature voice interaction?

2. What roles have game platforms had in enabling and shaping voice interaction in their game libraries?

3. What kind of a historical continuum will the studied games and platforms form?

4. What are examples of different design approaches to voice interaction that have been used in games?

The first question is aimed to identify a large sample of games that feature a degree of voice interaction. In order to form a comprehensive overview, the games should cover a long time span as well as different genres and platforms. The second question shifts the focus from the game to the platform and seeks to understand how platforms have affected the frequency and the design approaches to voice interaction in their game libraries. The third question ties together the games and the platforms in a chronological continuum that aims to identify any historical patterns. Lastly, the final question looks for differences and similarities in the ways the games have implemented voice interaction, which should be highlighted in interesting examples that will give the reader a better understanding of the concepts.

1.3   Limitations of the Study

The subject of this thesis has been covered previously, for example, in the 2017 study *Word Play: A History of Voice Interaction in Digital Games* (Allison et al. 2017) [1]. However, the field is currently changing at a rapid pace, and recent developments include the emergence of digital assistants as platforms for voice games. This thesis also uses the term voice interaction to refer to the use of voice to interact with technology. The study covers commercially published digital games that feature voice interaction. Games have also been used as research objects in a number of

studies which, with one exception, are outside the scope of this study. While the Appendices section includes a table of all the voice games mentioned in the thesis, it does not attempt to be a thorough list of all the voice games ever released. Existing lists of voice games have been used as material for this study [2]. Interesting examples of different design approaches to voice interaction will be highlighted in the thesis. However, it has been researched more extensively, for example, in the 2018 study *Design Patterns for Voice Interaction in Games* (Allison et al. 2018) [3]. While the history of speech recognition is briefly touched, it has been studied from a more technological perspective in a number of other studies. Other recent studies of voice interaction in games include the 2019 paper *Frame Analysis of Voice Interaction Gameplay* (Allison et al. 2019) [4].

2   The History of Voice Games

Verbal communication with humans and computers has been a recurring concept in science fiction for decades. Famous examples in Western popular culture include Robby the Robot in the 1956 movie *Forbidden Planet*, the HAL 900 computer in the 1968 movie *2001: A Space Odyssey*, the R2-D2 and 3-CPO robots first seen in *Star Wars* (1977), the female computer voice of the U.S.S. Enterprise starship in the *Star Trek* television series, the AI-enabled KITT car in the 1980's television series *Knight Rider*, and so on. At the time when these shows were filmed, such fluent communication with computers was indeed closer to science fiction than reality. However, developments during the past decades have brought this vision closer to realization.

The earliest home computers and video game consoles that were capable of producing sound were limited to simple blips and beeps, which are familiar from early classics such as *Pong* (1972). In a 1987 article in the *Compute!'s Gazette*, Kathy Yakal remarks that the first video games were graphics-intensive but sound-poor. On the hardware side, this was the result of limited memory and basic sound chips. On the software side, there were only little snippets of sound effects that could be repeated over and over. [5] The use cases of sounds in games have diversified in parallel with the technology becoming more advanced. As a result, games have started incorporating human voice in a various ways, including voice interaction, starting from the 1980s.

Games have featured voice interaction in several waves, usually as a reaction to new hardware capabilities. In recent years, the pace has intensified. A 2017 study by Allison and colleagues (Allison et al. 2017) attributes the renewed relevance of voice interfaces in game design to three parallel developments. These developments include a series of rapid improvements in speech recognition capabilities due to technological advancements in other fields, the growing presence of conversational AI agents, and the proliferation of microphones and speech recognition systems in consumer electronics. These developments have resulted in a growing opportunity for game developers to build new kinds of gameplay experiences around voice interaction. [1]

2.1   Echoes of Early Laboratory Experiments

Early advances in speech recognition and other voice technologies have often first manifested to the public as games and children's toys. Radio Rex was the first commercial toy to respond to voice commands. Radio Rex is a toy bulldog made of celluloid and metal, and was produced in 1922 by Elmwood Button Co. The toy dog can respond to its name being called by leaping out from its house. The movement of the dog is controlled by a spring, which is held back by an electromagnet that disconnects when subjected to sound patterns at around 500 Hz. While the vowel sound in "Rex" was designed to trigger the toy, the system was imprecise, and the dog would often not move despite being called. [6]

The first speech recognition systems were developed in the 1950s. The earliest systems were often speaker dependent, which meant that they would understand only one person, and were focused on simple tasks, such as recognizing numbers or a limited number of syllables or vocals. Many of the methods still in use in modern speech recognition systems are based on methods developed in the 1960s. Important innovations developed around that time include a phoneme detector that could break speech into smaller parts and recognize them individually. Another innovation was adding statistical information of correct phoneme orders to speech recognition systems, which simplified the process of recognizing longer words. [7]

While speech recognition technology was advancing further during 1970s, games were sometimes found as suitable research objects. One of the earliest examples of voice interaction in a game is *Voice-Chess*, which was described in a 1973 research paper (Reddy et al. 1973). *Voice-Chess* used the Hearsay speech understanding system, which was developed by Raj Reddy and his colleagues at Carnegie-Mellon University in the United States. [8] The Hearsay system took spoken language as input and produced a typed version of what was said as output [9]. Chess was chosen as a task for the Hearsay system because it has a well-defined syntax, semantics, and vocabulary. [8]

> "Chess plays the role in artificial intelligence that the fruit fly plays in genetics. Just as the genetics of *drosophila* are studied not to breed better flies, but to learn the laws of heredity, so we study chess to understand the laws of artificial intelligence." (Reddy et al. 1973). [8]

Hearsay system typed out chess moves spoken by real people while playing chess. Because the vocabulary of chess consists of just 31 words, interpreting chess moves is easier than understanding a general conversation. However, despite the limited grammar and vocabulary of chess, there

are 108 legal ways to say, for example, "bishop to queen knight three". [9] The rules of chess and the current board situation were used by the system to generate a list of legal moves. It was used in restricting the plausible utterances to around 40 moves that the player could make in a given board situation, thus increasing the system's accuracy of understanding the spoken moves. [8]

Speak & Spell is a product line of electronic hand-held computers for children. The first model was released by Texas Instruments in June 1978. Speak & Spell was designed to teach children how to spell and pronounce words by first speaking them aloud through voice synthesis. After hearing the word pronounced, the user would write the word by using the device's built-in keyboard. Besides its main operational mode, it also had game-modes. [198] Speak & Spell was translated to other languages, and the product line was expanded to models such as Speak & Math, Speak & Read, Speak & Music, and other speaking children's toys. The technology was also used later in a speech synthesizer for the TI-99/4A home computer. [11]

At the time of Speak & Spell's development in 1976, memory chips were not capable of storing recorded speech that could be used in the product [12]. Instead, hundreds of utterances were recorded by a real person, which were broken into their constituent parts and used to tune an electronic simulation of a human voice box to reproduce them [198]. Strings of data were stored that correspond to a certain word which, when fed to the speech chip, results in a particular word. Data patterns for new words were determined in a laboratory by analyzing real speech, which resulted in easily understood words when applied to the speech synthesizer. As a result, Speak & Spell only has a limited vocabulary of around 200 words. [12]

While Speak & Spell did not use any type of voice recognition technology, as it only took typed input through its built-in keyboard, it fits in the same historical continuum with the voice-activated toy Radio Rex. Both toys are examples of voice interaction between humans and non-humans. In the case of Radio Rex, it was the human who spoke. In the case of Speak & Spell, it was the computer that spoke. *Voice-Chess*, on the other hand, is an important landmark because it demonstrated that speech recognition could be used in a game. In the early 1980's and in the wake of the microcomputer revolution, speech recognition technology became available to consumers in mass market products.

2.2   Mass Market Speech Recognition Systems of the 1980s

2.2.1   Voice Modules for Home Computers and PCs

In the early 1980s, computer games could use human speech as sound effect. Computers of the time could produce speech either by using digitized speech or synthetizing speech. A speech digitizer converts analog sounds to series of digital numbers that represent the frequencies and the volume of the words spoken. To replay the digitized sounds, the numbers are fed through a program to the computer's sound chip. A speech synthesizer, on the other hand, strings together phonemes, such as consonants and vowels. After the user has written an input, the program concatenates phonemes together to pronounce the written words. While taking more space, digitized speech is of higher quality, and was used in games such as *Impossible Mission* (1984). [10]

Speech recognition can be described as another form of digitizing, where the computer digitizes words spoken to a microphone and matches the digital pattern to a previously digitized command that performs a preprogrammed function [5]. On Mid-1980s PCs, for example, speech recognition software was usually speaker-dependent, which meant that the software had to be trained for each user. Both speech training and speech recognition use spectral analysis to capture the audio frequency waveform of a spoken word and then convert it to a digital template. In the case of multiple users, each user had a specially trained template file, which contained a list of digital templates for each voice command. [13]

Unlike many other computers at the time of its release in 1982, Commodore 64 came with a high-quality sound chip called SID (Sound Interface Device). In a 1987 article, Kathy Yakal remarks that the power of sound has added tremendous emotional impact to many games on Commodore 64. One example of adding a section of digitized speech is in the game *Impossible Mission*, where the player is greeted with the iconic taunt "Stay awhile, stay forever!". Software designers and peripheral manufacturers caught on SID's performance early on and started developing software and hardware tools that included speech digitizers, synthesizers, and speech recognition modules such as Hearsay 1000, Magic Voice, Votalker, and Voice Master. [5]

Hearsay 1000 is a speech synthesis and speech recognition module that plugs into Commodore 64's expansion port. It came with educational software for children and with software for generating user-programmed speech. It could also be used to give voice commands on various text-

based programs, including text adventure games such as *Zork*. [5] The Covox Voice Master is another third-party peripheral for Commodore 64 that was also available for other 8-bit home computers, including Apple II and Atari 800. Voice Master is a speech digitizer and speech recognition module. It came with educational, productivity and entertainment applications, including a voice-controlled blackjack game. [5,14]
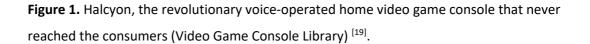
Magic Voice, released in 1984 by Commodore, is a speech synthesizer for Commodore 64. Magic Voice plugs into Commodore 64's cartridge slot. The module also has its own cartridge slot, into which other cartridges, including games, can be inserted. Magic Voice speaks with a realistic female voice and has a built-in vocabulary of 235 words, which can be extended with extra cartridges. However, instead of building speech out of phonemes, a limited vocabulary was spoken by a real person, which was then digitized for Magic Voice. Commodore released a few games on Commodore 64 that supported Magic Voice, including *Gorf* and *Wizard of Wor*. [15] Votalker by Votrax was another speech synthesizer for Commodore 64 [5].

In Mid-1980s, voice command features were also available on PCs through speech recognition boards such as VocaLink and AutoPilot 1000. The separately purchased boards came with software packages that could be used to create voice commands for using existing applications, including flight simulators. For example, VocaLink came with a pre-written vocabulary of around 100 words for Microsoft's *Flight Simulator*. While *Flight Simulator* did not support voice commands natively, it could be operated entirely through voice commands by using VocaLink's pre-written voice command scheme. The VocaLink system also included a speech synthesizer, which repeated the commands and asked follow-up questions. [13]

2.2.2   Early Attempts to Introduce Voice Interaction on Game Consoles

Speech recognition features were also considered for home video game consoles. The Voice Commander module for the Atari 2600 console was a joint project between Atari and Milton Bradley, an American board game and toy manufacturer. The module would plug into Atari 2600's controller ports and included a headset and custom joysticks. While wearing the headset, the player could utter voice commands to control games. The project was, however, cancelled by Atari in 1983, which caused Milton Bradley to sue Atari for breach of contract and to proceed on the project with Texas Instruments. [16] While Voice Commander was never released for Atari 2600, its design was used in the Atari 2600 Jr, released in 1985 [17].

The Texas Instruments TI-99/4A, released in the United States in 1981 by Texas Instruments, is a home computer that also had some games available for the system. Milton Bradley released the Milton Bradley Expansion System, meant initially for Atari 2600, for TI-99/4A in September 1983. The expansion system, also known as MBX, enabled speech synthesis and speech recognition when used with specific Milton Bradley cartridges. The speech recognition required an initial voice training, after which the system would recognize specific voice commands. However, because the TI-99/4A was cancelled in March 1984, shortly after the MBX expansion system became available, only few MBX systems were ever sold. [16,18]

Figure 1. Halcyon, the revolutionary voice-operated home video game console that never reached the consumers (Video Game Console Library) [19].

Halcyon (See Figure 1) is a home video game console by the inventor Rick Dyer and his company, RDI Video Systems. Scheduled for release in 1985, it would be controlled through voice commands and was marketed as having artificial intelligence capabilities. It consisted of two components: a laserdisc player and a computer module. The player would control Halcyon either through keyboard or by giving voice commands on a headset. The system would know up to 200 words. It would also be able to learn about the player and have simple conversations. It was even proposed to support add-on modules with smart home functionalities. According to the proposition, Halcyon could, for example, control the player's home by opening and closing doors. [20]

The market conditions were not, however, perfect, since the North American Video Game Crash of 1983 had caused the video game market to shrink considerably. Halcyon also faced competition. For example, the Nintendo Entertainment System, which was launched in the United States

in 1985, cost only USD 90 and already had many games available for the console. However, Halcyon would cost up to USD 2,500 and would ship with only 2 games: *Thayer's Quest* and *NFL Football*. Eventually, investors pulled out because of the expensive price tag of the console, the lack of consumer demand, and the high cost of production. RDI Video Systems went bankrupt and the console never reached consumers. [20]

In 1983, Nintendo released the Family Computer console in Japan. Famicom had two controllers hardwired to the system, and the Controller II (See Figure 2) had a built-in microphone [21]. While Japanese game developers very initially wary of using the microphone, first games with voice interaction appeared in 1985 [1]. Games that made use of Famicom's microphone included *The Legend of Zelda* (1986), where the player could kill a monster by making loud noises, [22] *Kid Icarus* (1986) and *Takeshi no Chōsenjō* (1986) [23]. However, the basic system could only register sound as a binary on-or-off signal [1]. Features that made use of it were usually optional or even easter eggs that could only be discovered in the game's manual [23].

Figure 2. The Controller II of Nintendo's Famicom home console features a built-in microphone in the middle, marked by the text 'MIC' (Wikimedia Commons) [24].

Famicom also supported games that shipped with peripherals, such as *Karaoke Studio*, released by Bandai in 1987. The karaoke game came in a cartridge but was connected to a microphone by a cable. The game cartridge also has its own cartridge slot, into which expansions with additional songs could be plugged into. [25] Players sang into the microphone, and the game would evaluate the performance based on timing but without an element of speech recognition [1]. The game came with 25 songs, which played in an 8-bit format with lyrics and imagery appearing on the screen [25]. Later game releases, *Karaoke Studio: Top Hits 20, Vol. 1* and *Karaoke Studio: Top Hits 20, Vol. 2*, added more songs to the system [26].

While the early 1980s saw attempts to introduce voice interaction to video games in the form of speech recognition modules such as Atari Voice Commander and Milton Bradley Expansion System, and the Halcyon console which was built around voice interaction, each of these products proved unsuccessful due to market conditions. Sega AI computer, released in 1986 with voice recognition software and educational games, also became a commercial failure [27,28]. While Famicom did feature games with limited voice interaction, the microphone was eventually removed from later models of the console [1]. After these developments, voice interaction on console games was not widely embraced again before the end of 1990s.

2.3 1990s and the Renewed Interest in Voice Interaction

The console market of the 1990s was dominated by Nintendo, Sega, and Sony. Since none of the 16-bit and 32-bit consoles of the time featured a built-in microphone, no voice interaction games were developed on the respective platforms. [1] Sega did, however, release the Mega-CD Karaoke add-on in 1992 on the Sega Mega Drive console in Japan. The karaoke add-on bundled with a microphone and required the Sega Mega-CD accessory. [29] On the console side, things changed towards the end of the decade when Nintendo and Sega released microphone peripherals and a handful of voice interaction games. On the PC side, the first voice interaction game with native support for voice commands was released several years earlier in 1995.

Command: Aces of the Deep (1995) was the first commercially published video game on PC that featured built-in voice interaction [1]. *Command: Aces of the Deep* is a World War II submarine simulator game, which was originally released for the MS-DOS operating system and then re-released with the new title for Windows 95 with voice command features. After calibrating the microphone, the player could use voice commands listed in the game's manual. To use a voice command, the player will first have to press the microphone icon with a mouse and then speak the voice command to the microphone. The player can, for example, maneuver the submarine by saying "Make depth 150 meters". [30]

Allison and colleagues (Allison et al. 2017) identified the style of voice interaction in *Command: Aces of the Deep* as having the characteristics of game design that predominated in North American and European games in the 2000s. These characteristics include the player being in the role of a military authority figure, having a fundamentally top-down communication structure where the player's subordinates are semiautonomous agents, and finally, having voice commands as

optional features rather than being a core game mechanic. This style of game design was in contrast with that in Japanese games, where the games often followed a more conversational style that was less top-down and was set in a peaceful setting. [1]

After its release in 1995, *Command: Aces of the Deep* remained for several years the only major PC game to feature voice interaction [1]. Starting at the end of 1990's, the PC platform received a new iteration of software that could be used to issue voice commands in games and engage in voice chat with other players. Game Commander, released by Sontage Interactive on Windows in 1998, allows the user to program and customize voice commands to trigger keyboard inputs in video games and integrated with existing voice chat software. [31] In 2000, Microsoft released the Microsoft SideWinder Game Voice accessory, which competed with Voice Commander 2 [32]. Some games, such as *Star Trek: Bridge Commander* (2002), might even include custom-made profiles to support specific voice recognition software [33].

In 1998, Nintendo released the game *Hey You, Pikachu!* (1998), which bundled with the Voice Recognition Unit (VRU) peripheral (See Figure 3). The unit came with a microphone, which was tuned to pick up more high-pitched voices to better accommodate it for children. While playing the game, the player could speak out commands to game characters like "Pikachu, come here!". Throughout the game, the character would grow more responsive to the player's commands. However, some players experienced difficulties while trying to make the game understand their commands. The other game that the unit was compatible with was the train driving simulation game *Densha de Go! 64* (1999), which released exclusively in Japan. [34]

Figure 3. Microphone peripherals for late 1990s game consoles, featuring Voice Recognition Unit (left) for Nintendo 64 and Dreamcast Microphone (right) for Sega Dreamcast (Wikimedia Commons). [35,36]

Around the same time, Sega bundled a microphone peripheral with the Dreamcast game *Seaman* (1999). In *Seaman*, the player takes care of a fish-like virtual pet and uses the microphone to have simple conversations with the pet. [37] The microphone stand was connected to a microphone body, which was inserted into the Dreamcast controller (See Figure 3) [38]. The microphone was also made available to other games, including *Alien Front Online* (2001), where it could be used to communicate in a voice chat with other players [39]. It was similarly supposed to be used for the in-game voice chat of the unpublished 2001 game *Propeller Arena*, which had to be cancelled due to controversy [40].

The sudden emergence of voice interaction games at the end of 1990s has been identified by Allison and colleagues (Allison et al. 2017) as the response of game developers to new console hardware. Because game developers for the PC platform could not count on players to have microphones, little to none of voice interaction games were developed for that platform. Similarly, voice interaction games took off on consoles only after microphone peripherals had become available. The reason for console platforms releasing microphones at that time has been attributed to the rise of online multiplayer gaming and voice chat. While the microphones bundled with voice interaction games, they could afterwards be used for voice chat. [1]

2.4   2000s and the Enthusiastic Experimentation with Voice

2.4.1   The Karaoke Craze of 2000s

Starting from late 1990's, music games were becoming increasingly popular. *PaRappa the Rapper* (1997) for PlayStation popularized the rhythm game subgenre while the *Dream Audition* series for PlayStation 2 awakened the karaoke subgenre in 2000. [41,1] *Dream Audition* followed the same style of implementation first seen in *Karaoke Studio* on Famicom, where the player would sing to a stage-style microphone over an instrumental version of the song. Since the performance was rated based on vocal pitch, they could sing their own lyrics as long as they hit the correct notes. [1] In 2001, Sega released the *Dreamcast Karaoke* peripheral for Dreamcast that came with a microphone and connected below the console [42].

Karaoke has been described as the most successful genre of voice interaction in game history [1], and *Karaoke Revolution* and *SingStar* were the two most popular series in the genre. The first *Karaoke Revolution* game was developed by Harmonix and released initially for PlayStation 2 in

2003 and later for Xbox in 2004. Similar to earlier karaoke games, the scoring was based on pitch and rhythm. However, *Karaoke Revolution* (changed the format by adding a scoring meter and an overall crowd meter on the game's UI (See Figure 4). The player would have to try and keep up a good score while singing in front of a virtual crowd. [43] This new format would prove popular and be imitated in the following years by other karaoke games [1].
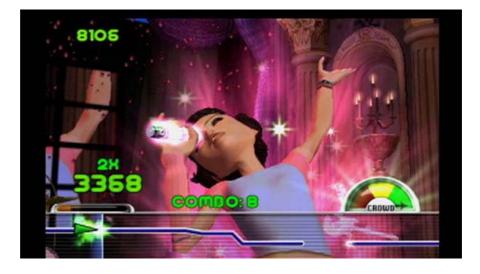

Figure 4. Screenshot of *Karaoke Revolution 2*, displaying the scoring meter and the crowd meter on the game's UI (Sony Computer Entertainment Inc.) [44].

The first *SingStar* game was published in 2004 on PlayStation 2. *SingStar* used pitch and rhythm to rate the performance with the exception of rap mode, which first featured in *SingStar Pop* (2005). The scoring system in rap mode uses speech recognition together with rhythm detection to track the lyrics [45]. *SingStar* was popular especially in the PAL region and helped to drive main-stream console adoption outside of traditional gamer demographics. Sony bundled *SingStar* games with PlayStation 2 consoles, and the series is said to have played a big part in the console's successful sales. Over time, more than 20 *SingStar* games were released on PlayStation 2 and PlayStation 3. [46]

Karaoke style singing portions have also been included in other types of music games that do not revolve solely around singing. Rhythm games are one example where the gameplay has in some cases been supplemented with voice interaction. Harmonix, the original developer of *Karaoke Revolution* and *Guitar Hero* series, released the first title in the *Rock Band* series in 2007 for PlayStation 3 and Xbox 360. While the game is mainly a rhythm game that utilizes several instruments, it also came with a USB microphone for singing portions that measure the player's vocal pitch. [47] Likewise, *Guitar Hero: World Tour* was released in the next year with similar features and was the first game in the series to include singing portions [48].

By the end of 2000s, the success of karaoke had spawned a number of similar titles and series, such as *Get On Da Mic* (2004), [49] *Boogie* (2007), [50] *Lips* (2008), [51] and *Disney Sing It!* (2008) [52]. As a result, karaoke games were available on all major game platforms. Over 120 karaoke games were published between 2003 and 2010, and over 70 of them during the peak years from 2008 to 2010. [1] By 2009, the music game market was saturated with new releases, and game sales dropped rapidly during the next years [41]. In early 2010s, the pace of new releases slowed. Many series, including *Karaoke Revolution*, were discontinued. The last *SingStar* game was released in 2017, while the online support for the series ceased in 2020 [46].

2.4.2   Voice Commands in Shooters and Sport Games

Starting from early 2000's, voice interaction features were being implemented in North American tactical shooter games as a result of headset becoming available for voice chat [1]. For example, the original *SOCOM U.S Navy SEALs* (2002) game for PlayStation 2 shipped with a USB headset. The headset was used for voice chat in multiplayer and for issuing voice commands to AI squad members and navigating menus in single player. [53] The implementation of voice interaction in the *SOCOM* series share characteristics with what was first seen in the Mid-1990s PC game *Command: Aces of the Deep*, which include a role of military leadership, a top-down command structure, and having voice interaction features as optional [1].

Voice commands were used in a similar fashion in other tactical shooter games on the sixth-generation home consoles PlayStation 2 and Xbox. These titles included other games in the *SOCOM* series, [54] games in *Tom Clancy's Rainbow Six* series such as *Rainbow Six 3* (2003), games in *Tom Clancy's Ghost Recon* series such *Ghost Recon 2* (2004), and games such as *Delta Force: Black Hawk Down* (2003), *SWAT: Global Strike Team* (2003), [55] and *Greg Hastings Tournament Paintball MAX'D* (2005). [56] While there was less voice command support on the PC side, the 2004 first-person shooter *Unreal Tournament 2004* did support voice commands [57]. Many of the games used voice technology delivered by Fonix or ScanSoft [58].

Sport and racing games also featured voice commands starting from early 2000s. The style of implementation was very similar to tactical shooters in that the player was again placed in an authoritative role calling plays and issuing commands to AI team members. Sport games released for PlayStation 2 that feature such voice commands, issued through a USB headset, which was also used for online voice chat in some games, include the *NFL Gameday 2004* (2003) and *NCAA*

GameBreaker Football 2004 (2003) football games, [59,60] and the *NBA Shootout 2004* (2003) basketball game [61]. *NASCAR 06: Total Team Control* (2005) racing game for PlayStation 2 and Xbox also featured in-game voice commands [62].
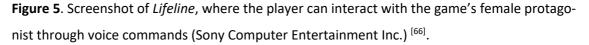
2.4.3 More Voice Games on Sixth Generation Home Consoles

In popular North American and European titles, voice interaction has commonly been implemented as an optional overlay of authoritative voice commands in genres like tactical shooters, sports games, and racing games. In contrast, games that have integrated voice interaction as the primary game mechanic and placed emphasis on conversing and building relationship with a virtual companion have utilized a different design approach. This style of design has been described by Allison and colleagues (Allison et al. 2017) as relationship-oriented voice interaction, which has remained characteristic of Japanese game design and featured in games such as *Hey You, Pikachu!*, *Seaman*, Lifeline, and *N.U.D.E.@*. [1]

Seaman is a simulation game that was developed by Vivarium and released on Sega Dreamcast in 1999. In *Seaman*, the player takes care of a virtual pet that resembles a human-faced fish. The game is set inside a small aquarium, and the player is a god-like character that manages the aquarium. The player takes care of *Seaman* by ensuring that the conditions inside the aquarium remain stable, by feeding it, and by keeping it company by opening the game every day. The Dreamcast microphone (See Figure 3) is used to have conversations with *Seaman*, who can present questions and understand the player's responses through speech recognition. The game also got a sequel, *Seaman 2* (2007), which was released on PlayStation 2. [63]

Lifeline (*Operator's Side* in Japan) is a 2003 survival horror game for PlayStation 2. In *Lifeline*, the player wears a USB-compatible headset that is used to interact with a female character through voice commands [64]. While the player does not play as the female character, they can use voice commands to make her move, inspect items, solve puzzles, fight enemies, and engage in regular conversation (See Figure 5). A review from 2004 commented on the game's speech recognition system. In order for it to work properly, it requires a distraction-free environment and comes with a learning curve, which involves learning to speak at a certain speed and learning the game's vocabulary to identify objects with specific names. [65]

Figure 5. Screenshot of *Lifeline*, where the player can interact with the game's female protagonist through voice commands (Sony Computer Entertainment Inc.) [66].

N.U.D.E.@ Natural Ultimate Digital Experiment, released for Xbox in Japan in 2003, is a voice-controlled life simulation game. In the game, the player is in charge of training a service robot. The training includes language tutoring and teaching the robot to perform various tasks through a series of phases that get more complex as the game advances. The Xbox Communicator headset is used to issue voice commands. A review commented negatively on the game's context-sensitive vocabulary and the single word limitation of voice commands. In the review, the game is compared to *Lifeline*, which understood basic sentences and enabled more natural conversation, which is said to lack in N.U.D.E. [67]

PlayStation 2 also had other Japan-exclusive titles from the early 2000s that utilized voice interaction in different and interesting ways. In *Yoake no Mariko* (2001), the player has the option to play as different actors in cheesy movie scenes and is scored for reading lines from the script with correct timing. The game can also be played with other person in a dual mode or without a headset as a rhythm game. It's sequel, *Yoake no Mariko 2nd Act* (2002), added new minigames and a karaoke mode. [68] A similar implementation is seen in *Shibai Michi* (2003), where the player is a voice actor and must impress the judges with a well-timed and properly toned delivery in different scenarios [69].

Manhunt by Rockstar North, released for PlayStation 2 in 2003, is an example where optional voice input is used to add an unpredictable human element to gameplay. The game can be played with a USB headset to use the voice features. Instead of using verbal interaction through speech recognition, the game simply detects sounds through the microphone and uses them to trigger in-game events. For example, if the player is surprised by an event on the screen and yells in

surprise in real life, it can alert nearby enemies inside the game. In the words of a review from 2003, it adds an unpredictable human element to the game. The player can also intentionally attract attention by yelling into the headset's microphone. [70]

Similar to its predecessor Nintendo 64, the GameCube console had its own microphone peripheral. The GameCube microphone was used in games such as *Mario Party 6* (2004), *Karaoke Revolution Party* (2005), and *Odama* (2006). [71] *Mario Party 6* has a minigame mode that is specifically designed to be played with the bundled microphone. The game has several minigames where the player must give voice commands to the microphone to perform actions in the game, including navigating an obstacle course and answering quiz questions. [72] *Odama*, developed by the *Seaman* creator Vivarium, combines pinball with elements of real-time strategy. The player can issue voice commands to the troops on the battlefield through the microphone. [71]

2.4.4   Seventh Generation Handheld Consoles

Figure 6. The Nintendo DS handheld console was the first console after Famicom to feature a built-in microphone (Wikimedia Commons) [73].

Voice interaction features became available on handheld consoles starting from the seventh console generation in Mid-2000s. Nintendo DS (See Figure 6), which was released in 2004, has a built-in microphone. While Nintendo 64 and GameCube had microphone peripherals, DS was the first Nintendo console since Famicom to feature a built-in microphone. DS sold over 150 million units, [1] which brought voice interaction features available to a large audience. The microphone was used in various games for voice interaction, including *WarioWare: Touched!* (2004), [74] *Phoenix*

Wright: Ace Attorney (ported to DS in 2005), [75] *Nintendogs* (2005), [76] *Brain Age: Train Your Brain in Minutes a Day!* (2005), [77] and *The Legend of Zelda: Phantom Hourglass* (2007) [78].

In the pet simulation game *Nintendogs*, the player can use the DS microphone to name their puppy and also give names to new tricks that the puppy can learn. The tricks can be ordered verbally instead of drawing the preset stylus motions on the touch screen. To improve the accuracy of voice recognition, the name has to be repeated several times when naming the puppy. [79] The puzzle game *Brain Ages* uses both handwriting recognition and speech recognition, and the player can optionally use verbal answers to solve certain puzzles [80]. However, the speech recognition might sometimes misinterpret, and in a review, the game was criticized for lacking a voice training option to improve its accuracy [77].

In *Ace Attorney*, the player can interact during court sessions either by pressing buttons or optionally shouting a limited number of voice commands, such as "Hold it!", to the microphone [81]. The player can also use the microphone non-verbally by blowing to it while dusting fingerprints [75]. However, not all games that feature voice interaction rely on verbal commands. For example, *Touched!* uses the microphone in a variety of non-verbal ways, including blowing to the microphone and doing animal impersonations [74]. Similarly, in *Phantom Hourglass*, voice interactions are limited to minor features such as killing big-eared monsters and extinguishing candles by blowing to the microphone [78,82].

Unlike DS, the PlayStation Portable handheld console did not have a built-in microphone before the 3000 model that launched in 2008 [83]. In older models, voice commands could be issued through a separate headset or a microphone peripheral. PSP games that feature voice interaction include games in the SOCOM series, such *Fireteam Bravo* (2005) and *Tactical Strike* (2007) [84,85]. The built-in microphone in the 3000 model could be used for online communication with other players and for using Skype [86]. While examples of voice interaction in PSP games are few and far between, the augmented reality virtual pet simulator *EyePet* (2010 for PSP) has a mechanic where the player can blow to the microphone [87].

Talkman (2005) for PSP is an interesting example utilizing speech recognition on the handheld console. *Talkman* is a voice-supported translation tool that comes with a separate microphone add-on. The talk mode covers common traveling scenarios, such as airport and hotel scenarios, and each scenario has a list of context-sensitive questions that can be translated to a supported language. While using *Talkman*, the user is accompanied by Max, a goofy blue bird that acts as an intermediary. After choosing a question either by speaking it or selecting it from the list, Max

reads it aloud in the chosen language. [88] The first release supported Asian languages while the 2006 release supported European languages [89].

2.5   2010s and the Emerging Frontiers of Voice Games

2.5.1   Seventh Generation Home Consoles

Figure 7. The Kinect sensor bar for Xbox 360 featured a microphone array and a speech recognition system. (Wikimedia Commons) [90].

At the end of 2000s, voice interaction features were slowly becoming less utilized on console platforms outside of karaoke games. While Xbox 360 was launched back in 2005, voice commands had failed to gain traction outside of tactical shooters such as *Rainbow Six Vegas* (2006), [91] *Tom Clancy's EndWar* (2008), [92] *Rainbow Six Vegas 2* (2008), and *Tom Clancy's H.A.W.X* (2009) [93]. The introduction of the Kinect sensor bar (See Figure 7) for Xbox 360 in 2010 changed the voice landscape because it featured a microphone array and a speech recognition system. Using Kinect did not require expertise in speech recognition, which allowed game developers to more easily implement voice interaction features in their Xbox 360 games. [1]

In the years following Kinect's release, a number of titles were released that support voice interaction. This time the spectrum of genres was bigger and included the pet simulation game *Kinectimals* (2010), [94] the role-playing game *The Elder Scrolls 5: Skyrim* (2011), the first-person shooter *Halo: Combat Evolved Anniversary* (2011), [95] the racing game *Forza Motorsport 4* (2011), [96] the sports game *Kinect Sports: Season 2* (2011), [97] the role-playing game *Mass Effect 3* (2012), the

survival horror game *Dead Space 3* (2013, See Figure 8), and the stealth game *Tom Clancy's Splinter Cell: Blacklist* (2013). [95] Games such as *Kinectimals*, *Kinect Sports*, and *Blacklist* make full use of Kinect's features by using both voice commands and motion controls.

Figure 8. A cheat sheet revealing the voice commands for the survival horror game *Dead Space 3* (Engadget 2013) [98].

Some games did not support voice interaction at launch but added support through an update. *Skyrim*, for example, had no support for voice commands when it originally launched in 2011. However, game modders released popular mods that allowed players to perform various actions in the game through voice commands [1]. In a 2012 update, Bethesda officially added support for over 200 voice commands through Kinect on Xbox 360. The player can use voice commands to navigate through game menus, issue commands to allies, assign spells and equipment to their character, and cast spells by reading incantations. [99] People have even tried to complete *Skyrim* through voice commands alone [100].

PlayStation 3 supports various accessories that include microphones, but relatively few games on the console use voice interaction. While PlayStation 2 clearly surpassed Xbox in the number of games that supported voice interaction during the previous console generation, the roles were reversed during the seventh generation of consoles largely due to Kinect's success. Games that do feature voice interaction on PlayStation 3 are mainly tactical shooters. These games include *Rainbow Six Vegas* (2006), [101] *Rainbow Six Vegas 2* (2008), [102] *Tom Clancy's EndWar* (2008), [92]

and *Binary Domain* (2012), [103] all of which were also available on Xbox 360 with voice commands, and some on PC.

EndWar is a notable example of voice interaction on a mainstream console game, because it successfully integrated voice commands into a complex real-time strategy game as a core gameplay mechanic. By holding the trigger on the controller and speaking a voice command to the headset, the player can order units to perform a variety of actions. *EndWar* can still be played without voice commands, and some micromanagement actions, such as ordering a unit to perform a special attack, still require button presses on a physical controller. [92] A review noted that while voice commands were necessary on the console version, they were less useful on PC because it already has a better control scheme in the form of a keyboard and a mouse [104].

Nintendo Wii pioneered the use of motion control in games, [105] but similar to PS3, few if any games on the system feature voice interaction outside of karaoke games. The reason behind the lack of voice interaction games on Wii might be explained by the fact that DS, which was released a couple of years earlier, already included a built-in microphone and catered for games that made us of voice interaction features, while games on Wii that did not use traditional control schemes revolved around motion control. Wii supported microphone accessories such Wii Speak, but it was used for online chat in games such as *Animal Crossing: City Folk* (2008), *The Conduit* (2009) and *Endless Ocean 2: Adventures of the Deep* (2009) [106].

2.5.2 Eight Generation Handheld Consoles

Nintendo 3DS was released in 2011 as a successor to DS and came with a built-in microphone and a backwards compatibility to DS games [107]. The 3DS system features microphone-enabled easter eggs where player can cause various effects by blowing to the microphone while, for example, in the home screen or the camera mode [108]. In addition to games in the DS library, 3DS also has several games released on the system that feature voice interaction. These games include *Nintendogs + Cats* (2011), [109] *The Sims* (3DS port in 2011), *Mario Party: Island Tour* (2013), [110] Phoenix Wright: *Ace Attorney – Dual Destinies* (2013), [111] and *WarioWare Gold* (2018) [112].

Like the later PSP models, the PlayStation Vita handheld console also features a built-in microphone [113]. However, similar to the previous generation of handheld consoles, Vita had less voice interaction games available when compared to the Nintendo counterpart. Examples of voice interaction games on Vita include the racing game *Wipeout 2048* (2012) [114] and the pet simulation

game *PlayStation Vita Pets* (2014) [115]. The limited amount of voice interaction games on Vita could be tied to the console's lackluster sales as Vita faced competition from Nintendo 3DS and mobiles games [116]. Sony stopped making games for the system in 2015 and it was eventually discontinued in 2019 [117].

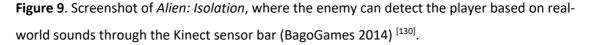## 2.5.3   Eight Generation Home Consoles

During its launch in 2013, Xbox One had an extensive support for operating the system with voice commands. Voice commands could be used to navigate menus, launch games, use apps such as Skype and TV, and switch between apps and games. [118,119] Also, Xbox One bundled with Kinect as a mandatory peripheral for six months after its release, which brought the voice-enabled device to a wider user base [1]. The introduction of Kinect on Xbox 360 resulted in a wave of games that supported voice interaction in a variety of ways, and the trend continued on Xbox One after its launch. The new Xbox console was released with an updated Kinect sensor that featured some improvements [118].

Over 30 major Xbox One titles have featured a varying level of voice interaction [1]. Many of the games support voice interaction exclusively on Xbox One through Kinect, while some might also support them on PlayStation 4 and PC. Games that support voice interaction on Xbox One include action-adventure games, such as *Ryse: Son of Rome* (2013) and *Dead Rising 3* (2013), [120,121] adventure games such as *D4: Dark Dreams Don't Die* (2014), [122] racing games such as *Need for Speed Rivals* (2013) and *Forza Horizon 2* (2014), [123,124] sports games such as *FIFA 14* (2013) and *Kinect Sports Rivals* (2014), [125,126] role-playing games such as *Dragon Age: Inquisition* (2014), and simulation games such as *Zoo Tycoon* (2013) [127].

Forza Horizon 2 features an interesting application of voice interaction in the form of an in-game, in-car digital assistant named Anna. Instead of using the game's menu, the player can, for example, ask Anna to give them directions to the next racing event. In a review, this feature was praised for saving the player from navigating complicated game menus. [128] Besides increasing convenience, voice interaction can also add immersion. *D4: Dark Dreams Don't Die* uses Kinect's motion controls extensively, and also features voice interaction by enabling the player to present questions verbally when interrogating suspects. One review praised the accuracy of the speech recognition and the feeling of satisfaction of using one's own voice. [122]

Ryse: Son of Rome was originally supposed to be a Kinect showcase title on Xbox 360. However, it was made an Xbox One launch title and the Kinect control scheme was stripped down. *Ryse* released with a limited amount of voice commands that could be used, for example, to fire the catapult or a volley of arrows towards enemies. [129,120] While the Kinect sensor on Xbox One has generally been praised for its improved speech recognition capabilities, the implementation of voice interaction has not always been achieved without problems. For example, in *Need for Speed: Rivals*, environmental sounds and conversation have been misinterpreted as voice commands, which could lead to the interruption of the race and result in a crash. [123]

Figure 9. Screenshot of *Alien: Isolation*, where the enemy can detect the player based on real-world sounds through the Kinect sensor bar (BagoGames 2014) [130].

PlayStation 4 had a limited numbers of voice commands available for operating the system at launch but got more in a 2014 update [131]. PlayStation 4 uses voice commands though PlayStation Camera, which, unlike Kinect on Xbox One, was not bundled with the console but sold separately. Its features were compared unfavourably to the more sophisticated Kinect sensor for Xbox One. [132] Games that support voice interaction on PlayStation 4 include *NBA 2K14* (2013), *Tomb Raider: Definitive Edition* (2014), [133] *Wolfenstein: The New Order* (2014), [134] *NBA 2K15* (2014), and *Alien: Isolation* (2014) [135] It is worth noting, however, that the afore-mentioned games also support voice interaction on Xbox One.

While many games have implemented voice interaction through traditional voice commands, there have also been exceptions. In *Alien: Isolation* (2014), voice interaction is used in a similar fashion as in *Manhunt* for PlayStation 2. In both games, real-world audio is used to allow enemies to track the player based on volume detection through a microphone (See Figure 9). In addition

to voice interaction, the game also utilizes motion controls that can be used to peek around corners. [135] *Tomb Raider: Definitive Edition* (2014) features both voice interaction and gesture controls on. Voice command can be used, for example, to open the map and equip weapons, while gesture controls can be used to grab and rotate artefacts. [133]

Wii U does not have a built-in microphone on the console itself, but instead has one on the GamePad controller [136]. Outside of karaoke titles, [137] games on the Wii U system do not use voice interaction extensively and rarely if ever feature voice commands through speech recognition. Games that do feature a level of voice interaction mostly include short sections where the player can blow to the microphone to cause various things to happen in the game. These games include titles such as *Nintendo Land* (2012), [138] *Super Mario 3D World* (2013), [139] *Wii Party U* (2013), [140] *Captain Toad: Treasure Tracker* (2014), [141] *The Legend of Zelda: Spirit Tracks* (Wii U port in 2016), [142] and *3Souls* (2016) [143].

Nintendo Switch was released in 2017 and entered the eighth generation of consoles relatively late. Unlike Wii U, Switch does not have a built-in microphone [144]. Nintendo did, however, release Famicom-style controllers in Japan that also featured a microphone [145]. Examples of voice interaction on Switch titles seem nonexistent, and the conversation around Switch's voice features has revolved around its limited support for voice chat. Under these conditions, it is not surprising that game developers have not embraced voice interaction in their Switch games. While Switch's voice audio capabilities have gotten better through third-party hardware and software products, [146] it remains to be seen what effect this will have on future games.

2.5.4   PC Games

Starting around Mid-2000s, voice interaction has been experimented with in small-scale and low-budget indie games, which were commonly distributed as Flash-based browser games on sites such as Kongregate, Miniclip, and Newgrounds. Examples of voice-enabled online games include the 2006 promotional game *Ford Fiesta Connexxion*, [147] *Microphone Game* (2007), [148] *The Wind Sea Adventure* (2008), [149] *Micromissile* (2009), [150] and *Gamic* (2010) [151]. Often these simple browser games would utilize a similar mechanic seen on Nintendo DS and 3DS games, where the player would simply blow to the microphone to raise an object, such as a hot air balloon, spaceship, or a bullet, while guiding it around obstacles, or stay silent to lower it.

Flash games, which had been a billion-dollar business, started losing popularity towards the end of the decade due to the rise of mobile games [152]. However, a new wave of voice-enabled indie games for PC has been available on marketplaces such as itch.io. For example, itch.io has a category for games with voice control support that had 53 games in March 2020 [153]. Games on itch.io range from simple noise games such as *Insane Screaming Mayhem* (2017) to pitch games such as *Resonance: The Lost Score* (2017), where the player must match the tone of their voice to clear their way through obstacles, [154] to games that use speech recognition such as *Chant Savant* (2016), where the player can summon creatures by chanting incantations [155].

After the release of Kinect for Xbox 360 in 2010 and the introduction of voice commands to popular titles such as *Skyrim* in the following years, more voice-enabled games have also been released on PC [1]. Aside from hobby projects, games made at game jams, school projects, and similar small-scale indie games, voice interaction has also been embraced by more established game developers, though which could still be considered indie developers. These games include titles such as *Bot Colony* (2014), *In Verbis Virtus* (2015), and *There Came an Echo* (2015). In contrast to games by larger studios, where voice interaction is usually a bonus or an overlay, these games have made voice interaction the core game mechanic [1].

Bot Colony is a particularly interesting title due to its ambitious goal, which is to achieve unlimited and unscripted dialogue through natural language understanding. *Bot Colony* is an episodic adventure game by North Side Inc. that, after many years of development, has been on Steam's Early Access program since 2014 [156]. Players can converse with the game's robots about several topics, including their general knowledge, the events they have witnessed, and their surroundings. The robots in the game are aware about objects in their surroundings and can describe them or answer questions like "What is this?". [157] However, the game has encountered several delays and setbacks due to issues while developing the proprietary language technology [158].

There Came an Echo, released in 2015, is a real-time strategy game. The game is designed with voice commands being the primary method of control, though it can also be played with a mouse. In the game, the player does not have an avatar, but instead, they guide units through combat situations by giving them voice commands. The game has alphanumeric designations to things the player can interact with voice, including cover spots and enemies. For example, to order a unit to attack an enemy, the player can say "Miranda, focus fire on Enemy one". The game did, however, receive some criticism due to voice commands not always working properly during real-time combat situations, which might occasionally leave the player helpless. [159]

A popular game mechanic that voice-driven action-adventure and role-playing games have used is using speech recognition to cast spells. For example, *In Verbis Virtus* (2015), the player casts magic spells by speaking incantations to a microphone. During the course of the game, the player explores a cavern filled with puzzles while looking for spells to solve them. For example, to cast a spell that creates light, the player can say "LUMEH TIAL". In a review, the speech recognition system was praised for understanding the spells effectively even from basic sounds. [160] *The Broken Seal* (2018) is another game with a similar mechanic, which combines virtual reality and voice interaction to interact with the virtual world [161].

The past decade has seen new iterations of voice control software for PC. Some provide means to control most aspects of the operating system through voice commands and macros, while some are focused on adding a layer of voice control specifically over games, similar to Voice Commander and Game Voice in early 2000s. Examples of software that fit in the games-oriented category include VoiceAttack (2009), [162] Dragon Gaming Speech Pack (2010), [163] ControlMyJoystick (2014), [164] VoiceBot (2015), [165] and *VoiceWarrior* (2017). [166] A variety of options with different features, such as support for various peripherals, ensures that each player can choose a tool that is most suitable to their own needs and use cases.

Today, a layer of voice control can be added over many popular PC games, including on games that do not have native support for voice commands. For example, VoiceBot by Binary Fortress has premade game profiles for seven of the top 10 games on Steam Chart in March 2020, including for games such *Counter-Strike: Global Offensive* and *PlayerUnknown's Battlegrounds,* [167] and also for games that are sold outside Steam, including *Fortnite*, *Overwatch*, and *Minecraft*. [165] Dragon Gaming Speech Pack by Nuance, though slightly older, is another popular software that promises compatibility with games such as *Call of Duty: Black Ops*, *Mass Effect 2***,** *Microsoft Flight Simulator X*, *Second Life*, *Warhammer 40,000*, and *World Of Warcraft: Cataclysm* [168].

Over the years, PC as a game platform has had more freedom for experimentation when compared to more restricted console environments. As a result, voice interaction games are available from indie and established developers, and game mods and voice control software are further extending the availability of voice commands for games. However, a limiting factor on PC has been the less uniform hardware when compared to consoles, with game developers not always being able to rely on players having a microphone. [1] Nevertheless, voice interaction games for PC are currently coming out at a frequent pace and expand the extensive catalogue of voice-supported games that is already available for PC gamers.

2.5.5 The Rise of Mobile Games and Virtual Assistants

The release of iPhone in 2007 and App Store in 2008 contributed to the rise of mobile gaming that kicked off in late 2000s [169,170]. Accordingly, the 2010s has been a decade of continuous growth for mobile games. By 2019, mobile games were responsible for 60% of the global revenue generated by video games [171]. Compared to other game platforms in the context of voice interaction, such as PC and consoles, mobile devices have the advantage of having microphones as a standard feature [1]. As a result, mobile game developers can implement voice interaction features on mobile games and expect the players to be able to use those features without having to rely on external peripherals.

Similar to PC, the mobile platform has seen numerous games that feature voice interaction by indie developers, and also by more established developers. However, the biggest distribution channels for mobile apps, App Store for iOS and Google Play for Android, do not as of March 2020 have dedicated categories for games that feature voice interaction. Also, the number of mobile games in the market is in millions, as App Store alone had over 900,000 games in July 2019 [172]. As a result of these factors, the discoverability of voice interaction games on the mobile platform is an issue as it is for other types of games as well. Despite this, many voice-driven mobile games have already gained popularity and even gone viral.

A popular feature in several viral voice-driven indie games has been a non-verbal volume detection mechanic, where a constant but quiet noises causes movement forward, but short and sharp noises cause actions such as shooting or jumping. Examples of this type of design include *Pah!* (2011), where the player guides a spaceship and shoots horizontal projectiles, [173] *The Howler* (2013), where the player guides a hot air balloon and drops bombs vertically, [174] and *Chicken Scream* (2017), where the player moves a character forward and jumps across platforms [175]. Many of such games have incorporated the word "scream" into the game's title to reflect the gameplay, including other similar titles such as *Scream Go Hero* (2017 [176].

Another game mechanic has the player being in the role of a helper that gives guidance to game AIs based on visual cues that only they can see, such as a radar display or a map. For example, *ATC Voice* (2013) for iPad is an air traffic control simulation game, where the player has to keep track of airplanes approaching an airport through a radar display and manage flight paths by giving AI pilots instructions on radio. [177] Similarly, *Mayday! Deep Space* (2015) uses a similar mechanic where the player gives instructions to a survivor stuck on a spaceship with monsters. The

player cannot see what's happening in the station, but instead, has to rely on audio cues and a live map of the area. [178]

Voice interaction has opened new ways in which games can be played. In contrast to traditional playing sessions where a game is the primary focus of attention, voice interaction has made it possible to play games while focusing on other activities, such as cooking or driving. *Drivetime* (2018) is an example of a game that caters for the in-car entertainment space. The *Drivetime* app contains interactive entertainment and games such as the quiz game *Jeopardy!*. The player can interact with the app and its games verbally while keeping attention on their current activity. [179] *Drivetime* is also available as an Alexa skill, which highlights the emergence of voice apps and virtual assistants in late 2010s as a new platform for games.

Figure 10. The Amazon Echo Dot is part of the Amazon Echo line of smart speakers and features the Amazon Alexa virtual assistant (Flickr 2016) [180].

While the past decade has been characterized by the rise of mobile games, the emergence of virtual assistants in the early 2010s is another important development. The so-called modern era of virtual assistants began in 2011 with the launch of Apple's Siri, which was the first voice-enabled virtual assistant to reach a wide consumer audience. [181] Siri was followed by Google Now in 2012, Microsoft's Cortana in 2013, Google Assistant in 2016, and Samsung's Bixby in 2017 [182]. The release of Amazon Alexa with the Amazon Echo (See Figure 10) smart speaker in 2014 has been described as the start of the smart speaker revolution [181]. Accordingly, the smart speaker market has become the fastest growing sector of consumer electronics in recent years [183].

In addition to smart speakers, virtual assistants can be accessed through other smart devices, including smart displays, smart watches, and mobile devices. Virtual assistants, most notably

Alexa and Google Assistant, have become vibrant platforms for voice interaction games and other types of interactive entertainment. On Alexa, voice apps are called skills whereas on Google Assistant, they are called actions. Third-party developers can develop voice apps and games for virtual assistants, which serve as platforms through which they are accessed. When a user wants to use a given voice app, they will first need to access the virtual assistant, and then say a specific invocation phrase to open the desired voice app. [184]

A number of companies have already released games and other interactive entertainment experiences on digital assistants, especially towards the end of the decade. These companies include Chatty Creations, Doppio Games, Drivetime, Earplay, labworks.io, matchbox.io, Musicplode Media Ltd, Pretzel Labs, Stoked Skills, The Magic Door, Verto Lab, Volley, and Xandra. This has resulted in a variety of voice games, including children's games such as *Kid's Court* (2018) for Alexa, franchised games such as *Jurassic World Revealed* (2018) for Alexa, companion apps such as *The Division Network* (2019) for Alexa, trivia games such as *Question of the Day* (2019) for Alexa and Bixby, and adventure games such as *The Vortex* (2018) for Alexa and Google Assistant.

Many of the games on digital assistants only feature limited graphics or none at all and can typically be played even on devices that do not have displays. While the focus of this study is on digital games, virtual assistants have also been used to add a layer of voice interaction over more traditional games, including board games. For example, *Monopoly Voice Banking* by Hasbro uses an electronic top hat with voice interaction features to remove physical currency from the classic board game by handling all the transactions through voice commands [185]. The detective board game *St. Noire* by X2 Games uses an Alexa device to play background sounds and voice lines, and also enables the board game's voice interaction features [186].

Voice-enabled assistants provide brands a way to interact with their customers, and this also applies to the relationship between game companies and players. For example, Ubisoft launched the voice-enabled chatbot Sam in 2018 through the Ubisoft Club mobile app. Players can interact with the chatbot through speech or by writing. Players can, for example, talk with Sam about the Ubisoft games in their game libraries or engage in small talk. [187,188] The emergence of voice assistants is a development that builds on the proliferation of microphone-enabled smart devices such as mobile phones. As a result, people can now easily access voice interaction games and use voice-enabled game services such as Sam.

2.6   2020s and Onwards

2.6.1   Recent Developments

The 2020s have started with companies enthusiastically implementing voice interaction features on game systems, and voice-enabled assistants are playing an important role in the change. For example, the original Kinect voice command features on Xbox One were first replaced with voice commands through Microsoft's Cortana, and later through Alexa and Google Assistant [189]. Similarly, patent filings suggest that Sony might add a voice assistant in the upcoming PlayStation 5 console [190]. The new DualSense controller for PlayStation 5 will nevertheless include a built-in microphone [191]. The inclusion of a built-in microphone in the PlayStation 5 controller can potentially result in a wave of voice games on the system.

In late 2019, Google enabled a limited support for Google Assistant on the Stadia cloud gaming service as part of an early access program [192]. On a similar note, recent firmware updates point to the direction that the Oculus Quest virtual reality system might include a voice assistant in the future [193]. However, while these changes mostly affect game systems with initial rippling effects on games running on them, they nevertheless affirm the role of voice interaction both in the eyes of game developers and players alike. While the 2020s in video games have begun with hustle and bustle around voice interaction, there still remain several challenges that game companies and developers should address.

2.6.2   Future Challenges

The increased prevalence of voice interaction features has resulted in concerns over privacy. To improve the accuracy of voice commands in their products, companies have used human supervision to review audio snippets of people using them. For example, Microsoft has used contractors to listen to people using voice commands on Xbox One through Kinect. This has raised privacy issues for a number of reasons. People might not be aware of themselves being recorded, they might trigger the voice interaction features accidentally during normal conversation, and often the people who were recorded would be children. Microsoft is not, however, an exception, and companies such as Amazon, Apple, Facebook, and Google, have used similar practices. [194]

Speech recognition offers a versatile tool for game developers influence the gameplay experience. It has already been used in games to modify player behaviour by, for example, discouraging unsportsmanlike conduct in sports games. For example, if the Kinect sensor bar catches the player swearing while playing the basketball game *NBA 2K13*, they will be penalized for a technical foul, for example, by giving the opposing team free throws and possession of the ball. [195] In this type of implementation, speech recognition is used not only for empowering the player through voice commands that they have intentionally initiated, but also for producing results that the player might not expect or agree with.

Voice interaction can have a powerful emotional impact on a game. However, if the feature relies solely on its perceived feeling of novelty, players might simply regard it as unmeaningful gimmick. Voice interaction features have long suffered from being perceived as gimmicks, which is apparent from game reviews and online conversations about voice games. For example, a user on the GameSpot forums complained in 2007 about the excessive use of the microphone blowing mechanic in Nintendo DS games under a thread titled: "Blowing into the microphone must be banned!" [196]. While different platforms set limits for games in what degree of voice interaction is feasible to implement, game developers should always seek fresh design approaches.

When implementing voice interaction features that affect both games and system running them, developers should make sure that the systems are robust. For example, in 2014, a player found a way to abuse Xbox One's voice command features to gain advantage in the first-person shooter *Call of Duty: Ghosts*. The Xbox One system automatically listened for voice commands through Kinect even when the player was in a game. In *Call of Duty: Ghosts*, the player entered the game's online multiplayer mode with an account that had the username "Xbox Sign Out". Whenever the player was addressed by other players through the game's online chat, Kinect picked up the words, and interpreted them as a voice command to turn off their Xbox One system. [197]

While the technology enabling voice interaction has improved over the years, there is still room for future improvement. Jeferson Valadares, CEO and co-founder of Doppio Games, compares the state of voice games today to the state of mobile games during pre-iPhone days. "Mobile games didn't become truly global until iPhone. It had an amazing touch experience and unlocked a good gaming experience on mobile devices." According to Jeferson, virtual assistants, which serve as platforms for many voice games, have to overcome challenges including shortening the response time and moving away from turn-based conversation to mimic organic conversation, where people regularly talk over each other (Jeferson Valadares, CEO of Doppio Games, Interview on March 3, 2020).

"The definitive voice game has not yet been made." (Jeferson Valadares, CEO of Doppio Games, Interview on March 3, 2020)

3   Conclusion

3.1.1   Summary of Research Findings

The research shows that voice interaction has been experimented with in commercially published games and systems starting from the 1980s. Games featuring voice interaction have appeared in waves, typically as a reaction to new hardware features. The long silence of the 1990s was broken at the end of the decade by microphone peripherals released on popular consoles. The 2000s saw the rise of the karaoke craze, and voice interaction was being implemented in a wide range of games. The degree of voice interaction has varied from volume and pitch detection mechanics and simple voice commands to more conversational approaches. Some of the console games were available on PC, and PC also saw voice-enabled flash games.

During the past decade, the field become more fragmented. In addition to traditional platforms, such as consoles and PCs, voice games are now available on new platforms such as mobile devices and virtual assistants available on different smart devices. Traditional platforms, most notably home consoles, are keeping up the pace by integrating voice interaction features in the form of voice assistants. At the same time, game companies like Ubisoft are also launching voice assistants to integrate with their games. As a result of games escaping outside of traditional game platforms, voice interaction is now being implemented in a variety of games both by indie developers and more established developers.

Research demonstrates that games that feature voice interaction typically fall into four categories. The first category of games features non-verbal voice interaction in the form of simple volume detection. In this kind of implementation, the player has to create noise, for example, by blowing or screaming to the microphone. In contrast, the player might also have to remain silent and avoid attracting the attention of enemies, as seen in *Manhunt* and *Alien: Isolation*. In the second category, the player has to mimic the game through verbal or non-verbal voice interaction, the former of which is common in karaoke games, where the player is scored based on pitch and rhythm. However, most karaoke games do not as of yet feature speech recognition.

Thirdly, games can feature voice commands that are used to command game characters or perform actions such as navigating menus. Voice commands have been used in genres such as tactical shooters, real-time strategy games, racing games, sports games, and simulation games. This type of implementation uses speech recognition, and the commands can consist of either single

words or strings of several words. Lastly, games that rely on speech recognition can be more conversational in nature and go beyond simple voice commands. In games like *Seaman*, the player has to interact with the game world by asking questions and answering to them. While the depth of conversations can vary, they are more complex when compared to voice commands.

Future challenges that platforms and developers have to address include taking into account players' privacy when improving the quality of their services. Seeking fresh design approaches to voice interaction is important in order to make the interaction more meaningful. To encourage players using voice interaction, game developers should make sure that the features are empowering and not constricting the player. Voice-enabled systems should be robust so that players cannot abuse them to gain unfair advantage over other players. Finally, technologies enabling different voice interaction systems are still improving, and game developers should keep an eye out for any technological improvements to make best use of them in their games.

3.1.2   Discussion

The research was conducted mostly online through keyword searches on Google Search. The searches targeted relevant websites, including video game websites such as Eurogamer, Gamasutra, Game Informer, GameSpot, GamesRadar, IGN, Kotaku, and Pocket Gamer, technology websites such as CNET, Engadget, Polygon, The Verge, and VentureBeat, voice-related sites such as VoiceBot.ai and the *Speech Technology* magazine, and digital marketplaces such as Itch.io and Steam. Other online tools included Google Books, which was used to find published literary sources, and Wayback Machine by Internet Archive, which was used to access old websites and digitalized magazines such as *PC Magazine* and *Compute!'s Gazette*.

A recurring problem during the research was the inconsistent and incorrect terminology used, for example, in game reviews and news articles. For example, terms like speech recognition and voice recognition were often used interchangeably. In game reviews, voice interaction features were often left unmentioned or touched only briefly, which made the keyword search challenging. The research project started as an extensive overview of voice interaction in games while covering several topics and case studies, but the scope was reduced to an in-depth history review while highlighting different design approaches. As a result, the research became more focused, and the updated research objective was achieved.

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Appendices

Appendix 1: Table of games that were mentioned in the thesis and feature a native support for voice interaction.

Note: Some games are available across several platforms. In the table below, the platform that was mentioned in the thesis as featuring voice interaction is indicated while other platforms are represented by the '+' icon.

#	Title	Year	Platform	Publisher
1.	*Voice-Chess*	1973	-	-
2.	*The Legend of Zelda*	1986	Famicom	Nintendo
3.	*Kid Icarus*	1986	Famicom	Nintendo
4.	*Karaoke Studio*	1987	Famicom	Bandai
5.	*Karaoke Studio: Top Hits 20, Vol. 1*	1987	Famicom	Bandai
6.	*Karaoke Studio: Top Hits 20, Vol. 2*	1988	Famicom	Bandai
7.	*Command: Aces of the Deep*	1995	Windows 95	Sierra On-Line
8.	*Hey You, Pikachu!*	1998	Nintendo 64	Nintendo
9.	*Densha de Go! 64*	1999	Nintendo 64	Taito
10.	*Seaman*	1999	Sega Dreamcast	Sega
11.	*Dream Audition*	2000	PlayStation 2	Jaleco
12.	*Dreamcast Karaoke*	2001	Sega Dreamcast	Sega
13.	*Phoenix Wright: Ace Attorney*	2005	Nintendo DS	Capcom
14.	*Dreamcast Karaoke*	2001	Sega Dreamcast	Sega
15.	*Yoake no Mariko*	2001	PlayStation 2	Sony Computer Entertainment
16.	*SOCOM U.S Navy SEALs*	2002	PlayStation 2	Sony Computer Entertainment
17.	*Yoake no Mariko 2nd Act*	2002	PlayStation 2	Sony Computer Entertainment

18.	*Delta Force: Black Hawk Down*	2003	PlayStation 2 +	Novalogic
19.	*Karaoke Revolution*	2003	PlayStation 2 +	Konami
20.	*Lifeline (Operator's Side)*	2003	PlayStation 2	Sony Computer Entertainment
21.	*Manhunt*	2003	PlayStation 2 +	Rockstar Games
22.	*NBA Shootout 2004*	2003	PlayStation 2 +	SCEA
23.	*NCAA GameBreaker Football 2004*	2003	PlayStation 2	SCEA
24.	*NFL Gameday 2004*	2003	PlayStation 2	SCEA
25.	*N.U.D.E.@ Natural Ultimate Digital Experiment*	2003	Xbox	Microsoft Game Studios
26.	*Rainbow Six 3*	2003	PlayStation 2, Xbox, +	Ubisoft
27.	*Shibai Michi*	2003	PlayStation 2	Sony Computer Entertainment
28.	*SWAT: Global Strike Team*	2003	PlayStation 2, Xbox	Sierra Entertainment
29.	*Get On Da Mic*	2004	PlayStation 2	Eidos Interactive
30.	*Tom Clancy's Ghost Recon 2*	2004	PlayStation 2, Xbox, +	Ubisoft
31.	*Mario Party 6*	2004	GameCube	Nintendo
32.	*SingStar*	2004	PlayStation 2	Sony Computer Entertainment
33.	*Unreal Tournament 2004*	2004	PC	Epic Games
34.	*WarioWare: Touched!*	2004	Nintendo DS	Nintendo
35.	*Brain Age: Train Your Brain in Minutes a Day!*	2005	Nintendo DS	Nintendo
36.	*Greg Hastings Tournament Paintball MAX'D*	2005	PlayStation 2, Xbox, +	Activision
37.	*Karaoke Revolution Party*	2005	GameCube, +	Konami
38.	*NASCAR 06: Total Team Control*	2005	PlayStation 2 Xbox	EA Sports
39.	*Nintendogs*	2005	Nintendo DS	Nintendo
40.	*SingStar Pop*	2005	PlayStation 2	Sony Computer Entertainment
41.	*SOCOM U.S. Navy SEALs: Fireteam Bravo*	2005	PlayStation Portable	Sony Computer Entertainment

42.	*Talkman*	2005	PlayStation Portable	SCEI, SCE Korea
43.	*Odama*	2006	GameCube	Nintendo
44.	*Ford Fiesta Connexxion*	2006	Browser game	-
45.	*Tom Clancy's Rainbow Six Vegas*	2006	Xbox 360, PlayStation 3, +	Ubisoft
46.	*Boogie*	2007	PlayStation 2, Nintendo DS, Wii	Electronic Arts
47.	*Microphone Game*	2007	Browser game	-
48.	*Rock Band*	2007	PlayStation 3, Xbox 360, Wii, +	MTV Games
49.	*Seaman 2*	2007	PlayStation 2	Sega
50.	*SOCOM U.S. Navy SEALs: Tactical Strike*	2007	PlayStation Portable	Sony Computer Entertainment
51.	*The Legend of Zelda: Phantom Hourglass*	2007	Nintendo DS, +	Nintendo
52.	*Disney Sing It!*	2008	PlayStation 3, Xbox 360, Wii, +	Disney Interactive Studios
53.	*Guitar Hero: World Tour*	2008	PlayStation 3, Xbox 360, Wii, +	Activision
54.	*Lips*	2008	Xbox 360	Microsoft Game Studios
55.	*The Wind Sea Adventure*	2008	Browser game	-
56.	*Tom Clancy's EndWar*	2008	PlayStation 3 Xbox 360, +	Ubisoft
57.	*Tom Clancy's Rainbow Six Vegas 2*	2008	PlayStation 3 Xbox 360, +	Ubisoft
58.	*Micromissile*	2009	Browser game	-
59.	*Tom Clancy's H.A.W.X*	2009	Xbox 360, +	Ubisoft
60.	*EyePet*	2010	PlayStation Portable, +	Sony Computer Entertainment
61.	*Gamic*	2010	Browser game	-
62.	*Kinectimals*	2010	Xbox 360, +	Microsoft Game Studios
63.	*Forza Motorsport 4*	2011	Xbox 360	Microsoft Studios
64.	*Halo: Combat Evolved Anniversary*	2011	Xbox 360	Microsoft Studios
65.	*Kinect Sports: Season 2*	2011	Xbox 360	Microsoft Studios

66.	*Nintendogs + Cats*	2011	Nintendo 3DS	Nintendo
67.	*Pah!*	2011	iOS	-
68.	*The Elder Scrolls 5: Skyrim*	2011	Xbox 360, +	Bethesda Softworks
69.	*The Sims*	2011	Nintendo 3DS, +	Electronic Arts
70.	*Binary Domain*	2012	PlayStation 3 Xbox 360, +	Sega
71.	*Mass Effect 3*	2012	Xbox 360, +	Electronic Arts
72.	*Nintendo Land*	2012	Wii U	Nintendo
73.	*Wipeout 2048*	2012	PlayStation Vita	Sony Computer Entertainment
74.	ATC Voice	2013	iOS, +	Looking West
75.	*Dead Space 3*	2013	Xbox 360	Electronic Arts
76.	*Mario Party: Island Tour*	2013	Nintendo 3DS	Nintendo
77.	*NBA 2K14*	2013	PlayStation 4 Xbox One	2K Sports
78.	*Need for Speed Rivals*	2013	Xbox One, +	Electronic Arts
79.	Phoenix Wright: *Ace Attorney – Dual Destinies*	2013	Nintendo 3DS, +	Capcom
80.	Super Mario 3D World	2013	Wii U	Nintendo
81.	The Howler	2013	Mobile PC	Antanas Marcelionis
82.	*Tom Clancy's Splinter Cell: Blacklist*	2013	Xbox 360, +	Ubisoft
83.	*Wii Party U*	2013	Wii U	Nintendo
84.	*Zoo Tycoon*	2013	Xbox One, +	Microsoft Studios
85.	*Alien: Isolation*	2014	PlayStation 4, +	Sega
86.	*Bot Colony*	2014	PC	North Side
87.	*Captain Toad: Treasure Tracker*	2014	Wii U, +	Nintendo
88.	*D4: Dark Dreams Don't Die*	2014	Xbox One, +	Microsoft Studios
89.	*Dragon Age: Inquisition*	2014	Xbox One, +	Electronic Arts

90.	*FIFA 14*	2014	Xbox One, +	EA Sports
91.	*Forza Horizon 2*	2014	Xbox One, +	Microsoft Studios
92.	*Kinect Sports Rivals*	2014	Xbox One	Microsoft Studios
93.	*NBA 2K15*	2014	PlayStation 4 Xbox One, +	2K Sports
94.	*Tomb Raider: Definitive Edition*	2014	PlayStation 4 Xbox One, +	Square Enix
95.	*Vita Pets*	2014	PlayStation Vita	Sony Computer Entertainment
96.	*Wolfenstein: The New Order*	2014	PlayStation 4 Xbox One, +	Bethesda Softworks
97.	*In Verbis Virtus*	2015	PC	Indomitus Games
98.	*Mayday! Deep Space*	2015	iOS	Iron Cloud Entertainment
99.	*There Came an Echo*	2015	PC, +	Iridium Studios
100.	*3Souls*	2016	Wii U	Red Column
101.	*Chant Savant*	2016	PC	-
102.	*The Legend of Zelda: Spirit Tracks*	2016	Wii U, +	Nintendo
103.	*Chicken Scream*	2017	iOS	Perfect Tap Games
104.	*Insane Screaming Mayhem*	2017	PC	-
105.	*Resonance: The Lost Score*	2017	PC	-
106.	*Scream Go Hero*	2017	Android, iOS	Ketchapp
107.	*Drivetime*	2018	Android, iOS, Amazon Alexa	Drivetime
108.	*Jurassic World Revealed*	2018	Amazon Alexa	Universal Studios Interactive
109.	*Kid's Court*	2018	Amazon Alexa	Pretzel Labs
110.	*The Broken Seal*	2018	PC	XAREA
111.	*The Vortex*	2018	Amazon Alexa Google Assistant	Doppio Games
112.	*WarioWare Gold*	2018	Nintendo 3DS	Nintendo
113.	*Question of the Day*	2019	Amazon Alexa Bixby	Matchbox.io

114.	*The Division Network*	2019	Amazon Alexa	Ubisoft