

'FO FIGHTER

2D Real-Time Game

Graphics Senior Project

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Abstract

‘FO Fighter is a 2D real-time game for Android and iOS mobile devices. The game utilizes the motion sensors and touch screens built within these devices to give the player a great amount of control over their character’s position and firing direction. This control allows for a reactive environment set in outer space, where gravity is determined by the device’s orientation, while the player must dodge, fight and destroy multiple enemy fighters on each planet in the solar system. ‘FO Fighter has been tested throughout its development cycle on numerous devices on both the Android and iOS platforms, with testers including pre-adolescents and young adults with various levels of gaming experience. The result is a functioning prototype that engages the user with a tutorial and three fully-formed levels.

Introduction: Problem Description and Motivation.

Historically, video games have been seen as a hobby for kids and young adults, and these games were designed to suit their audience. In recent years, the smartphone market has boomed and created an entirely new market of mobile gaming. Smartphones and tablets are now in the hands of billions of people spanning multiple generations, bringing video games to a much wider audience. Some of the most popular mobile games utilize innovative new controls based on the multi-touch screens and tilt gestures ubiquitous on smartphones.

However, many games appeal to this wider audience who are not necessarily accustomed to a more traditional style of real-time gameplay. Popular games like Angry Birds or Candy Crush are turn-based games, which do not require much user feedback or interaction throughout gameplay. Other real-time games like Temple Run or Geometry Dash simplify the gameplay by having the player constantly move in one direction, leaving the player's duties to avoid obstacles or collect objects. In a large majority of console games, the player is given a lot of control, like where to move, where to look, and when to shoot. 'FO Fighter seeks to bring console quality visuals and control to a smartphone; with innovative uses of the smartphone hardware to make it exciting, addictive and entertaining.

Overview of Project

Genre and Setting

'FO Fighter is an arcade game that caters mainly to experienced video game players. Previous experience with video games will allow new users to start enjoying the game quickly, but it is not intentionally prohibitive to more casual users of smartphone games. Development focused on creating a fast-paced, challenging game with plenty of visual and audio feedback. The ultimate goal was to embed the experience of a classic arcade game with the rich visual feedback and challenges from a console game into a smartphone device.

Objectives

The object of the game is to traverse through the solar system in a UFO device that has weapons capable of destroying enemy ships. Points are collected for each ship that is destroyed. For each level of the game, the player must shoot at the enemy ships until they are all destroyed.

Depending on the strength of the targeted enemy ship, several shots may be necessary to destroy it. Once all enemy ships have been destroyed, the player may advance to the next level. There is a set of levels for every planet in the solar system. The player must defeat all levels in order to win the game. The game is saved after every level and can be paused during a level so that the player can play at their leisure.

Look And Feel

'FO Fighter aims to recreate the look and feel of classic arcade style games in a modern era. The game utilizes bold cartoony artwork and 8-bit sound effects for nostalgic effect. High resolution images and special effects give the game a modern throwback style. While the planets and enemy ships are colorful to grab the user's attention, the background is dark with stars which make it easier on the eyes to look at the screen for extended periods of time while playing the game.

Story

The current story for 'FO Fighter is the player follows the perspective of a UFO pilot as it traverses through the solar system, destroying the crew and leaders of enemy squads. This story will likely undergo some embellishment in order for the player to have more connection with the UFO pilot.

The game is developed in Java, utilizing the LibGDX [1] Java game development framework. LibGDX includes many useful tools for 2D and 3D game development, and allows for easy deployment to desktop, Android, HTML, and iOS environments. The iOS version also utilizes RoboVM [2], a tool which allows for Java to native Objective-C code conversion. This

allows for all deployable platforms to share the same code base and have the same expected outcome. Two libraries also used are the Universal Tween Engine [3] and bloom-lib [4]. The Universal Tween Engine is used to generate and apply smooth, time-based equations for any desired numerical value. This library can be seen in use for player size, enemy size, and planet size and position. The bloom-lib is a small library to apply a bloom effect to images on-screen. This library is currently in use on the particle effects, as well as the blurred, colorful background while in the options menu.

Previous Work/Related Work

‘FO fighter draws inspiration from several similar genres. Many of these games are known for bringing innovation, visual appeal, and challenging game play to the gaming world. Elements of these popular games have influenced ‘FO Fighter’s design in multiple categories. Some previous works include an Android game called Cat’n’Mouse and an older version of ‘FO Fighter. These previous works created the desire to continue developing ‘FO Fighter into a challenging game with great visual appeal and innovative use of the hardware found on most smartphones and tablets.



Figure 1 – Galaxy Monkey from Ape Escape

Figure 1 is a screenshot of “Galaxy Monkey,” one of the three included mini games included in “Ape Escape” for the Playstation 1 console. “Ape Escape” is critically acclaimed for its innovative use of the DualShock analog sticks on the Playstation 1 controller [5]. One of their innovative uses of the analog sticks is apparent in “Galaxy Monkey” (Figure 1). The left analog stick controlled the player UFO’s direction on a 2D space, while the right analog stick controlled the direction of the player’s lasers. The analog sticks allowed the player to have smooth, continuous control over the player and its actions.

The tilt and touchscreen control scheme in ‘FO Fighter aims to establish a control scheme as native and fluid for the smartphone platform as the analog stick controls for “Galaxy Monkey.” Galaxy Monkey also inspired the dark starry background with planets in ‘FO Fighter to help enemies and dangers stand out from the background.



Figure 2 - The Binding of Isaac: Rebirth

The artwork in The Binding of Isaac: Rebirth inspired the bold, cartoony artwork in 'FO Fighter. Rebirth's artwork has an 8-bit color palette and simple geometry, but fairly high resolution images. Although Rebirth generally contains gore and earth tones, the style can still be applied to the solar space. Rebirth also has many weapon upgrades, enemies of various difficulty and difficult bosses [6]. These features haven't yet been implemented in 'FO Fighter, but are planned to be in the final version of the game.

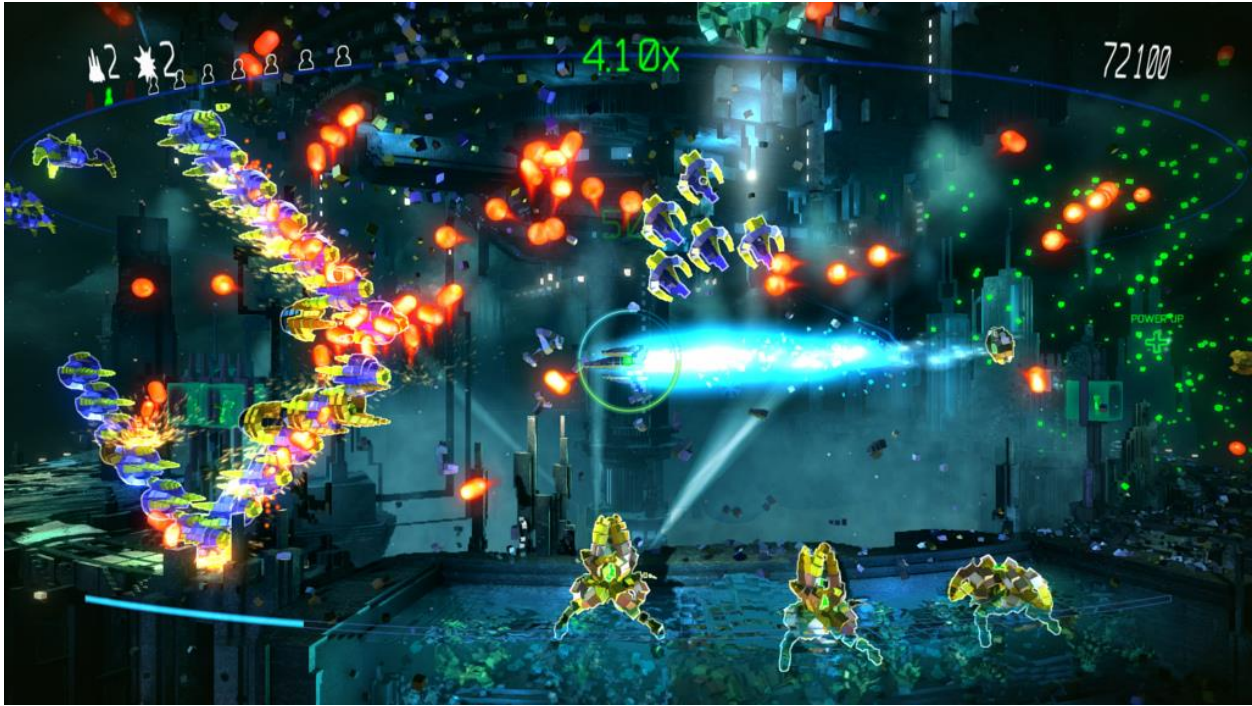


Figure 3 – Resogun

‘FO Fighter draws some of its art style from Resogun. The use of bright colors to draw the player’s attention is really important in Resogun, especially with the large number of enemies, lasers, and points on the screen [7]. The enemies in ‘FO Fighter enter the world on the left and right sides of the screen, as inspired by Resogun. Destroyed enemies drop extra points that the player can collect, which inspired ‘FO Fighter’s mechanic of dropping extra points and power ups for every enemy destroyed.



Figure 4 – Cat'n'Mouse

Cat'n'Mouse is an Android game developed with AppInventor in the CPE123 Android class. The premise of the game is to keep the mouse away from the cat which is always chasing the mouse. There was no way to win the game, just a high score of how long the player could survive. Cat'n'Mouse served as a direct precursor for 'FO Fighter, which inspired the need to have a large amount of control over a player using a technology other than fingers, and to directly drag the player around onscreen, because fingers can obstruct the player's view of the scene.

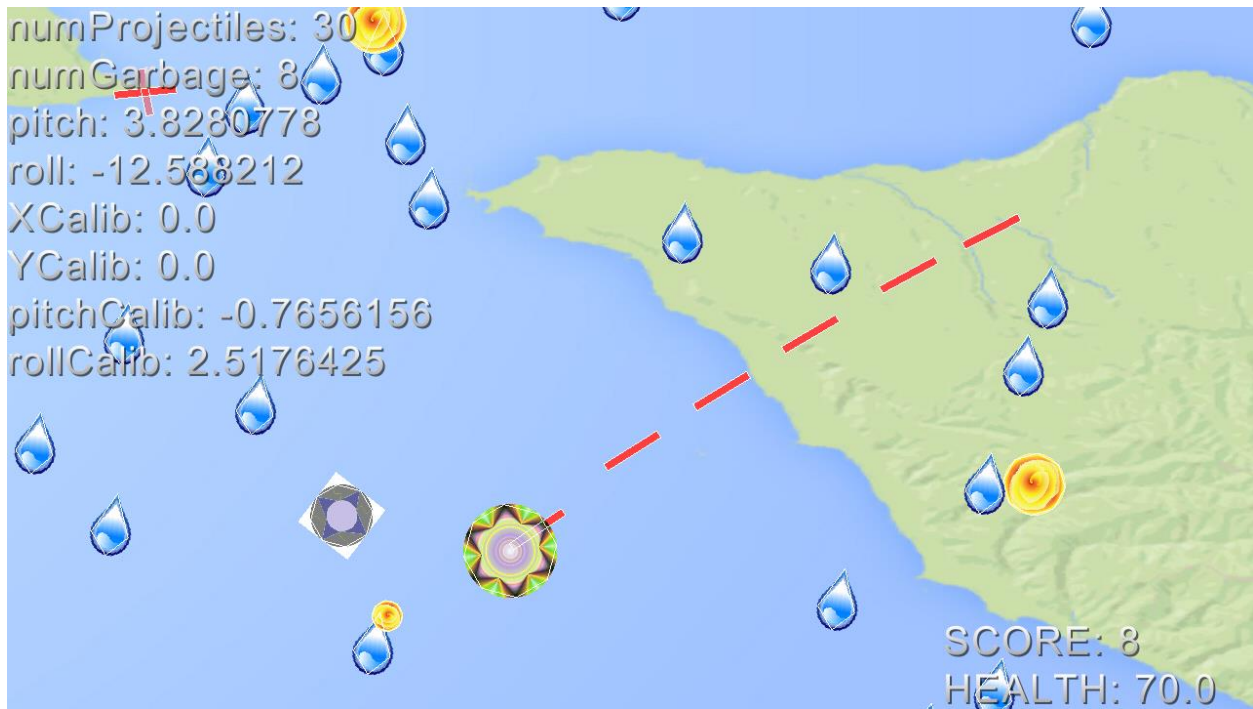


Figure 5 – ‘FO Fighter version 0.5.9.1

‘FO Fighter originally started as a personal project started on March 1, 2014. After nine months of intermittent development, version 0.5.9.1 served as the starting point for this senior project. ‘FO Fighter was originally intended to be based on earth, with UFOs and man-made machines attempting to destroy the protagonist. Since this starting point, development focused on the visual and audial interaction with the player, as well as planning level design, level selection, and overall style of the game.

Algorithm

Overview

The player controls the UFO by tilting the smartphone in the direction they want to move. This tilt motion also changes the gravity in the world, causing objects and some enemies to be

drawn towards the location where the UFO is. Using multiple fingers, the player can tell the UFO to shoot lasers from the UFO towards the pressed fingers. The player traverses through levels on each planet, destroying all of the enemy ships. At the end of every level, the player is given a score for how well the player completed the level.

Shooting Mechanic

In game design, it is important to have precise controls that the player can understand and utilize in order to be successful at a game. Having controls that don't feel responsive, or may result in unintended actions, will frustrate the player. The shooting mechanic for 'FO Fighter is no exception. When a player's touch is registered, a laser should spawn from the player's UFO and move in the direction of the registered input, regardless of screen size of the device. The registered touch is translated from screen coordinates, into world coordinates according to the current viewport. Then, the angle between the UFO's position and the touch position is calculated, and used to spawn a laser which will move with this desired angle.

For 'FO Fighter, the goal was to take full advantage of the multi-touch screens on smartphones. The player's UFO may fire any number of lasers in the intended direction, and it is important for these lasers to be spaced out away from each other, yet still originate from the UFO regardless of the UFO size, and move in the intended direction. The total number of lasers to be fired, the size of the UFO, and the locations of all fingers all dictate the firing procedure. The total number of lasers is first divided evenly across all fingers, ensuring that any remainders are still accounted for and applied evenly. Then, using the UFO size and number of shots for a given finger, a spacing interval is determined to generate an even and centered arrangement of laser starting positions, no larger than the size of the UFO. Using the angle between the UFO and

touch position, the arrangement of lasers has a velocity applied which matches the calculated angle. This algorithm has no limit for the total number of lasers, the total number of fingers, or the size of the UFO. However, many touchscreen devices have a limit on the number of fingers that can be registered at a given time, and a person generally has only 10 fingers. For this reason, the total number of fingers to be accounted for has been artificially limited to 10.

Results

For this project, the game was developed to include sprites which interact and collide with each other, with three levels, supported by a vivid cohesive art style and smooth reactive controls. The result of this project is a fully functional proof of concept that can be expanded upon, featuring an 8-bit throwback style, physics simulations, and operates on both Android and iOS platforms. Although many technologies are implemented and fully functioning, some technologies are particularly notable for this project.

The player has a few settings available to them upon starting the game. They can navigate around the planet select screen and select any planet or level they wish to play. Many of these choices have animated transitions to create a fluid contextual experience for the player. The game utilizes viewports and scaling to fit the game screen on any device, regardless of resolution or aspect ratio. This allows the game to have a very consistent experience across many devices.

The player controls the gravity in the level with the position of the UFO. This gravity causes the world to be a very reactive world, encouraging players to be strategic with their movements. For example, the player may inadvertently cause an enemy ship to move much

faster, making it much harder to hit and to avoid. The player must be cautious with their movements, and stay towards the center of the screen to avoid affecting gravity.

The image assets for this game were created by Danielle Dobeck. She has done a masterful and amazing job making a cohesive set of unique images of recognizable planets, distinct enemies, and dark starry backgrounds. The graphics were designed to enhance the appearance of the game and allowed the developer to focus on refining gameplay and other visual and audial improvements.



Figure 6 – Main Menu Screen

The main menu screen has a close up shot of the player's UFO, with its three layers spinning at different rates. This UFO contains a bottom light layer, seen as the red in the image, an inner circle, and an outer circle. The background and title screen both move according to the

orientation of the device, creating a 3D effect to the world. The player can choose some basic game options like disabling music or sounds before entering the planet select screen. When the player pushes on the start game button, the UFO shrinks down to regular size and the buttons and title fade away. The player can come back to this screen from the planet select screen to change these options. These options are planned to be added inside the pause menu so that the player doesn't have to quit a game in order to change settings. The look of the buttons and title may change before final release because they currently blend in too well with the UFO.

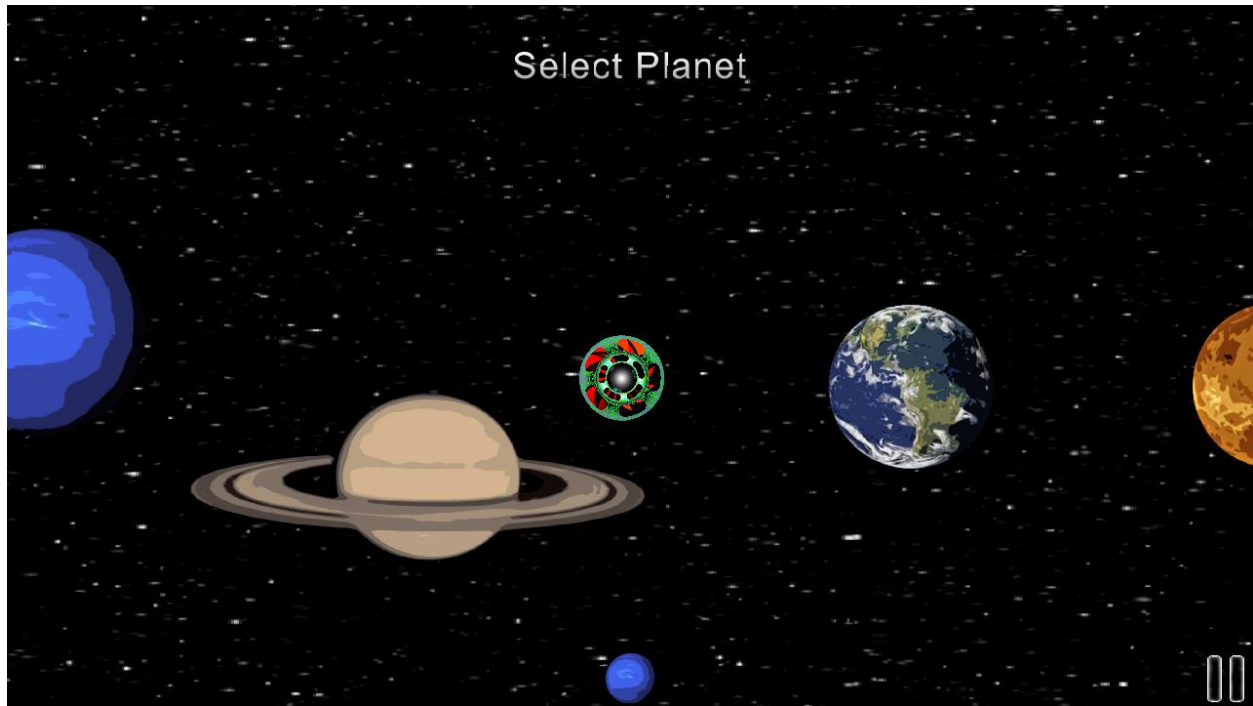


Figure 7 – Planet Select Screen

The planet select screen has many of the in-game components built in. The player can practice their skills in this mode as they would when playing a level, with the added mechanic of scrolling through the planets by tilting in the desired direction. This allows for the player to become more familiar with the controls and to hone their skills. The player can tap on the desired

planet, which will center the planet on the screen, provide a description of the planet, and allow the player to select a level to play. The star field is comprised of three image layers that have different sensitivities to tilt and UFO position, creating a 3D effect of the background of the game. The heads up display (HUD) controls can be seen along the bottom of the screen. These buttons currently include a pause button, and a button for debug purposes. The pause button will suspend the game and display a menu, where you can resume, exit, or reset the level. The HUD is planned to be used to toggle weapons or fire bombs, which are currently not implemented.



Figure 8 – Neptune: Multiple Lasers

When inside a level, enemies will come from the left and right sides of the screen, heading towards a player. Enemy UFOs will bounce around the screen being influenced by gravity, while enemy fighter planes will fly towards the player. In figure 8, the player can be seen firing two streams of lasers in independent directions. This is the shooting mechanic in

action, dividing the player's number of lasers (in this case two) to the number of fingers (also two), and firing independent streams for each finger. The levels have the selected planet centered in the background and also utilize the same three image layers to provide a 3D feel during gameplay. The HUD described in the planet select screen is also used inside the level. When an enemy is destroyed, they have the chance of dropping a power up. Currently, the only power up is a health increase, but more upgrades are planned to be made in the game.



Figure 9 – Saturn: Getting Injured

When the player becomes injured, the translucent background will flash red to tell the player that they are receiving damage in addition to sound and vibration cues on the device. A similar screen flash in green will occur when the player becomes healed. The player and enemies

will also flash yellow and orange to indicate they are receiving damage. In figure 9, both the player and the enemy fighter plane are receiving damage due to colliding with each other, causing both of them to have a yellow tint in this case.

One concern during development was the concern that the game would cause the player to have poor posture. An article on CBS News describes how smartphones are causing back pain due to poor posture, and 'FO Fighter would likely contribute to the problem [8]. A chiropractor also noted how the increased strain of holding a device up and away from the user can cause adverse effects on the hands and arms. He recommended bringing the device as close to the user as possible to avoid any extra strain on the arms.

Player Feedback

'FO Fighter was tested throughout its development cycle across numerous devices on both the Android and iOS platforms. Player testing and feedback has been summarized on each phase throughout development. Both new and previous testers provided feedback, providing insight from both an as-is experience, as well as how well the game has progressed. Testers include college-age students, young professionals (late 20's), and pre-adolescents, with various levels of gaming experience.

| Phase | Pros | Cons | Recommendations |
|------------------|-------------------|---------------------------|----------------------------------|
| Quarter 1 Week 1 | Working prototype | Graphics are not artistic | Develop basic story and location |
| | | Graphics are not | Replace temporary |

| | | | |
|--|--|----------|--------------------|
| | | cohesive | helicopter graphic |
|--|--|----------|--------------------|

| Phase | Pros | Cons | Recommendations |
|---------------------|--|--------------------------------------|--|
| Quarter 1 Week 7-10 | <p>Added more visual effects: particles, transitions, color flicker on damage</p> <p>Many actions have sounds now</p> <p>Ported to iOS</p> <p>Graphics more cohesive</p> | No ability to select planet or level | <p>Add level select screen</p> <p>Add tutorial</p> |

| Phase | Pros | Cons | Recommendations |
|------------------|---|---|-----------------|
| Quarter 2 Week 1 | <p>Added level selector</p> <p>Partial tutorial –</p> <p>Testers read directions although directions were incorrect</p> | <p>Enemies getting stale, need more content</p> | |

| Phase | Pros | Cons | Recommendations |
|--------------------|--|--|---|
| Quarter 2 Week 4-7 | <p>New enemy design</p> <p>New sound effects</p> <p>Starting to feel like a full game</p> <p>Can't wait for the next version</p> | <p>Level select screen felt more like a level with dangers</p> | <p>Add "Select Planet" title to level select screen</p> |

| Phase | Pros | Cons | Recommendations |
|-------------------|--|--------------------------|---|
| Quarter 2 Week 10 | <p>Very polished, reactive experience</p> <p>Visual and audial cues help with smaller screen sizes</p> <p>Found visual style</p> | <p>Not much gameplay</p> | <p>Multiple control schemes for user preference</p> |

The most common comment from player feedback is how well the game experience is progressing and how visually it is becoming more cohesive and polished. Another common sentiment is that the gameplay is fun in its current form, and more content will improve an ongoing experience.

One of the most controversial features is the use of tilt-controls for controlling the player movement. While some players have taken the time to get used to the tilt-controls and enjoy the accurate and intuitive controls, other players would prefer more traditional forms of control, such as joystick controls reminiscent of modern gamepads.

Before their first time playing the game, many players also ask about the problem of fingers blocking the player's view of the screen and possibly oncoming enemies. There isn't as much concern after playing a few levels, once players learn where enemies tend to come from and adapt their view and finger positions to prevent this scenario. Still, this may be a concern for other players, and likely should be addressed by giving the player an array of options to best suit their preferred play style.

Future Work

Although much progress has been made with 'FO Fighter, there are still many goals and features for the future. While what is currently done is a great proof of concept for the technologies that have been implemented, the experience should be expanded upon and diversified.

Because players prefer different control schemes, it would be impossible to have a single control scheme and expect all potential players to enjoy the game. Giving the player a choice of

control schemes would be the best choice, and would allow for players to determine their favorite control schemes. There are currently two versions of control schemes implemented in the game. These include using tilt-controls to move the player, and using a finger to drag the player. Adding a joystick on the screen will give players an alternative to the current controls and give the player a chance to choose their favorite mode of play. The joystick controls may also address concerns over a player's fingers blocking the screen, as well as allow players to use devices with larger or smaller screen sizes and have a more consistent experience.

'FO Fighter will eventually have levels for the entire solar system. Currently, there are only levels for three planets. To prevent players from finishing the game in minutes, the levels could be made harder, but risks losing the player. Having more levels can also offer a more diverse set of enemies, challenges, and play styles to keep the player challenged and entertained.

There are currently a relatively small number of enemies in the game, although many more have been conceptualized. Having a diverse group of enemies to choose from would greatly help in creating levels with different gameplay, challenges, and overall feel, as well as keep the player's attention. In addition, each enemy will have different difficulty levels, and will be denoted by the overall color of the enemy. This will further expand the set of available enemies and make the game more diverse and challenging.

Players like to have a grand finale battle to give them more challenge and sense of accomplishment. The introduction of a boss at the end of every planet level would give the players a final challenge for each planet and ensure that they are worthy for the encounters ahead. The fight would last much longer than it would with a single enemy and would require

more strategy than just point and shoot. Bosses would have weak points that the players should aim for and would keep the player guessing what it will do next.

Many games have a story to tell. 'FO Fighter doesn't have a well-developed story at the moment. Players like understanding the world around them and become fully immersed in the story and accomplish the goals of the story. The story will discuss the purpose of the player's mission to go to every planet and destroy enemy fighters.

Once the player finishes the story, there currently wouldn't be much replay value. Adding an endless arcade mode to try and get the highest score might be exciting and an endless way for the player to have fun. This arcade mode can also be more random and get more difficult, allowing only the most skilled of players to progress further and get a higher score. This mode could reuse many of the enemies and bosses that the player fought against while in the story mode, and could provide limitless combinations of enemies for the player to face.

Multiplayer was one of the original goals for 'FO Fighter but it was put aside to focus on the core mechanics and experience of the game. Many mobile games utilize social competition such as leaderboards, challenges, trophies, and multiplayer gaming in order to make the game a social experience. Multiplayer for 'FO Fighter would likely use leaderboards for the single-player campaign and multiplayer combat. Synchronizing game state between devices may be too difficult and cause a poor gaming experience, so multiplayer combat may not make it into the final version.

While leaderboards would add some interest to revisit levels and improve upon their previous scores, there is no direct benefit to the player. To add more incentive to improve their

scores, currency will be awarded to the players depending on their success. This currency would be used to upgrade their ships and aide the player in competing in the harder levels in the game. This could also allow for those who struggle with the game to replay a level multiple times to improve their skills and accumulate currency to upgrade their ship and overcome any challenges without as much need to improve their skills. Any time put in will be a benefit to the player.

In the best interest of the player, a help section on the best posture for holding the game device while playing the game may be added. Enjoying a game should not cause users discomfort, and 'FO Fighter would like to help its players as much as possible. Timers to remind players to stretch or relax may be very beneficial. It will be important to gather more advice from chiropractors and relay that information to benefit the players.

Ultimately, the plan is to release 'FO Fighter for Android and iOS devices in their respective marketplaces. Many if not all of the improvements mentioned above will be implemented before release, so that a large group of people can enjoy the game.

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