Game Lab I Project - Gravity Boots

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***Abstract*—This paper describes the development process of the video game "Gravity Boots". It names the main inspirations, illustrates the core concepts of the project and explains the refinement process of certain aspects of the game. Finally, it is discussed whether the goals were achieved and how the can game can be further improved upon.**

I. Introduction

The task, given by the Game Lab I Supervisor, was to create a video-game with a unique selling point as well as a primary core mechanic. The solution the developer came up with was to combine classic elements of the "2D-Platformer" game genre with smooth movement and the challenging core mechanic of gravity-manipulation: The direction the player is being pulled to can be altered to all four orientations, namely up, down, left and right. Utilizing this mechanic in a precise and creative manner is necessary to overcome the obstacles on his way to the end of each level.
Another goal in mind was to ensure proper difficulty balancing to make the game accessible to the highest amount of people without making the game too easy, with the intention of creating a game that casual players as well as long time gamers can enjoy. In order to achieve these goals a survey has been conducted to obtain the feedback of a number of participants according to the perceived difficulties. By means of multiple playtesting-iterations and survey analysis each aspect of the game has been further refined.

II. Related Work

A. Super Mario Franchise

Super Mario [1] is a franchise so well known that any further introduction seems redundant. Its Super Mario Bros[2] game was one of the earliest 2D-Platformer games and is credited for laying out the foundation of the entire genre. A lot of games were inspired by the classic platformer elements present in Super Mario Bros, such as the principle of clearing level by level, collecting valuables and overcoming obstacles on the path to the finish. "Gravity Boots" is no exception since its core level design and game principles are similar to those in Super Mario Bros.

B. Rick and Morty

Rick and Morty[3] is an animated science fiction tv-series, whose main protagonists are the mad scientist Rick and his grandson Morty. In the first episode of the show, Rick gives his grandson one of his inventions: Grappling shoes. These shoes allow the wearer (if used correctly) to walk on any surface: ground, walls and ceilings alike. While this is not precisely what the gravity boots in the Game Lab I project allow you to do, it was the main inspiration for the game's core mechanic nonetheless.

C. VVVVVV

VVVVVV[4] is a fast paced 2D-Platformer game developed by Terry Cavanagh in 2010. The game's setting is in outer space and the player controls a roboter, alternating between upwards and downwards gravitation to get through the levels. While not portraying the main influence to the core mechanic, VVVVVV still inspired the general setting of "Gravity Boots" and was also a great resource for art- and sound-design ideas.

D. Celeste

Celeste[5] is a 2D-Platformer game, whose movement is widely considered to be among the smoothest feeling in this genre. The publicly available insights into the development process, given by the developers of Celeste, were used to improve the movement mechanics of "Gravity Boots".

III. Methodology

A. Core mechanic and player character

The core mechanic of "Gravity Boots" is gravity manipulation. The player can change the direction the character is being pulled to, allowing him to walk on ground, ceilings and walls alike, while maintaining the ability to use all of the basic movement mechanics of the game. This allows for a a huge variety of possible movement combinations, as the character is very agile and has a wide range of possible approaches to choose from. At the same time it is precisely for this reason, that players can feel overwhelmed when first starting to play the game. The attempt of trying to maintain the variety, keeping the game balanced and causing as little confusion as possible is described in the following segment.

1) *Gravity manipulation:*
The player can change the direction he is being pulled to by using the arrow-keys, each arrow represents the corresponding direction of gravity. Not only does this trivially prevent confusion, it also completely frees up the users left hand for the other movement inputs, allowing him to reach all necessary buttons without much effort. However, a balancing problem arose during development: By chaining together multiple gravity changes the player

was able to stay in the air indefinitely, basically allowing him to fly right to the finish, which resulted in the game being too easy. In order to prevent this from happening the player is only allowed to change gravity for a short period of time after leaving the ground. Afterwards all gravity changes will be ignored until he lands on the ground again. This solution maintains balance while also not lowering the skill-ceiling by taking away a fundamental movement mechanic.

2) *Basic movement:*
As in most platformer games, the player is allowed to walk as well as jump. However, in "Gravity Boots" the player can use these mechanics no matter the current direction of gravity. This allows for a lot of interesting elements, such as walking up walls or jumping downwards from the ceiling and getting pulled back up, to name a few. But the survey results showed that especially the interaction of walking with gravity caused a lot of confusion. The way it was implemented at first made it so that all walking was done with the buttons 'A' (=left) and 'D'(=right) relative to the player. As a result, the same inputs caused a different absolute movement according to the player's position, depending on the direction the gravity is pointing. To make it more intuitive the decision was made that movement inputs would be translated to be relative to the screen, where 'W' = up, 'A' = left, 'S'= down and 'D' = right no matter the player position or gravity direction, intended to make new players feel less overwhelmed.
3) *Camera:*
The game uses a 2D-Camera that follows the player position with an offset, allowing the player to see as much of the relevant level elements as possible. In order to achieve this it is necessary to adjust the offset depending on the current direction of gravity, since the position of relevant elements changes relative to the camera.

B. Level Design

Especially in a platformer game, level design is an immensely important factor, since the main goal remains the same throughout the whole game: reaching the end of the level. In order to ensure that this does not feel repetitive and stale, a way to make each level unique had to be found. Thankfully, the variety of different movement-combinations allows for a wide spectrum of possible level designs, some of which might require sheer skill and precise execution of movement inputs, while others might require the player to come up with a plan as the solution is not obvious right away. But it is also the job of a game developer to make sure that the player is neither bored nor overwhelmed by a level after unlocking it, which requires for a steadily increasing difficulty curve. In the following segment the thought-process behind the level design in "Gravity Boots" and its attempt to solve the objectives listed above is described.

1) *Tutorial:*
The first level the player starts is a Tutorial, in which all the fundamental mechanics of the game are introduced in a playful manner. The basic sequence stays the same throughout the whole level: A textbox explains the control or mechanic, after that a quest is assigned to the player, which can only be completed if he or she uses the previously explained mechanic, thus ensuring the player learned it properly.
2) *Early levels:*
After the tutorial has been finished there will no longer be any disruptions of the gameplay and the player is on his own. While the player should have learned all the necessary mechanics to beat each level by this point, one of the harder levels of the game might still overwhelm the player and eventually even cause frustration. In order to avoid this, early levels are not only relatively easy compared to later levels, but they also have a clear objective in mind: Focusing on specific mechanics one by one and increasing the players skill in this regard. Doing so is supposed to accelerate the players learn-process to make sure he is ready for the harder levels. Additionally, the diverse enemies and obstacles are introduced one by one in an relatively manageable manner in terms of difficulty.
3) *Difficulty scaling*
A high priority during the development process was to make sure the game is neither too easy nor too hard. While a game that is too hard gets frustrating over time, a game that is too easy gets boring quickly, both resulting in a less fun experience. What makes balancing difficult though is the fact that some players learn and get better at the game quicker than others. In some other genres the solution to this problem is rather obvious: Include different difficulty settings that the user can choose from. However, in "Gravity Boots" this solution was not optimal, since the levels would have to be reconstructed according to the difficulty. Instead, the means taken by the developer to solve this problem can be split into two aspects, the first aspect being an increase of level difficulty throughout the game. After the player has cleared the early levels, it is to be expected that he or she has also gotten better at the game. In order to keep the game challenging, the levels get increasingly difficult the further the player progresses.
The second aspect is putting up an extra challenge for the better players. In each level there are 3 optional coins that can be picked up by the player if he or she is up for the extra challenge. In order to make it feel rewarding to do so, the player gets rewarded visually and with audio upon coin pickup. This system attempts to allow players who have not gotten as good at the game yet to skip some challenging parts while keeping the game interesting for those who have nearly mastered it.

C. Enemy- and Obstacle- Design

Enemies are a measure of adjusting the difficulty of each level as they are the main challenge the player has to face on his or her way to the end of each level. Most of them have been inspired by other games of the genre and all of them were designed with a specific idea in mind, a certain aspect of the gameplay they aim to make harder by forcing the player to react to them in some way. Some might require careful planning, while others might require good reactions and timing. Additionally, especially the moving enemies and obstacles, aim to make the levels feel more alive and interactive. A wide variety of different traps try to help prevent repetitiveness throughout the game. In the following section similar enemies are grouped and their purpose is described.

1) *Spikes and Lasers:*
   These obstacles are as basic as it gets. Their purpose is to block certain areas of a level, creating a necessity for the player find a different path to the finish, either by making him have to jump over or by using the gravity manipulation mechanic to walk around them. Lasers are also used to block certain areas of the map altogether until certain conditions are met, for example reaching a checkpoint.
2) *Saws and Crushers:*
   Saws are deadly traps that move back and forth between two fixed points while the Crushers are enemies that rise in a fixed direction until they either hit ground or reached a certain height after which they slam down rapidly, crushing the player on hit. Both obstacles fulfill the purpose of blocking the players path - but only for a limited time window. Overcoming them requires good timing and reactions.
3) *Moving Platforms and Self-destructing Platforms:*
   Moving platforms are inanimate objects that move in a fixed direction until they hit a wall, after which they turn around and move in the opposite direction. If the player lands on them he follows their path on top of them. In order to do so the player has to wait for the right moment before making his move, Self-Destructing platforms are platforms at a fixed position that start crumbling after the player collides with them, triggering a short timer after which they are destroyed altogether, often leaving the player falling to his death. Planning the path ahead or, if that is not possible, quick decision making is necessary to survive these traps. These different types of platforms have in common, that they can replace normal ground and make it an obstacle by itself. This is especially used in the later levels of the game, where less and less normal ground is found in order to make the levels more challenging.
4) *Slimes:*
   Slimes are enemies that stick to ground and ceiling where they patrol a given area, mindlessly walking back and forth. However, if the player is nearby they instead start chasing him and in case their target is below or above them they launch themselves towards the player, killing him on impact and sticking to the new surface. Their purpose is to cover a whole area where they can react to the player, forcing caution when crossing their path but at the same resulting in a more lively environment in the game.

D. User Interface and Visualization

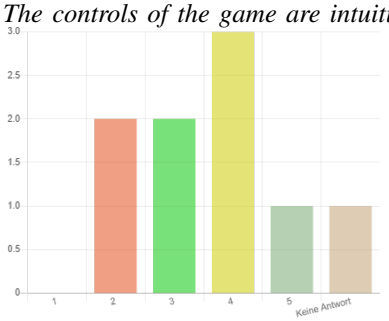
Early playtest results have shown, that the core mechanic of the game can be rather confusing when starting to play the game. In order to help the player get used to the new mechanic quicker, an arrow that always points to the current direction the player is being pulled to was added. It is located in the top left corner, just big enough to be clearly visible without disturbing the view of the level. As described earlier, coins were added as a way to scale difficulty indirectly by rewarding players that push the game to its limits. To further increase the subjective significance of the coins collected, an interface was added to the top right corner of the screen that always shows the player which collectables of the current level he has already collected and which he is missing. Additionally, if a player did not collect all collectibles in his first play-through, but decides to replay the level, the placeholders at the top of the screen keep track of the current process, which helps figuring out which coins are still missing. These star-interfaces were also added to the Level-Select-Screen where the player has a compact overview of all the stars he collected.

IV. Results

In the following section the results of the final playtest iteration as well as the results of the survey will be described. The volunteers were given a test-version of the game consisting of the tutorial as well as 3 other levels. Players would usually start off the game by moving around with the basic movement controls before starting to experiment with the gravity change mechanic. It was not uncommon to see players loose control of their character after changing gravity for the first few times, often resulting in some early respawns. After completing the tutorial though, most players seemed to have a rough grasp on how the game was intended to be played, managing to get through the first level with rather few restarts. In the remaining two levels there seemed to have been a significant spike in failures, especially in parts where horizontal gravity was required. Nonetheless, most playtesters managed to beat all the levels of the test version, some quicker than others.

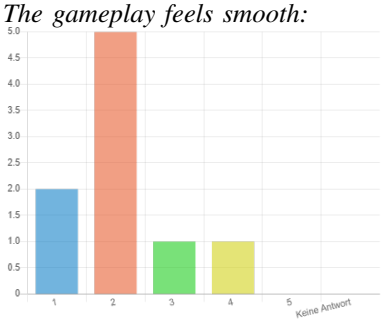
The main goal of the survey was to find out if players can get used to the core game mechanic without too much effort, if the level difficulty is appropriate and if the movement mechanics feel smooth and natural. The survey had 9 participants and the 3 most significant questions in regard to the objective of the project will be listed below with their answers plotted.

1) *The controls of the game are intuitive:*



2) *The game was too hard:*

3) *The gameplay feels smooth:*



V. Discussion

The following segment is an attempt at interpreting the playtesting results in regard to the main objective of the game, namely creating a game that merges classic platformer elements with the challenging mechanic of gravity-manipulation while maintaining a good difficulty balance as well as a smooth gameplay experience.

When asked whether or not the controls of the game were intuitive a total of four out of nine participants either disagreed or strongly disagreed, which might hint at a confusing interaction of the movement commands and the gravity mechanic. The fact that during the playtest more people died while using horizontal gravity in comparison to vertical gravity reinforces this assumption further. The answers to the question whether or not the game was too hard were as follows: no participants strongly agreed, one participants agreed, two were neutral, four disagreed and two strongly disagreed. Since not every player learns at the same rate as the others and the playtesting time was rather short this discrepancy was to be expected. These answers combined with the fact that most players were able to complete all levels of the playtest might suggest that the game is rather beginner friendly and thus can appeal a broad audience. It can only be speculated upon if the difficulty scaling measures taken after the playtest will succeed in providing enough of a challenge for the players who are seeking a hard game. When asked whether or not the gameplay feels smooth, two participants strongly agreed, five agreed, one was neutral and one disagreed. These answers suggest that the game was successful in achieving one of its primary objectives, providing smooth movement and gameplay experience. Before drawing the conclusion it should be noted that the playtest as well as the survey was done on an older version of the game and a lot of the issues that these results hinted at have already been addressed as described in III. Methodology. If these changes cause their desired effect then the core objectives of the project were mostly successful, otherwise especially the movement commands but also the difficulty scaling requires some further improvement.

VI. Future Work

The conclusion drawn in the discussion above suggests, that while some goals were fulfilled to an acceptable degree, others might require further improvement. Especially the rework of the basic movement commands requires further exploration in a new playtesting iteration, as ensuring intuitive controls is essential for any game. It is also possible that the game might benefit from adding a storyline to the game, which is something that was not possible due to lack of time, resources and scope. However, doing so would help putting the events of the game into a better context, which might bring the player to identify with the character, thus increasing the engagement and long time motivation of the users. Furthermore, additional levels could be added to the game, since not content and creativity were a limiting factor, but time. This would significantly increase the time it takes to complete the game resulting in a broader experience and leaving more room for better difficulty scaling. This would allow for more opportunities to prepare the player for the later and more difficult stages of the game by increasing the number of repetitions in easier levels. Lastly, at the moment the end of the game seems rather sudden, as there is no special event in the last level, meaning other than the higher difficulty there is nothing that informs the player that his playthrough is nearing the end. One possibility for such an event might be a boss-battle, meaning in the last level the player has to defeat a difficult enemy in order to finish the game. While certainly even more possibilities for improvements exist, the aforementioned ones appear of the highest priority, since they portray the greatest potential to further the quality of the gameplay experience.

References

[1] Super Mario, Nintendo EAD (1985–2015) / Nintendo EPD (since 2015), franchise
[2] Super Mario Bros, Nintendo, 1985, video game
[3] Rick and Morty, Adult Swim, 2013, tv series
[4] VVVVVV, Terry Cavanagh, 2010, video game
[5] Celeste, Matt Makes Games, 2018, video game