

Aim Assistance in Video Games: A Review of Techniques for Accessibility and Player Support

Milos Kostic¹[0009-0005-0912-9518], Emilija Kisic¹[0000-0003-3059-2353],
Miljan Milosevic^{1,2}[0000-0003-3789-2404], Nemanja Zdravkovic¹[0000-0002-2631-6308]
and Petar Pejic¹[0000-0003-4155-8038]

¹ Belgrade Metropolitan University, 11000 Belgrade, Serbia

² Institute for Information Technologies, 34000 Kragujevac, Serbia

milos.kostic@metropolitan.ac.rs
emilija.kisic@metropolitan.ac.rs
miljan.milosevic@metropolitan.ac.rs
nemanja.zdravkovic@metropolitan.ac.rs
petar.pejic@metropolitan.ac.rs

Abstract. Competitive video games, especially First-Person Shooters (FPS), often suffer from skill inequality that can influence and potentially reduce enjoyment for less skilled players. The use of algorithmic techniques to help with targeting process, has shown to be a reliable solution to subtly balance gameplay. This paper presents a detailed review of the state of aim assistance research. Paper begins by establishing the theoretical foundation of challenging aiming process, described by Fitts's Law. Core adaptive techniques used in both 2D and 3D environments, including bullet magnetism, area cursor, sticky targets, and target gravity, are reviewed and explained by combining the findings from multiple studies. The review examines the application of these techniques in both commercial and research applications, their effectiveness and their impact on player experience and skill development. Research shows that techniques like bullet magnetism and area cursor, can effectively improve score difference between players of different skill levels without being too noticeable, leading to a more competitive and enjoyable player experience. The paper concludes by discussing and identifying open challenges and potential future research directions, such as machine learning-based aim assistance designed for improving shooting games gameplay inclusivity.

Keywords: Aim assistance, Target Assistance, Accessibility, Video Games, Game Balancing.

1 Introduction

Online multiplayer video games represent an important social and competitive platform for millions of players worldwide. Main challenge in this domain is maintaining balanced and enjoyable gameplay when participants possess varying skill levels and control game with different control types. Any major skill gap between players can often easily lead to frustration for novices and a lack of motivation and challenge for experts, which may potentially cause players to give up [1]. This problem is most noticeable in First-Person Shooter (FPS) games, where precise aiming is a core game mechanic.

Traditional balancing methods, such as matchmaking systems that group players of similar skill, are not always feasible, especially in casual session played by friends

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with different skill levels or in smaller indie games. An alternative approach, which has gained traction in both commercial games and academic research, is the use of so called aim assistance or target assistance. Vicencio-Moreira et al. define aim assistance as "algorithmic changes that alter the accuracy of targeting movements" [2]. These techniques are not developed to replace player skill but to subtly augment the abilities of less capable players, and narrow the performance gap while making the game more competitive and enjoyable for all participants [3].

The use of targeting assistance is already common in console gaming (e.g., the Halo and Call of Duty series) to compensate for the lower precision of gamepad analog sticks compared to a computer mouse [4, 5]. However, deliberate use of assistance as a dynamic balancing mechanic is more novel approach. A series of studies has systematically explored how different assistance techniques can be applied to balance gameplay and improve player inclusivity [2,3,5].

This paper combines research findings to provide a comprehensive review of aim assistance for competitive balancing and their application for accessibility. We begin by outlining the theoretical principles of human motor performance that underpin targeting tasks. Paper explains the core aim assistance techniques, categorizing them by their fundamental operating principle. We examine spatial and temporal assistance methods, analyze their effectiveness across different contexts, and identify future research directions, particularly regarding machine learning-based adaptive systems.

2 Theoretical Foundation

Aim assistance and Targeting assistance techniques are based on human motor performance model known as Fitts's Law [6, 7]. Fitts's Law is a predictive model that states the time required to rapidly move to a target area is a function of the distance to the target and the size of the target. The binary index of difficulty (ID), defined by Fitts is calculated as

$$ID = \log_2 \left(\frac{A}{W} + 1 \right) \quad (1)$$

where A is the amplitude (distance to the target) and W is the width (size) of the target. A higher ID value indicates a more difficult targeting task, resulting in a longer movement time.

The underlying process of selecting a target based on research involves three phases [11]: an initial "ballistic motion" where the user rapidly moves the pointer towards the target, a "corrective phase" where finer adjustments are made to align the pointer with the target, and a final "acquisition phase" where the selection action is performed. Aim assistance techniques function by artificially manipulating the parameters of Fitts's Law, either the effective amplitude (A) or the effective width (W) - to lower the index of difficulty and help in one or more of these phases [8].

Balakrishnan [8] organized assistance techniques into three groups based on which parameter they manipulate: techniques that reduce the amplitude, techniques that increase the width, and techniques that manipulate both. This conceptual framework offers a useful lens for understanding how different algorithms fundamentally alter the targeting task to make it easier. All aim assistance, in 2D and 3D game worlds, operates on these core principles. [9, 10]

It is also worth mentioning that players with disabilities encounter significant challenges when playing video games and they are often excluded from participating due to physical limitations. Shooting games especially demand higher levels of motor, sensory, and cognitive skills, and they are not often designed with accessibility in mind. Players with disabilities may face: motor challenges (difficulty maintaining steady aim, articulating precise movements, and responding quickly to threats), temporal challenges (limited reaction time for detecting and engaging targets), fatigue (extended gameplay sessions may increase motor control difficulties), and problems with multiple simultaneous inputs (many games require coordinated use of multiple controls). These challenges result in lower participation rates among players with disabilities [2, 9, 11-13], highlighting the need for effective assistance technologies.

3 Aim Assistance Techniques

In this section, we look at the key aim assistance techniques from previous research. We describe how each technique works, its connection to Fitts's Law, and its known advantages and disadvantages.

3.1 Assistance Through Width Manipulation

These techniques function by effectively increasing the target's size, either in visual space, motor space, or the activation logic, thereby making it easier for interaction.

Area Cursor - Instead of a single-pixel cursor, the area cursor technique expands the cursor into a larger square or circular area [14]. Aiming dot/crosshair is pointing at the target if any part of this larger cursor area overlaps the target position. In a 3D FPS context, this is implemented by using a larger projected rectangle for bullet collision detection instead of a single raycast [2, 5]. In typical implementations, the crosshair radius grows with assistance level, for example: $\text{radius} = 10\text{px} + (5\text{px} \times \text{Level})$, where Level ranges from 1 to 10 [5, 17]. In terms of Fitts's Law, this directly increases the target's width (W), lowering the index of difficulty. Studies have found that this technique helps older adults and users with motor impairments target more effectively [15]. The main issue is what happens when several targets overlap with the larger cursor area—the system needs some way to figure out which one you're aiming for. The usual solution is to select the target nearest to the cursor's center [5], but there's always a risk of hitting multiple targets with a single shot which is not a valid game behavior.

Bullet Magnetism - Exclusive to shooting games, Bullet Magnetism "bends" the trajectory of a fired projectile towards a nearby target if the initial shot was within a certain activation range [2, 5]. Conceptually, this is similar to increasing the target's width, as it allows players to hit targets without perfect aim. It does not move the player's crosshair or change the control-display ratio, making it less intrusive than other methods. When a target is within a defined range (e.g. 160 units \times Level), the bullet vector is adjusted toward the nearest opponent [5, 17]. The level of assistance can be varied by adjusting the activation range and the strength of the "magnetic" pull. A significant drawback is that it can be attracted to the wrong target in cluttered environments, and players may feel a lack of control if a target they did not intend to hit is struck accidentally [5]. The technique is widely used in commercial games including "*Halo*" and "*Gears of War*" series.

Sticky Targets - This technique operates by manipulating the control-to-display (CD) ratio when the cursor is over a selectable target [16]. The CD ratio defines how input device movements map to cursor movements on screen. When the cursor reaches a target, reducing this ratio requires larger physical movements for the same cursor displacement. Users experience this as a sticky or friction-like sensation around the target. In Fitts's Law terms, this effectively increases the target's width in world space [3], facilitating the corrective phase of aiming by making fine adjustments easier. Sticky Targets are common in console FPS games under names like "reticule magnetism" [4]. A potential issue is "overshooting": as the player moves off a target, the stickiness ceases, which can cause an unexpected acceleration and make it difficult to transition between closely spaced targets [4].

3.2 Assistance Through Amplitude and Hybrid Manipulation

These techniques are based on reducing the effective distance between cursor and target while aiming or combining amplitude reduction with other assisting effects.

Target Gravity - This technique creates a magnetic effect that draws the player's crosshair toward targets that are close by [3]. It is a steady, passive effect that introduces subtle warping of the cursor's path. Like the Sticky Targets approach, it helps player in the phase of aiming correction before performing the shot. In terms of Fitts's Law, target gravity is presented as a dynamic reduction of the amplitude (A) remaining to reach the target. The implementation involves calculating an estimated average of the positions of all nearby targets and warping the cursor towards this position [5]. The strength of the gravitational pull can be tuned to vary the level of assistance which may keep the effect less noticeable to player. Gravity is only applied when the cursor is moving, preventing unwanted drift when stationary. Similar to other techniques, it can be disrupted by distractor targets. If stronger pull is applied it may cause a negative effect in player experience, because they will feel like they are not in control and that someone else is aiming instead of them.

Target Lock - The most direct form of assistance, Target Lock, involves the player pressing a button to instantly "snap" their crosshair onto the closest target [5, 18]. This drastically reduces the amplitude (A) to almost zero for the initial acquisition. Even

though it is highly effective while playing, it is considered too obvious and powerful for most competitive FPS games where aiming is a primary skill, as it largely automates the core task. It is more commonly found in other genres, such as action-adventure games (e.g. "The Legend of Zelda" and "GTA" series) [5]. Its explicit activation and high perceptibility make it less suitable for subtle balancing and it may be considered as cheating by some players.

3.3 Temporal Assistance Techniques

Researchers have studied spatial assistance extensively, but temporal assistance is still relatively unexplored. Temporal aiming problems occur when players have good spatial aim but shoot too early or too late, particularly when targets are moving quickly. Published temporal assistance research is quite limited, which represents a significant research gap.

Comet Variant - The Comet technique extends the Area Cursor concept by increasing target size in the direction opposite to its movement [19]. This creates a "comet tail" that compensates for clicking too late. Advantages of this approach is addressing timing errors and it can easily be combined with standard Area Cursor assistance. Unfortunately, this approach only addresses late clicks, not early ones, and very often effectiveness and impact on player perception can vary with target speed.

Predictive Assistance - Some games implement predictive assistance by calculating where a target will be and adjusting aim accordingly. This is particularly relevant for games with projectile travel time. Systems can calculate bullet travel time and target velocity to determine lead requirements automatically [20].

3.4 VR-Specific Assistance Techniques

Aiming in VR comes with distinct challenges and possibilities. Eye-tracking technology looks particularly promising for providing aim assistance in VR [20].

Gaze-based Assistance - Studies have shown that combining gaze input with traditional controllers can improve aiming performance, particularly for throw and aim tasks [21]. Eye-tracking provides rapid target acquisition, which can be refined with hand controllers. Natural and intuitive target selection represents the main advantage, next to fast acquisition times and hands-free or hybrid control options. Next to the need for specialized software which could support this assistive technique, "Midas Touch" problem, unintentional activation from looking, also represents an important problem. Regarding accessibility, gaze-based Assistance may not work well for users with visual impairments or certain eye conditions.

4 Application and Effectiveness

Researchers dominantly relied on aim assistance while researching approaches for balancing multiplayer FPS games. A series of comparative studies has evaluated previously presented techniques to determine how effective they are for this purpose.

Vicencio-Moreira et al. evaluated five techniques: *Target Lock*, *Bullet Magnetism*, *Area Cursor*, *Sticky Targets*, and *Target Gravity*, across a target range and a realistic map environment [5]. Based on acquired results, *Bullet Magnetism* and *Area Cursor* were the most effective. Even though it occasionally resulted in unintentional hits on neighboring targets, players favored *Bullet Magnetism*. *Area Cursor* proved equally effective, with players rarely noticing the subtle visual expansion of the cursor.

Building on this, Bateman et al. demonstrated that these techniques could be used to subtly balance competitive play in a 2D shooting game [3]. Both *Area Cursor* and *Target Gravity* substantially reduced score differences between high- and low-skilled players. Players preferred the assisted experience, as the techniques improved their competitiveness while remaining subtle enough to go unnoticed.

Building on this work, Vicencio-Moreira et al. developed a system for 3D FPS games with dynamic balancing using *Bullet Magnetism* and *Area Cursor* [2]. The system provided assistance to the trailing player based on the current kill differential. Their findings demonstrated that these techniques were highly effective at producing more balanced matches. Furthermore, the most effective techniques also led to the highest ratings of game enjoyment, reinforcing the link between balanced competition and positive player experience.

An important question regarding aim assistance is whether it disturbs the natural development of a player's aiming skill ("guidance hypothesis" in motor learning). Gutwin et al. directly investigated this [18] by comparing an assisted group and an unassisted group in an FPS game and found that the inclusion of aim assistance led to significant improvements in performance and perceived competence. Crucially, there were no significant differences in performance gains between groups after assistance was removed. This suggests the balancing benefits of aim assistance are greater than potential risk of disturbing skill development by being too helpful, at least in this study's context.

5 Research Gaps and Future Directions

Despite the evidence that aim assistance improves player experience, there are still many open issues.

Obviousness and Finesse - Artificial involvement must be subtle to be seen as fair not patronizing or even cheating. Research shows that low to moderate *Sticky Targets* can go unnoticed [22], and *Area Cursor* expansion can be done if the effect is subtle enough [5]. *Bullet Magnetism* can be very noticeable if the player hits unintended

targets. Finding the right balance between effectiveness and imperceptibility is a big design challenge.

Temporal Aim Assistance - Most research has focused on spatial aiming in game world. But many game tasks have a temporal component (e.g. leading a moving target, quick-draw duels). Schneider and Graham [19] note that algorithms for temporal aiming are rare. Some spatial techniques like the *Comet technique* which expands a moving target in the opposite direction of its movement can help with temporal errors [20], but this is not a well explored area.

Personalization and Modeling - A future direction is to develop personalized assistance models based on machine learning (ML). Schneider and Graham [19] propose training models that can record each player's unique aiming patterns, both spatial and temporal. These models would allow the game to provide personalized support to detected weaknesses, resulting in better player experience.

Skill Decomposition - In FPS games it's not enough to just aim well, it requires movement, map knowledge, resource management and situational awareness. Vicencio-Moreira et al. said that aim assistance alone may not be enough to balance gameplay between experts and novices, because experts excel in other dimensions as well [2]. Future balancing systems may need to include multi-faceted assistance that addresses multiple core skills at once.

Future Accessibility Research - For any studies on accessibility to really make a difference, they need to include people with a wide range of disabilities, that way we can be sure the solutions we come up with are actually ones that will work for the people who need them most [23,24]. And once we've got the aim assistance sorted out, it needs to play nice with the rest of the assistive tech out there - adaptive controllers, eye-tracking, voice control, that kind of thing, to make it a comprehensive aid. It would also help a lot if the system could learn to adapt to the situation - is it a firefight or just a quiet moment of exploration, and should it be cranking up the assistance or letting you fly solo. Most importantly of all, accessibility has got to be built into the game from day one, not just tacked on as an afterthought [12].

6 Conclusion

This review has summarized the research that shows aim assistance is a viable and working solution for balancing competitive games. Based on Fitts's Law, techniques like Bullet Magnetism, Area Cursor and Sticky Targets can artificially lower the difficulty of aiming tasks for less skilled players. Studies have shown that these techniques can reduce performance gaps, make matches feel more competitive and more enjoyable without hindering native aiming skill.

The most effective techniques for subtle balancing seem to be the ones that are powerful but minimalistic, like *Bullet Magnetism* and *Area Cursor*. For designers the main challenges are managing distractor targets, keeping the assistance subtle and

dealing with the multi-faceted nature of player skill. Future research will explore temporal assistance, personalised models of player ability and holistic balancing. This paper is a foundation for that research, a summary of the aim assistance research for new researchers and practitioners.

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