ENHANCEMENT OF COLLISION AVOIDANCE TECHNIQUE IN DYNAMIC CROWD SIMULATIONS USING VISUAL CUES AND VISION BASED ALGORITHM

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ABSTRACT

Crowd simulations are widely used in virtual environment applications such as in entertainment, games, military training, safety issues, evacuation, and emergent situation. It visualizes the crowd behaviors, movement, and interactions in simulating a virtual environment. A dynamic crowd's density can be classified as high, medium or low depending on the situation. The abrupt obstacles occurrences may emerge at any time and anyway in a dynamic crowd simulation. At the same time, the dynamic changes of the obstacles would initiate a complicated path to obtain a prediction of the target's motion. Due to a lack of contacts amongst agents, they will interact only when prompted, such as in identified close proximity circumstances. In reality, each agent has its own goal and personal space. However, in an emergent or panic situation, the agent's goal can be altered to find the optimal free collision path to exit the environment. Therefore, agents could perceive the environment and try to find the optimal solutions with the aid of visual cues. The main objective of this study is to produce an enhanced technique that integrates the visual cue outcome in the collision avoidance pipeline during emergent situations. The proposed technique emphasised the need of avoiding sudden obstacles by including the bounding circle mechanism and a vision-based method into the free-path environment in order to achieve optimal and better exploration in crowded conditions. From the experiments conducted, the suggested method can reduce all evacuation time effectively and improve the overall proposed collision avoidance and pathfinding techniques in a dynamic crowd simulation environment. The Predetchenky and Milinskii method has been carried out to validate simulation results obtained by the Netlogo testing agent's evacuation system. The findings of this study can be used to mimic the evacuation of a single-layer floor of a structure, such as computer labs, science labs, hallways, or schools. The simulation can provide vital information for evaluating a design, assisting in the planning process, and training to cope with emergencies.

ABSTRAK

TEKNIK PENGELAKAN PERLANGGARAN YANG DIPERTINGKATKAN DALAM SIMULASI KELOMPOK DINAMIK MENGGUNAKAN ISYARAT VISUAL DAN ALGORITMA BERASASKAN PENGLIHATAN.

Simulasi kelompok digunakan secara meluas dalam aplikasi persekitaran maya seperti hiburan, permainan, latihan ketenteraan, isu-isu keselamatan, situasi di luar jangkaan dan memerlukan pengosongan segera. Ia menggambarkan tingkah laku, pergerakan, dan interaksi kelompok dalam mensimulasikan persekitaran maya. Kepadatan kelompok yang dinamik dapat diklasifikasikan sebagai tinggi, sederhana atau rendah bergantung pada keadaan. Kejadian halangan mendadak mungkin berlaku pada bila-bila masa dan apa jua cara dalam simulasi kelompok yang dinamik. Pada masa yang sama, perubahan dinamik halangan menyukarkan laluan untuk meramal pergerakan sasaran. Kekurangan interaksi di kalangan ejen-ejen menyebabkan mereka hanya berinteraksi hanya apabila diminta, seperti dalam keadaan jarak dekat yang dikenalpasti. Pada hakikatnya, setiap ejen mempunyai matlamat dan ruang peribadinya sendiri. Walau bagaimanapun, dalam keadaan tidak dijangka atau panik, matlamat ejen boleh diubah untuk mencari laluan tanpa perlanggaran yang optimum untuk keluar dari persekitaran yang ada. Oleh itu, ejen dapat melihat persekitaran dan cuba mencari penyelesaian yang optimum dengan bantuan isyarat visual. Objektif utama kajian ini adalah untuk menghasilkan teknik yang dipertingkatkan dan mengintegrasikan hasil isyarat visual dalam mengelakkan perlanggaran semasa situasi baru muncul secara mendadak. Teknik yang dicadangkan meningkatkan keperluan untuk mengelakkan halangan mendadak dengan mengintegrasikan mekanisme bulatan terlingkup dan kaedah berasaskan penglihatan dalam persekitaran laluan bebas perlanggaran untuk mendapatkan penerokaan optimum yang lebih baik dalam situasi sesak. Berdasarkan eksperimen yang dijalankan, kaedah yang dicadangkan dapat mengurangkan purata masa pemindahan dengan berkesan dan meningkatkan keseluruhan cadangan pengelakan perlanggaran serta teknik mencari jalan dalam persekitaran simulasi kelompok yang dinamik. Kaedah Predetchenky dan Milinskii telah dijalankan untuk mengesahkan keputusan simulasi yang diperolehi oleh pengujian Netlogo untuk simulasi sistem pemindahan ejen. Hasil kajian boleh digunakan untuk latihan dan simulasi pemindahan kelompok pada bangunan setingkat contohnya makmal komputer, makmal sains, dewan dan sekolah. Simulasi ini dapat memberi maklumat kepada penilaian rekabentuk, membantu dalam proses perancangan dan latihan menghadapi kecemasan.

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LIST OF ABBREVIATIONS

SFM	-	Social Force Model
CD	-	Collision Detection
CA	-	Collision Avoidance
2D	-	Two Dimensional

LIST OF SYMBOLS

β^+ - indicate the angle of tangent line vector

β^- - indicate the angle of tangent line vector

ψ - the heading angle

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CHAPTER 1

INTRODUCTION

1.1 Overview

Crowd simulations are extensively employed in a variety of virtual environment applications, including entertainment, gaming, teaching, safety science, military simulation, architectural design, psychology, robotics, sociology, city planning, traffic engineering, and cultural computing (Xu *et.al*,2014). It creates a virtual environment in which crowd behaviours, movement, and interactions are visualised. Crowd simulation is an excellent tool for visualising and anticipating panic situations, traffic congestion, crowd pressure prediction, and evacuation route planning. It may be used to determine ways to enhance crowd movement, prepare escape routes in the event of an evacuation or disaster, and educate emergency personnel to handle evacuation situations.

Crowd simulations are used in film production to produce virtual groupings of 'agents' with realistic features. There are two fundamental approaches to creating crowd simulations: either attaching the crowd's movement and response to 'particles' or endowing your crowd with 'artificial intelligence'. Agents might seem so realistic that it is sometimes unnecessary to bring in actual extras. Crowd creation tools like Golaem, Massive, and Miarmy are used to replicate conflict scenes involving many characters, such as those in "The Lord of the Rings," "The Avengers," "The Walking Dead" (zombies), and "Transformers: Dark of the Moon."

Crowd simulation may be used to model the behaviour of a crowd on an individual or group basis. According to Pan *et al*. (2007), there are three reasons for developing a computer simulation of crowd behaviour: to test scientific theories and

hypotheses, to evaluate design techniques, and to replicate the phenomena under study.

In architecture, the audience plays a significant role in the design of a structure or in urban planning. It is critical to design public places in buildings carefully so that crowds do not exacerbate risk during panic situations, particularly during building evacuation. Architects of such enclosed structures or buildings must ensure that crowd dynamics have a clear route to exit utilising a limited number of exit points in both normal and emergency situations. Verifying construction blueprints with a live audience is impractical from a financial and safety standpoint. Thus, crowd modelling and simulation may aid authorities in such instances by reducing the time required to flee, resulting in more efficient and safe public places.

Collision handling in crowd simulation refers to the detection and reaction to collisions. When a collision is detected, the collision response notifies the motion programme that one has happened, and they must deal with it. Individuals will be treated as agents in crowd simulation. Thus, crowd modelling and simulation with dynamic obstacles will boost the agent's ability to respond quickly or plan around impediments or collisions.

1.2 Problem background

According to Weidmann (1993), in a normal setting, people want to walk at their own pace, at a comfortable pace, in order to arrive at their destination or goal on time. In typical settings, there is lane formation in corridors and oscillations at bottlenecks. The desired pace or path may be adjusted in a panic, emergency, or evacuation situation. Crowd fatigue could slow people down and cause bottlenecks during an evacuation. Bottlenecks can also occur in overcrowded, congested areas. A crowd stampede can result from the bottleneck effect, which commonly results in fatalities when people are crushed or trampled. When congested people push one other to evacuate by an exit, the evacuation flow may be slower, causing the "faster is slower" effect (Helbing *et al.*, 2000). The time constraints and stress associated with an evacuation situation have an effect on how individuals process environmental information and, as a result, on the decisions they make. An individual's velocity will