Use of artificial intelligence in computer gaming media essay

Media

M. U. L. PereraFaculty of Information TechnologyUniversity of Moratuwamulperera@gmail. comAbstractThe computer games industry is now bigger than the film industry. Until recently, technology in games was driven by a desire to achieve real-time, photo-realisticgraphics. To a large extent, this has now been achieved. As game developers look fornew and innovative technologies to drive games development, AI is coming to the fore. This paper will examine how sophisticated AI techniques, such as those being used inmainstream academic research, can be applied to computer games and introduce threeprojects doing just that. 1. IntroductionThe computer games industry is now bigger than the film industry [7]. Until recently, technology ingames was driven by a desire to achieve real time photo realistic graphics. To a large extent, thishas now been achieved. At least, it will no longer be huge leaps in graphics technology that makeone game stand out in the manner that Doom (www. idsoftware. com) stood out when it was firstreleased in 1993. This leaves the stage set for another aspect of gaming technology to move to the forefront. One ofthe real contenders for this role is AI. Although graphics technology allows the creation of gamesset in environments that look incredibly realistic, the behaviour of computer controlled characters, referred to as Non Player Characters (NPCs), often leads to a shallow and unfulfilling gameexperience. The application of sophisticated AI techniques to the control of NPCs could rectify thissituation and create more immersive games. This paper will begin with an overview of the more important genres of computer games availabletoday, and some indication of the roles we see for AI in these games. From this we will explore thecurrent state of the art of game AI. This

will include a review of both the techniques being used incommercial games, and those being pursued by academic research projects. Section 4 will discussthe merits of game AI as a research topic, and outline some of its unique challenges. Finally, wewill discuss the projects being pursued as part of the TCD Game AI project and introduce thetechniques which we feel will be used in the next generation of game AI. 2. OverviewEvery year commercial computer games become more and more realistic. From strategy games to FPS(First Person Shooter) type games, the envelope of realism is constantly being pushed. It is due to the realism and idealised simulated environments of modern games that make them an excellent platform for testing artificial intelligence research . These methods of AI are generally hard coded rules which will map a specific state onto a desired function. The state-action approach to AI implies that the state space will be small enough that every state can be given a rule by a human programmer. Modern FPS(First person shooter) games, however, have an exponentially larger number states that an agent could find its way into. Most modern FPS AI systems are implemented with state-action tables, goal-based systems, and scripting, which can be extremely time consuming and lead to very predictable agents. As FPS games become more advanced, the task of creating a believable AI agent becomes increasingly difficult. Due to previous techniques often resulting in predictable static agent behaviors that can not seem to adapt to the strategy of a human opponent3. The role of AI in different game genresBefore embarking on a discussion of the different game genres on the market today, a glaringcontradiction needs to be resolved. A large, and ever growing, body of research work into

computerimplementations of classic games, such as chess, Go and Othello, already exists. When we refer tocomputer games, we are not referring to games such as these. Rather, we refer to what might bemore familiarly termed video games - games made specifically to be played on computers. Further, little of the research into classic games is applicable to the games considered by this project. Themain reason for this is that the number of degrees of freedom in modern video games is far beyondthat of classic games. What follows is a description of some of the more important genres of computer games on themarket today, and pointers to some of the interesting roles for the application of AI to these games. This discussion will loosely follow a similar discussion given in [7]. 3. 1 Action GamesAction games are the most popular game genre on the market today. The basis of the games canchange from conquering an alien horde single handed with just your trusty side arm, to Mad-Maxstyle, post-apocalyptic vehicle based carnage. The game-play, however, remains much the same –high adrenaline action where the aim of the game is to shoot everything that moves. Today’s typicalaction game takes place in a fully rendered 3-d environment viewed from a first person perspective, and populated by countless varieties of cannon fodder upon which to unleash your fury through awide range of exotic weaponry. It is in creating more intelligent opponents that the most obvious possibilities for integration ofsophisticated AI arise. Currently, the trend is to use schedule based finite state machines (FSMs)[12] to determine the behaviour of the player’s adversaries. Although this has been achieved to verygood effect (1999’s Game of the Year, Half-Life (www. valve. com) astounded game players withsquad based tactics, and enemies with

incredibly realistic sensing models), FSMs are by their naturevery rigid and, behave poorly when confronted by situations not dreamt of by the designer. A number of games (Opposing Force (www. valve. com), the sequel to Half-Life, stands out as anotable example) have also made impressive use of partners and support characters that assist theplayer throughout the game. Building upon this idea, some recent games have cast the player as amember of a squad or team [5]. Notable examples include Tom Clancy’s Rainbow Six: RogueSpear (www. redstorm. com/rogue_spear) and Star Trek Voyager: Elite Force(www. ravensoft. com/eliteforce). This is another area in which there is a real opportunity for thefurther application of sophisticated AI. 3. 2 Adventure GamesVisually, the adventure game has changed dramatically since " Adventure" was created by WillieCrowther and Don Woods in the early seventies. The basis of the genre, however, has remainedmuch the same. Gameplay involves the player moving around a restricted locale, solving puzzlesand interacting with characters in an attempt to further a story line. While the original examples of this genre were text based (commands were given through theplayer typing basic English commands – " eat the peach", " enter building", " open door" etc.), nowadays they are graphically stunning and input is given in a variety of novel ways – the mostcommon being the use of the mouse to direct the player’s character (from which came the name" point and click adventure"). Classic examples of this genre include the Monkey Island(www. lucasarts. com) and the Gabriel Knight (www. sierrastudios. com) series. Two interesting applications of AI to the genre are the creation of more realistic and engaging NPCsand maintaining consistency in dynamic storylines. 3. 3

Role Playing GamesOften seen as an extension of the adventure game style, role playing games (RPGs) stem from thepopular Dungeons & Dragons (www. playdnd. com) paper based games that originated in the 1970's. Over the past two decades the computer versions of these games have metamorphosed from beingmostly text based to the beautifully rendered, hugely involved games available today. Baldur's Gate(www. interplay. com/bgate) was a turning point for the genre. The level of detail in the Baldur'sGate world involves complexity far beyond anything seen before, with completion of the gameinvolving over 100 hours of gameplay. RPGs see the player taking on the role of an adventurer inan exotic, mythical world, where gameplay consists of questing across the land, engaging in amixture of puzzle solving and combat. Interactions with NPCs and an intricate plot are alsoimportant in the genre. The differences between RPGs and adventure games arise from the scope involved. RPGs takeplace in far larger worlds and the player has more freedom to explore the environment at their ownpace. Also, underlying RPGs is some rule set stemming from the original, and quite complex, Dungeons & Dragons rules. The RPG format offers the same kind of challenges to the AI developer as the adventure game. However, extra complication is introduced due to the amount of freedom afforded to the player. Maintaining story consistency becomes a bigger issue and the level of sophistication required in anRPG's NPCs is beyond that required in adventure games. 3. 4 Strategy GamesStrategy games cast a player in charge of a range of military units, controlled from a " gods-eyeview", which must be sent into battle against one, or more, opponents. Typically resources (such asgold, wood and stone) must be harvested in order to

create units or construct buildings. Thismanagement of the construction of units is at the core of strategy gameplay, as different unitsperform to varying levels against each other, and come at varying costs. More recently, diplomacyhas also featured strongly in strategy gameplay. Strategy games on the market today are an evenmix between mythical, fantasy and science fiction campaigns; and recreations of historical battles. Two distinct classes of game have emerged from the strategy genre. Turn based strategy (TBS)games involve each player taking their turn to move units, order production, mount attacks and soon, one after another. The Civilization (www. firaxis. com/civ3) series is the definitive example ofthis kind of game. Real time strategy (RTS) games, as the title suggests, take place in real-time withplayers moving units, ordering production etc. in parallel. The Age of Empires(www. ensemblestudios. com) and Command & Conquer (www. westwood. com) series, along withTotal Annihilation (www. cavedog. com), stand out as fine examples of this genre. One other sub-genre to spawned by the strategy game, is that of the God game. These cast theplayer in the role of a protective deity. The main factor distinguishing God games from strategygames is in the manner in which the player can take action in the environment. The player has theability to manipulate the environment – for example to raise or flatten mountains to make the landmore hospitable, or to unleash the fury of a hurricane or earthquake – and units are controlled lessdirectly than in strategy games. Classic examples of this genre include SimCity(www. simcity. com), the Populous series (www. populous. net) and, the recently released Black andWhite (www. lionhead. co. uk). AI in strategy games needs to be applied both at the level of strategic opponents and at

the level ofindividual units. AI at the strategic level involves the creation of computer opponents capable ofmounting ordered, cohesive, well planned and innovative campaigns against the human player. Thisis very challenging as players quickly identify any rigid strategies and learn to exploit them. At theunit level AI is required in order to allow a player's units to carry out the player's orders asaccurately as possible. Challenges at unit level include accurate path finding and allowing units adegree of autonomy in order to be able to behave sensibly without the player's direct control. 3. 5 OthersOf course, just like any attempt at categorization, not all computer games fit neatly into one of theniches defined above. There is a large amount of overlap between the different categories – thehugely successful Diablo II (www. blizzard. com), for example, is considered an RPG, but a hugeamount of the gameplay is made up of action combat sequences so, could it not also be consideredan action game? Similarly, from time to time, a completely original title is released that simplydefies categorization. One such example is the Sims (www. thesims. com) which was one of theshock successes of 1999. This game has been described as many things including an interactivesoap opera and a dollhouse simulator. In spite of this, forming a categorization such as that above isuseful in an attempt to clarify some of the basic requirements of game AI. 4. ApplicationsIn this section, we will describe the AI techniques that are currently being used in commercialgames and some of the more interesting research efforts being undertaken in the domain. 4. 1 The State of the Art within the game industryAI, as used by commercial games developers is simplistic in comparison to the techniques beingused in mainstream academic research

and industrial applications1. Some of the more importantreasons for this lack of sophistication include:• a lack of CPU resources available to AI in games (up to the year 2000, typically about 10%of processor cycles [18])• a suspicion in the game development community of the effects of using non-deterministicmethods, e. g. neural networks• a lack of development time – AI is usually only added to a game after most of the othersections of the game (e. g. the graphics engine) are complete• a lack of understanding of advanced AI techniques in the game industry1 That is not to say that AI in some games has not been very impressive. The techniques being used are simplistic incomparison to those being used by academic researchers in such fields as machine learning and robotics.• the fact that efforts to improve the graphics in games overshadowed all else, which led to alack of research into other areas, particularly AIThis has led to the emergence of a number of very well established, well understood and robusttechniques that are in wide use by game developers [18]. These include FSMs and their closerelation Fuzzy State Machines [12], the A* path finding algorithm [16], and a number of A-Lifetechniques including Craig Reynolds’ flocking algorithms [11]. The fact that a number of core techniques are being repeatedly used in game design has led to anumber of attempts to integrate them into a generic systems development kit (SDK). For example, Mathématiques Appliquées' DirectIA (www. animaths. com) and Louder Than a Bomb’s Spark!(www. louderthanabomb. com). SDKs, however, have failed to take hold in the industry andWoodcock [18] suggests current SDKs lack of flexibility as the main reason for this. Another well used technique in game AI is simply to cheat. This is particularly easy in some gamegenres. For example, in action

games computer opponents can have perfect aim or the ability to seethrough walls and so, track a player. Similarly, in strategy games the computer opponent might beable to produce exactly the units needed without having to engage in the complicated resourcemanagement faced by a player. Cheating as a technique is very processor efficient and can be very successful. However, it has onemajor drawback. If cheating is done badly and is noticed by the player it ruins the illusion ofplaying against an equally matched opponent, and destroys any sense of immersion built up by thegame. This leads to a very unfulfilling game experience and so should be avoided. To conclude, commercial game AI is dominated by a small number of simple, deterministic andprocessor efficient techniques that are very well understood and repeatedly used by the gamedevelopment community. 4. 2 Academic Research in Game AIAcademic research into AI for games has been rare over the past number of years, however thelevel of interest is growing. A number of research efforts are currently underway and courses arebeing offered in some US universities. Much of the research being undertaken has emerged fromwork conducted with military institutions. Many of the goals are similar and so there is a largecrossover of techniques. One such effort is the Soarbot project [17] in which agents have beencreated to play the 3D action game Quake (www. idsoftware. com) using the rule based SOARarchitecture. Forbus et al. [4] describe another interesting research project in which a militarysystem designed to analyse terrain in order to plan attacks [3] is being adapted for use in strategygames. Another area in which a lot of work is being transferred to computer games is in the area ofcomputer based story telling, a well-established research area. The

Oz Project [1] is a successfulresearch initiative that has been applying agent based AI techniques to the task of maintaininginteractive stories. The Excalibur Project [10] is another effort that is concerned with creatingagents to populate virtual game worlds. Finally work undertaken as part of the RoboCup robot soccer tournament (www. robocup. org) offersa number of insights into problems similar to those arising in computer games. 5. Development EnvironmentSome might say that research into AI for computer games is not the most noble undertaking. Wewould argue, however, that computer games offer an accessible platform upon which seriouscognitive research can be engaged. Laird and van Lent [7] go so far as to suggest that computergames are the perfect platform upon which to pursue research into human level AI. What followsare a number of the reasons we believe that computer games are a useful, and potentially rewardingresearch area. In section 3 we put forward a number of reasons as to why AI in computer games was at presentsimplistic. The majority of these are no longer valid. One of the main factors holding back game AIdevelopment was the lack of available CPU resources. With more and more graphics processingmoving to specialised graphics hardware, this is no longer an issue. Similarly, we mentioned thatthe games industry’s focus on graphics technology has held back AI development. Graphics havenow reached such a level that visually stunning games are the norm rather than the exception, causing games developers to look for innovations, other than superior graphics, to become theselling points of their games. This will inevitably lead to more time for research into areas such asAI. Thus, the stage is set for the emergence of superior AI to become the key feature in future gamereleases. In terms of a

research problem, AI for games is unique in the challenges it offers. One only has toconsider the discussion of the many roles for AI in games given in section 2 to realise the widerange of problems arising. Games take place in dynamic complex worlds in which complexdecisions, often based on partial knowledge must be made. This reads as a shopping list for theconditions required to formulate really hard AI problems. Laird and van Lent [7] suggest a number of reasons why game AI is an attractive research area. These include the fact that the increasing realism in computer games and the fact that many gamemanufacturers are creating games with hooks to allow people to modify the game (known as mods), makes them an attractive alternative to expensive home grown simulations. Also, computer gameworlds are reaching a level of complexity comparable with the real world, allowing simulationswhich concentrate on cognitive issues, without the extra burden of using unreliable physicalsensors, and motor systems such as those used in robotics. Finally, as was previously mentioned, computer games are now a multi-million dollar worldwideindustry. This means that a direct route exists from research projects into viable commercialenterprises. Coupled with this is the fact that commercial games companies run to frantic schedules. Because of this, they are reluctant to spend time investigating riskier techniques for fear that theymight not work out, and so precious development time will be lost. As researchers, we have theluxury of being able to research a technique without the burden of pressure that comes with havingto produce a commercially successful product. If research shows a technique is not suitable to aparticular task, that is still a valuable a piece of research, and time well spent. In the fast

paced, bottom line driven world of commercial games development, this is certainly not the case. The main drawbacks to research work on AI in games are the lack of formal structure surroundingthe subject, and the amount of suspicion, and degree of secrecy amongst games companies. Noformal journals exist and, apart from a few small conferences (for example the annual AAAI SpringSymposium on Artificial Intelligence and Interactive Entertainment), there is little contact betweenresearchers and games developers. This results in researchers having to rely on a small number ofwell run web sites (Steve Woodcock’s www. gameai. com being one of the better ones) in order todiscover exactly what techniques are currently being used. 6. Future DirectionsThe future of quantum computing is very bright because it is applicable on every field of quantum physics. There are some notable barriers accept different forms of error correction and the development of software. It is needed lot of expense to achieve such goal. However A 6 x 6 centimeter chip can accommodate nine quantum devices and four of the quantum devices are quantum bits that do the calculations. Scientists are sure that they can scale up to 10 qubits in the near future. Scientists in Australia said they had created the world’s smallest transistor and the first to be made by deliberately placing individual atoms. Then researchers from the University of Cambridge, in collaboration with Toshiba, revealed they had invented an Entangled Light Emitting Diode in another progression towards the supercomputers of the future. Therefore with these inventions a quantum computer would be able to do lots of things. A quantum computer will have massive processing power because it can do computational tasks in parallel and can solve problems which are virtually

intractable using an ordinary computer. Quantum Computer would be able to act as a quantum simulator. A quantum simulator is a quantum computer which basically simulates another quantum system. This could help us simulate a new molecule or new nano material and thereby help us design better materials in the future. Quantum Computers are very good at search problems and also for finding the primes of large numbers, which is an important area for cryptography. If people work with such devotion in the field of quantum computing we can achieve all technologies of the world. 7. DiscussionIn this research paper we have discussed what is a Quantum Computer, How it evolved, the requirement behind a Quantum Computer, the researchers are being carried out by now in the field of Quantum Computing, the applications of Quantum Computers and at the same time the advantages, what sort of environment is needed to develop quantum computing and future directions. Therefore if we consider all facts given we notice that there is requirement of super power and extensively high performance computers. However the current classical computers architecture can’t fulfill the above requirement. Therefore scientists have to think of another way of addressing the so called problem. One option that scientists are currently working out is trying to present a solution by the means of Quantum Computers. 8. My ContributionBy doing this research I was able to gather a bunch of knowledge related to the field of Quantum Computing. I have identified that in quantum computing, the data is represented by the quantum properties and the operations on data are represented by quantum mechanisms. Also go a clear view about the reasons for the difficulties of improving the current computer architecture in

order to gain a super power computer since the scientist have already optimized the silicon chip with maximum number of transistors. Therefore I understood that the computer performance cannot be further improved by increasing the number of transistors but it is possible through implementing multi cores with compatible software improvement. Quantum Computing is going for a entirely new computer architecture where we can attain a tremendous computer performance. Also I got an idea about what are the researches that are currently operating and in what sort of areas that Quantum Computing can be effectively apply. AcknowledgmentsI am very grateful to my supervisor Mr. who was one of the key characters for my interest in AI