An Intelligent Virtual Human System for Providing Healthcare Information and Support

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Abstract. Over the last 15 years, a virtual revolution has taken place in the use of Virtual Reality simulation technology for clinical purposes. Shifts in the social and scientific landscape have now set the stage for the next major movement in Clinical Virtual Reality with the "birth" of intelligent virtual humans. Seminal research and development has appeared in the creation of highly interactive, artificially intelligent and natural language capable virtual human agents that can engage real human users in a credible fashion. No longer at the level of a prop to add context or minimal faux interaction in a virtual world, virtual humans can be designed to perceive and act in a 3D virtual world, engage in spoken dialogues with real users and can be capable of exhibiting human-like emotional reactions. This paper will present an overview of the SimCoach project that aims to develop virtual human support agents to serve as online guides for promoting access to psychological healthcare information and for assisting military personnel and family members in breaking down barriers to initiating care. The SimCoach experience is being designed to attract and engage military Service Members, Veterans and their significant others who might not otherwise seek help with a live healthcare provider. It is expected that this experience will motivate users to take the first step – to empower themselves to seek advice and information regarding their healthcare and general personal welfare and encourage them to take the next step towards seeking more formal resources if needed.

Keywords. SimCoach, Virtual Humans, Military Healthcare, Barriers to Care

Introduction

Over the last 15 years, a virtual revolution has taken place in the use of simulation technology for clinical purposes. Technological advances in the areas of computation speed and power, graphics and image rendering, display systems, tracking, interface technology, haptic devices, authoring software and artificial intelligence have supported the creation of low-cost and usable PC-based Virtual Reality (VR) systems. At the same time, a determined and expanding cadre of researchers and clinicians have not only recognized the potential impact of VR technology, but have now generated a significant research literature that documents the many clinical targets where VR can add value over traditional assessment and intervention approaches (1-5). To do this, VR scientists have constructed virtual airplanes, skyscrapers, spiders, battlefields,

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social settings, beaches, fantasy worlds and the mundane (but highly relevant) functional environments of the schoolroom, office, home, street and supermarket. And this state of affairs now stands to transform the vision of future clinical practice and research in the disciplines of psychology, medicine, neuroscience, physical and occupational therapy, and in the many allied health fields that address the therapeutic needs of those with clinical disorders. This convergence of the exponential advances in underlying VR enabling technologies with a growing body of clinical research and experience has fueled the evolution of the discipline of Clinical Virtual Reality. This paper presents the design vision for a Clinical VR project called SimCoach that aims to create intelligent virtual human agents to serve the role of online healthcare guides/coaches for military Service Members, Veterans and their significant others in an effort to break down barriers to care.

1. Virtual Humans in Clinical VR

These shifts in the VR technological and scientific landscape have now set the stage for the next major movement in Clinical VR. With advances in the enabling technologies allowing for the design of ever more believable context-relevant "structural" VR environments (e.g. homes, classrooms, offices, markets, etc.), the next important challenge will involve *populating* these environments with Virtual Human (VH) representations that are capable of fostering believable interaction with *real* VR users. This is not to say that representations of human forms have not usefully appeared in Clinical VR scenarios. In fact, since the mid-1990's, VR applications have routinely employed VHs to serve as stimulus elements to enhance the realism of a virtual world simply by their static presence. More recently, research and development has appeared in the creation of highly interactive, artificially intelligent and natural language capable virtual human agents. No longer at the level of a prop to add context or minimal faux interaction in a virtual world, these VH agents are designed to perceive and act in a 3D virtual world, engage in face-to-face spoken dialogues with real users (and other VHs) and in some cases, they are capable of exhibiting human-like emotional reactions. Previous classic work on virtual humans in the computer graphics community focused on perception and action in 3D worlds, but largely ignored dialogue and emotions. This has now changed. Intelligent VH agents can now be created that control computer generated bodies and can interact with users through speech and gesture in virtual environments (6). Advanced virtual humans can engage in rich conversations (7), recognize nonverbal cues (8), reason about social and emotional factors (9) and synthesize human communication and nonverbal expressions (10). Prototype-level embodied conversational characters have been around since the early 90's (11) but significant advances have occurred more recently working systems used for training (12), intelligent kiosks (13) and virtual patients for clinical training (14). Both in appearance and behavior, VHs have now evolved to the point where they are usable tools for a variety of clinical and research applications.

2. Breaking Down Barriers to Care in Military Healthcare

Research suggests that there is an urgent need to reduce the stigma of seeking mental health treatment in Service Members (SM) and Veteran populations. While US

military training methodology has better prepared soldiers for combat in recent years, such hesitancy to seek treatment for difficulties that emerge upon return from combat, especially by those who may need it most, suggests an area of military mental healthcare that is in need of attention. Moreover, the dissemination of healthcare information to military SMs, Veterans and their significant others is a persistent and growing challenge. Although medical information is increasingly available over the web, users can find the process of accessing it to be overwhelming, contradictory and impersonal. At the same time, the need for military-specific health information is growing at an astounding rate. In this regard, the reports over the last few years of a surge in U.S. Army suicide rates have again thrust the challenges of military mental health care into the public spotlight. With annual suicide rates steadily rising since 2004, the month of Jan. 2009 saw 24 suspected suicides, compared to five in Jan. of 2008, six in Jan. of 2007 and 10 in Jan. of 2006 (15).

In spite of a Herculean effort on the part of the U.S. Department of Defense (DOD) to produce and disseminate behavioral health programs for military personnel and their families, the complexity of the issues involved continue to challenge the best efforts of military mental health care experts, administrators and providers. Since 2004, numerous blue ribbon panels of experts have attempted to assess the current DOD and Veterans Affairs (VA) healthcare delivery system and provide recommendations for improvement. For example, the American Psychological Association Presidential Task Force on Military Deployment Services for Youth, Families and Service Members (16) poignantly stated that they were, "…not able to find any evidence of a well-coordinated or well-disseminated approach to providing behavioral health care to service members and their families." The APA report also went on to describe three primary barriers to military mental health treatment: *availability, acceptability and accessibility.* More specifically: Well-trained mental health specialists are not in adequate supply (*availability*), the military culture needs to be modified such that mental health services are more *accepted* and less stigmatized, And even if providers were available and seeking treatment was perceived as more acceptable, appropriate mental health services are often not readily *accessible* due to a variety of factors (e.g. long waiting lists, limited clinic hours, a poor referral process and geographical location).The overarching goal reported in this and other reports is to provide better awareness and access to existing care while concurrently reducing the complexity and stigma in seeking psychological help. In essence, new methods are needed to reduce such barriers to care.

3. SimCoach Design Approach

While advances in technology has begun to show promise for the creation of new and effective clinical assessment and treatment approaches, from Virtual Reality to computerized prosthetics, improvements in the military health care dissemination/delivery system are required to take full advantage of these evolving treatment methodologies, as well as for promoting standard proven intervention options. In response to the clinical health care challenges that the conflicts in Iraq and Afghanistan have placed on the burgeoning population of service members and their families, the U.S. Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury (DCoE) have recently funded our development of an intelligent, interactive, online Virtual Human (VH) healthcare guide program currently referred to as SimCoach. The SimCoach project that aims to address this need by developing

virtual human support agents to serve as online guides for promoting access to psychological healthcare information and for assisting military personnel and family members in breaking down barriers to initiating the healthcare process. The SimCoach experience is being designed to attract and engage military SMs, Veterans and their significant others who might not otherwise seek help. It aims to create an experience that will motivate users to take the first step – to empower themselves to seek information and advice with regard to their healthcare (e.g., psychological health, traumatic brain injury, addiction, etc.) and general personal welfare (i.e., other non-medical stressors such as economic or transition issues) – and encourage them to take the next step towards seeking more traditional resources that are available, when the need is determined.

Rather than being a traditional web portal, SimCoach will allow users to initiate and engage in a dialog about their healthcare concerns with an interactive VH. Generally, these intelligent graphical characters are being designed to use speech, gesture and emotion to introduce the capabilities of the system, solicit basic anonymous background information about the user's history and clinical/psychosocial concerns, provide advice and support, direct the user to relevant online content and potentially facilitate the process of seeking appropriate care with a live clinical provider. An implicit motive of the SimCoach project is that of supporting users determined to be in need, to make the decision to take the first step toward initiating psychological or medical care with a live provider. It is not the goal of SimCoach to breakdown all of the barriers to care or to provide diagnostic or therapeutic services that are best delivered by a real clinical provider. Rather, SimCoach will foster comfort and confidence by promoting users' efforts to understand their situations better, to explore available options and initiate treatment when appropriate. Coordinating this experience will be a VH SimCoach, selected by the user from a variety of archetypic character options (See Figures 1-3), who will answer direct questions and/or guide the user through a sequence of user-specific questions, exercises and assessments. This interaction between the VH and the user will provide the system with the information needed to guide them to the appropriate next step of engagement with the system or to initiate contact with a live provider.

Figures 1-3. *SimCoach Archetypes – Female Aviator, Battle Buddy, Retired Sergeant Major*

The SimCoach project is not conceived to deliver diagnosis or treatment or as a replacement for human providers and experts. Instead, SimCoach will aim to start the process of engaging the user by providing support and encouragement, increasing awareness of their situation and treatment options, and in assisting individuals, who may otherwise be initially uncomfortable talking to a "live" care provider, in their efforts to initiate care.

Users can flexibly interact with these VHs by typing text, clicking on character generated menu options and have some limited speech interaction during the initial phases of development. The feasibility of providing the option for full spoken natural language dialog interaction on the part of the user will be explored in the later stages of the project. Since this is designed to be a web-based system that will require no downloadable software, it is felt that voice recognition is not at a state where it could be reliably used at the current time. The options for SimCoach appearance, behavior and dialog is being designed to maximize user comfort and satisfaction, but also to facilitate fluid and truthful disclosure of medically relevant information. Based on the issues delineated in the initial interview, the user will be given access to a variety of general relevant information on psychology, neurology, rehabilitation,

When relevant, users will also be directed to experts on specific areas such as stress, brain injury, marriage counseling, suicide, rehabilitation, reintegration and other relevant specialties the military healthcare system, and also to other SMs and Veterans by way of a variety of social networking tools (e.g., 2nd Life, Facebook, etc.). The user can progress through the system at their own pace over days or even weeks as they feel comfortable and the SimCoach will be capable of "remembering" the information acquired from previous visits and build on that information in similar fashion to that of a growing human relationship. The persistence of the SimCoach's memory for previous sessions will require the user to sign into the system with a user name and password. However, that is optional for use of the system. Interspersed within the program will be the option to allow the user to perform some simple neurocognitive and psychological testing to inform the SimCoach's creation of a model of the user to enhance the reliability and accuracy of the SimCoach output to the user, to support user self-awareness, and better guide the delivery of initial referral options. Users will also have the option to print out a summary of the computerized sessions to bring with them when seeking clinical care to enhance their comfort level, armed with knowledge, when dealing with the "real" human clinical care providers and experts. Software authoring tools are also being created that will allow other clinical professionals to create SimCoach "content" to enhance the likelihood that the program will evolve based on other care perspectives and emerging needs in the future.

A fundamental challenge of the SimCoach project will be to better understand the diverse needs of the user base such that appropriate individual user experiences can be delivered to promote effective healthcare access. At the most basic level, there are immense differences in the needs of service members and their families. Further, there are likely large differences in the level of awareness that users will have of existing resources and in their own need/desire to engage such resources. Within the service member population there is a high likelihood that individual users will have had very diverse combat experiences, help-seeking histories and consequent impact on significant others. The net result of attempting to engage such a diverse user base is that the system will need to be able to employ a variety of general strategies and tactics to be relevant to each individual user. Focus groups and "Wizard of OZ" user studies are currently in progress in order to prepare the SimCoach interaction system for a wide range of potential dialog.

In this regard, the SimCoach project is employing a variety of techniques to create the user experience. One relevant clinical model is the PLISSIT therapeutic framework (**P**ermission, **L**imited **I**nformation, **S**pecific **S**uggestions, and **I**ntensive **T**herapy) (17), which provides an established model for encouraging help-seeking behaviors in persons who may feel stigma and insecurity regarding a clinical condition. In the

SimCoach project, the aim is to address the "PLISS" components, leaving the intensive therapy component to live professionals to which users in need of this level of care can be referred. Another source of knowledge is social work practice. Such models take a case management approach, serving both as an advocate and a guide. The SimCoach development team is also leveraging knowledge from the entertainment/gaming industry. While knowledge from this community is not typically applied towards healthcare, a primary aim by this community is in the explicit attraction and engagement of individuals' attention. As we work to develop this web-based VH interactive system we are working closely with experts in all three of these models to achieve our goal of engaging and focusing this unique user base on the steps to initiate care as needed. Additionally, all interactions will be consistent with findings that suggest that interventions with individuals with PTSD and other psychosocial difficulties achieve the following: 1) promotion of perceptions of self-efficacy and control 2) encouragement of the acceptance of change; 3) encouragement of positive appraisals; and 4) an increase in the usage of adaptive coping strategies (18). These principles of intervention will be implicit in all of the interactions between the SimCoach and its users.

4. Conclusions

The systematic use of artificially intelligent virtual humans in Clinical Virtual Reality applications is still clearly in its infancy. But the days of limited use of VH's as simple props or static elements to add realism or context to a VR application are clearly in the past. In this paper we have presented our general approach to the design and development of the SimCoach VH project envisioned to serve as an online clinical healthcare guide or coach. This work is focused on breaking down barriers to care (stigma, unawareness, complexity, etc.) by providing military SMs, Veterans, and their significant others with confidential help in exploring and accessing healthcare content and for promoting the initiation of care with a live provider if needed. This work will also afford many research opportunities for investigating the functional and ethical issues involved in the process of creating and interacting with virtual humans in a clinical context. While the ethical challenges may be more intuitively appreciated, the functional technology challenges are also significant. However, although this project represents an early effort in this area, it is our view that the clinical aims selected can still be usefully addressed in spite of the current limits of the technology. As advances in computing power, graphics and animation, artificial intelligence, speech recognition, and natural language processing continue to develop at current rates, the creation of highly interactive, intelligent VHs for such clinical purposes is not only possible, but probable.

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