Simulating Military Radio Communications Using Chat-Bot Technology

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ABSTRACT

In most modern warfighter simulations users interact with semi-automated forces (SAF) through a graphical user interface (GUI). Players point and click on SAFs they wish to control and command them via the GUI. While this provides good command staff training it is not a realistic simulation of how the staff would actually function during exercises with troops or wartime. In the real world the command staff would use their radio networks to communicate with troops and issue orders. This type of communication using formatted radio messages is rarely modeled in simulations and could easily be added using modern Chat-Bot technologies.

Although Chat-Bot technology still has a long way to go in the field of parsing and responding to conversational natural language, the technology has developed enough to handle the structured forms of military radio communications. By modifying the AI of the Chat-Bot to handle these communications the Chat-Bot can interact with the user via formatted radio messages. The Chat-Bot can then be attached to the AI of the SAF and act as its command interface. The command staff can then send radio messages to the SAF, just as they would with real forces, and the SAF would act accordingly. Currently these radio messages must be text based, however given the available technology and advances in voice recognition software these interactions may soon be performed via voice or radio transmissions. A Battalion could set up their Tactical Operations Center and command real and virtual units over the same radio network operating as they would in wartime.

This paper will focus on the modification of the AI to interact using standard military radio messages, techniques for setting up a network of these entities, methods for connecting Chat-Bot AIs to the SAFs and some of the research and prototypes that are currently being tested.

ABOUT THE AUTHORS

Donald J. Stoner is a Software Engineer for the Titan Corporation. He has developed tools for visualizing simulation events, for networking multiple simulations, and is currently working on the Military Equipment Parametrics Engineering Database (MEPED) and the Deployable Intelligence Simulation for Collaborative Operations (DISCO). He has worked on modeling intelligence sensors in simulations for the Intelligence and Electronic Warfare Tactical Proficiency Trainer (IEWTPT). He is a former member of Army Military Intelligence and Special Forces with experience in signals interception, reconnaissance and surveillance. He is applying this experience by developing simulations designed to train intelligence system operators.

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INTRODUCTION

Most modern warfighter simulations require users to interact with the simulation through a role player who acts as a member of the military training audience but is actually a supplement to the computer simulation. This human's job is to provide the voice of the simulation and to serve as a translator from tactical orders into computer executable commands. In large staff training exercises, these role players are being partially replaced by the use of direct simulation-to-C4I interfaces. However, in lower-level operational training scenarios, the training audience must interact via spoken voice using radio equipment. Chat-Bot technologies have the potential to replace role players who must speak to the training audience. Our research has been in identifying the best chat-bots for this application and creating databases that can drive these chat-bots for military training. Applying these technologies also requires the integration of a number of different software applications, which is the secondary focus of our research.

Although Chat-Bot technology still has a long way to go in the field of parsing and responding to conversational natural language, the technology has developed enough to handle the structured forms of military radio communications. By modifying the AI of the Chat-Bot to handle these communications the Chat-Bot can interact with the user via formatted radio messages. The Chat-Bot can then be attached to the AI of the SAF and act as its command interface. The command staff can then send radio messages to the SAF, just as they would with real forces, and the SAF would act accordingly. Currently these radio messages must be text based, however given the available technology and advances in voice recognition software these interactions may soon be performed via voice or radio transmissions. A Battalion could set up their Tactical Operations Center and command real and virtual units over the same radio network operating as they would in wartime.

This paper will focus on the modification of the AI to interact using standard military radio messages, techniques for setting up a network of these entities, methods for connecting Chat-Bot AIs to the SAFs and some of the research and prototypes that are currently being tested.

HISTORY OF CHAT-BOT TECHNOLOGY

Chat-Bots have been around for nearly 20 years, but have only recently been gaining wide spread use. The first Chat-Bot was the Eliza program. This was a psychologist Chat-Bot created by a professor at MIT in the 1980's. A few years ago, Dr. Richard Wallace wrote A.L.I.C.E., the Artificial Linguistic Internet Computer Entity, a new Chat-Bot program. It won the Loebner Award, which is the first formal instantiation of a Turing Test. The test is named after Alan Turing the brilliant British mathematician. Among his many accomplishments was basic research in computing science. In 1950, in the article *Computing Machinery and Intelligence* which appeared in the philosophical journal Mind, Alan Turing asked the question "Can a Machine Think?" He answered in the affirmative, but a central question was: "If a computer could think, how could we tell?" Turing's suggestion was, that if the responses from the computer were indistinguishable from that of a human, the computer could be said to be thinking. After winning the Loebner Award, the program was later updated by Dr. Wallace, Jon Baer, and others and programmed in Java. They later set up the Alice AI Foundation to promote the programming of Alicebot's and help direct the new Artificial Intelligence Mark-up Language (AIML).

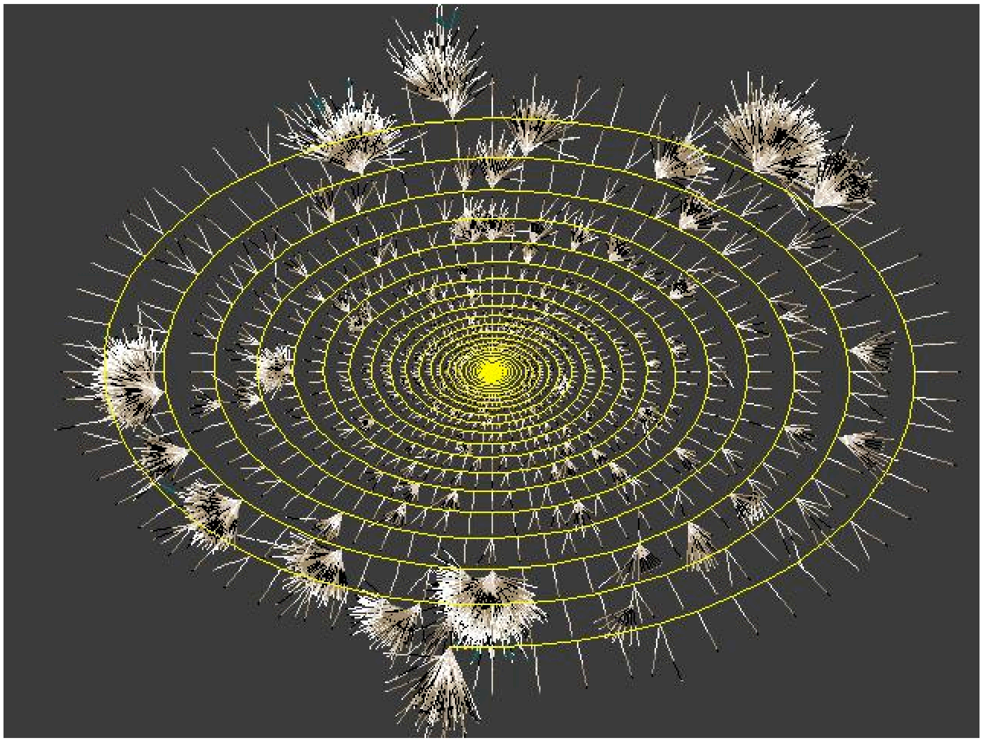

Figure 1 Graphic Representation of the AIML Parsing Tree used by the Graphmaster

Components of the Chat-Bot

The Chat-Bot software is composed of three main components. The first is the Responder, which is the interface between the user and the core routines. It handles the input and output, transfers user data to the Classifier, and delivers the bot's response to the user. The Classifier normalizes and filters the input. It applies substitutions and splits the user input into logical components. The normalized strings are then transferred to the Graphmaster. It also processes the output from the Graphmaster, handles various AIML instructions, and delivers the bot's reponse to the Responder. The Graphmaster organizes the storage of the brain contents. The content is stored as a graph. The Graphmaster handles the pattern matching process, which involve an advanced search-tree algorithm (see figure 1). The Graphmaster then returns the raw response to the Classifier.

Artificial Intelligence Mark-up Language

AIML enables people to input knowledge into Chat-Bots based on the A.L.I.C.E software technology. The Alicebot software community developed AIML during 1995-2000. It was originally adapted from a non-XML grammar also called AIML, and formed the basis for the first Alicebot, A.L.I.C.E.

AIML describes a class of data objects called AIML objects and partially describes the behavior of computer programs that process them. AIML objects are made up of units called topics and categories, which contain either parsed or unparsed data. Parsed data is made up of characters, some of which form character data, and some of which form AIML elements. AIML elements encapsulate the stimulus-response knowledge contained in the document. Character data within these elements is sometimes parsed by an AIML interpreter, and sometimes left unparsed for later processing by a Responder. The AIML also has the ability to use JavaScript within the categories and it can be used to call executables.

Figure 1 is a graphical depiction of the AIML parsing tree. The large nodes with numerous branches represent patterns associated with common interrogatives like WHAT, WHO, WHEN, and WHERE.

Chat-Bot Interfaces

Most Chat-Bots currently in use are text based. The user and the Chat-Bot communicate via text-messaging or some other form of keyboard interface. Technology for speech recognition and text to speech generation is improving rapidly and some Chat-Bot interfaces are beginning to use these. It will soon be common to deal with computers and even Chat-Bots through speech recognition. There are quite a few programs available today, such as Naturally Speaking or ViaVoice, that use this type of technology for hands free use of operating systems and computer applications. This technology can also be experienced in many automated phone response systems. By using this speech recognition and text to speech technology the Chat-Bots can be adapted to interface over phone lines, via computer terminals, and hopefully someday over standard radio communications devices.

THE PROBLEM: USER INTERACTION WITH SEMI AUTOMATED FORCES

In the majority of modern warfighter simulations interaction with the Semi Automated Forces (SAF) is typically controlled by point and click techniques. Drop down menus and other graphic interfaces controls are used to set SAF dispositions and its actions. These types of controls are effective for the purpose they were designed for but they do not provide a realistic interface.

In today's military training environment integrating simulations with real world exercises is becoming increasingly important. More and more simulations focus on interacting with real units out in the field, but how can a commander experience the realism of the training if they are directing half of their units by pointing and clicking on a computer screen and the other half by standard radio communications?

To create a truly realistic training environment the simulation should be able to interact with the battlefield commanders in the same manner as the real players. It is this problem of interaction that this paper focuses on and will attempt to address using the Chat-Bot technology.

SAF Communications

There is a variety of methods in which SAFs communicate. The automated forces may be directed by the user using point and clicks, by drop down menus on a graphic user interface, or the SAF may be directed by the simulation, directly based on orders or choices given by the users. These directions to the SAFs can take any number of forms from interactions to directly changing parameters within these automated forces.

These techniques are designed for efficiency in the computer system, and to accomplish the simulations over all mission. Often realism of interaction is not taken in to account or even considered by these simulations. This is not a shortcoming in the simulation it is simply how it was built given its design parameters.

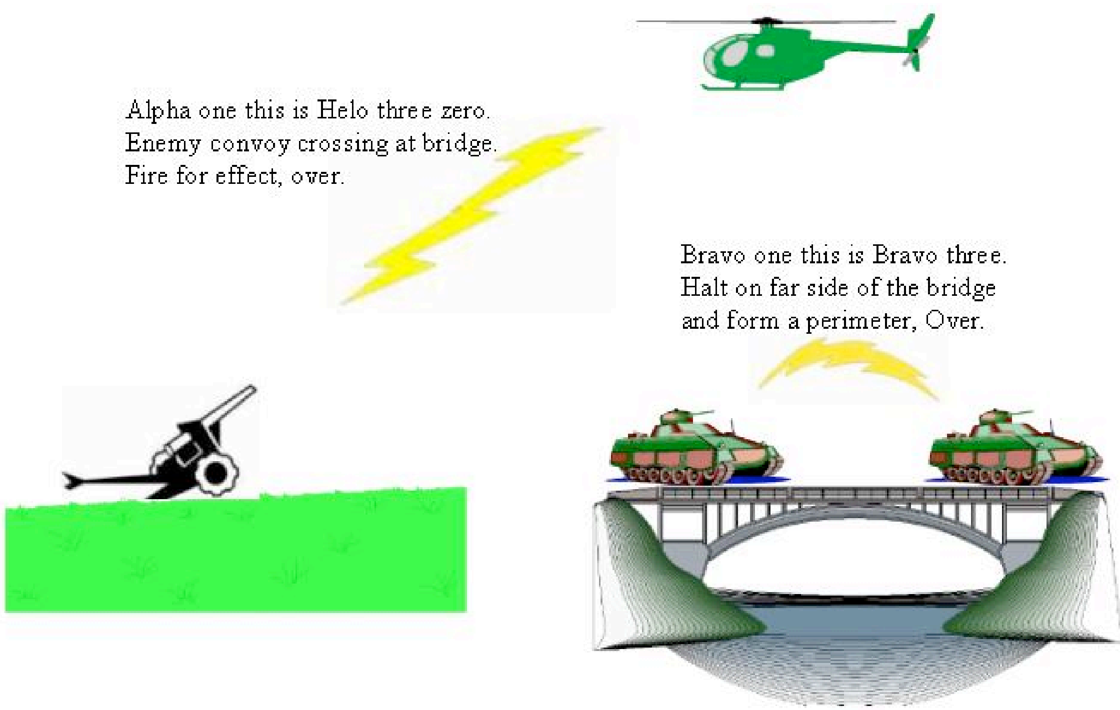

Figure 2 Radio Communications

Real World Communications

When a battlefield commander directs his troops it is typically done through radio message traffic. His communications staff operates the radios that keep him in touch with his troops as well as superior and subordinate commands. Everything from command and control through supply and support are handled via these radio messages.

The format for these messages is very static. Specific messages have a specific formats with each line having a specific meaning. Deviation from these patterns is rare and there is little change in standard radio procedures. These radio messages are also made up of generic radio communications such as radio checks, call-ups, sign-offs and authentication. It can be viewed as a small subset of natural language with some changes made to the grammatical rules and message structure.

Descriptions and specification for these messages and procedures can easily be found in military radio communications manuals such as FM 11-32 Combat Net Radio Operations, Signal Operation Instructions (SOI) and even the United States Message Text Format (USMTF) message format manuals.

This is how the battlefield commander communicates with his units, not through pointing and clicking on icons on a computer screen, or drop down menus, and while the day may come when that is how military units are directed that is not the case today. In an ideal training environment the commander would operate just as he would in wartime and the crux of the problem is how to integrate this realism into modern simulations.

THE SOLUTION: CHAT-BOTS AND THE SEMI AUTOMATED FORCES ARTIFICIAL INTELLIGENCE

How do you solve the problem of realistic SAF interaction? One possible solution has been developing on the internet. It is the use of Chat-Bot technology. Chat-Bots are software programs designed to interact with people using natural language typically through instant messenger type programs. These programs use artificial intelligence (AI) to create an interactive program that can be used for anything from marketing to a simple help desk. By tailoring the Chat-Bot's AI to handle standard military radio message formats and procedures it can be adapted as an interface for the SAFs.

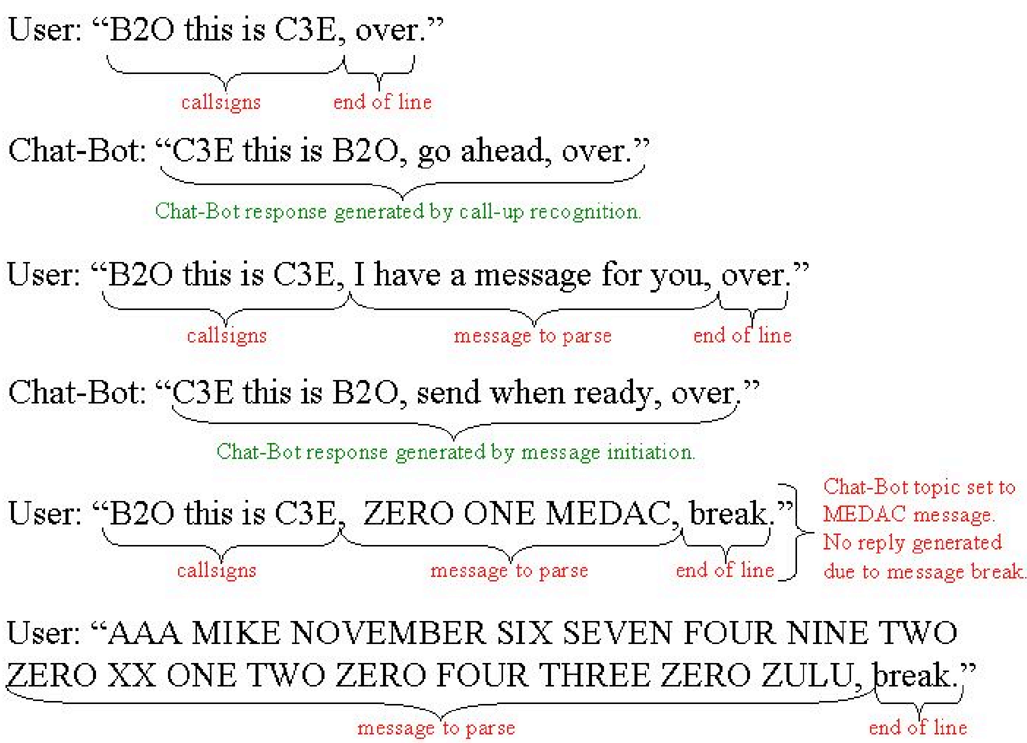

Figure 3 Chat-Bot Message Parsing Example

Modifying the Chat-Bot AI to Parse Military Communications

Creating an artificial intelligence program to deal with natural language is no small undertaking. The complexities of natural language are vast and trying to determine and deal with all possible permutations is a daunting task. Fortunately the patterns and rules of military communications breaks down to a small subset of the natural language complexities. Military communications are very structured in their nature and have certain protocols, which must be followed. There are certainly variations allowed but nothing as substantial as natural spoken language. Modifying a Chat-Bot AI to deal with these types of communications is certainly a non-trivial exercise but feasible and manageable.

The first step is in setting up the AI to deal with callsigns and programming in the rules of communications. Message structure must be set up and ways of determining content or topic must be written in. Formal radio messages should always begin with the sender and receiver's callsigns, and lines of message should always end with either "over", "break", or "out". The AI is set up to check these and determine if the proper sender and receiver were used in the message, and that messages are terminated properly. This is used for error checking, as a means for determining when the message is complete and parsing should begin, and will be seen as a device later used for determining which SAFs are being directed by the User.

All communications start out as generic radio messages. This means that the usual call-ups, radio checks and authentication are all covered under one section of the AI. When a message is initiated it starts with a call-up. This is the sender calling the receiver. The receiver in turn acknowledges this. Then the authentication takes place. Once this is completed the sender moves into the message they wished to send. When a specific message is sent the AI topic is set to that message and all messages are parsed under that message specific topic. This allows for putting the proper information in the correct context. The data can then be stored in a database for later use or it can be used by the SAF. Once this message is complete the AI resets to the generic radio message topic and is ready to deal with any new type of message. Once all messages have been sent and received the AI then resets to the generic communications and sign-off can take place between the sender and receiver. The Chat-Bot is then ready to begin again.

Given the correct type of prompts or stimulus from a driver program, such as a SAF, the AI can be used to send information as well. The AI can read the data from a database and insert it into a message. The message is then sent out to the user in military radio message formats using standard procedures. An example of this would be a SAF tank that is hit by enemy fire. The Chat-Bot would monitor the status of the tank and when its health was lowered due to the hit it would initiate a call to its higher headquarters stating that it had come under attack.

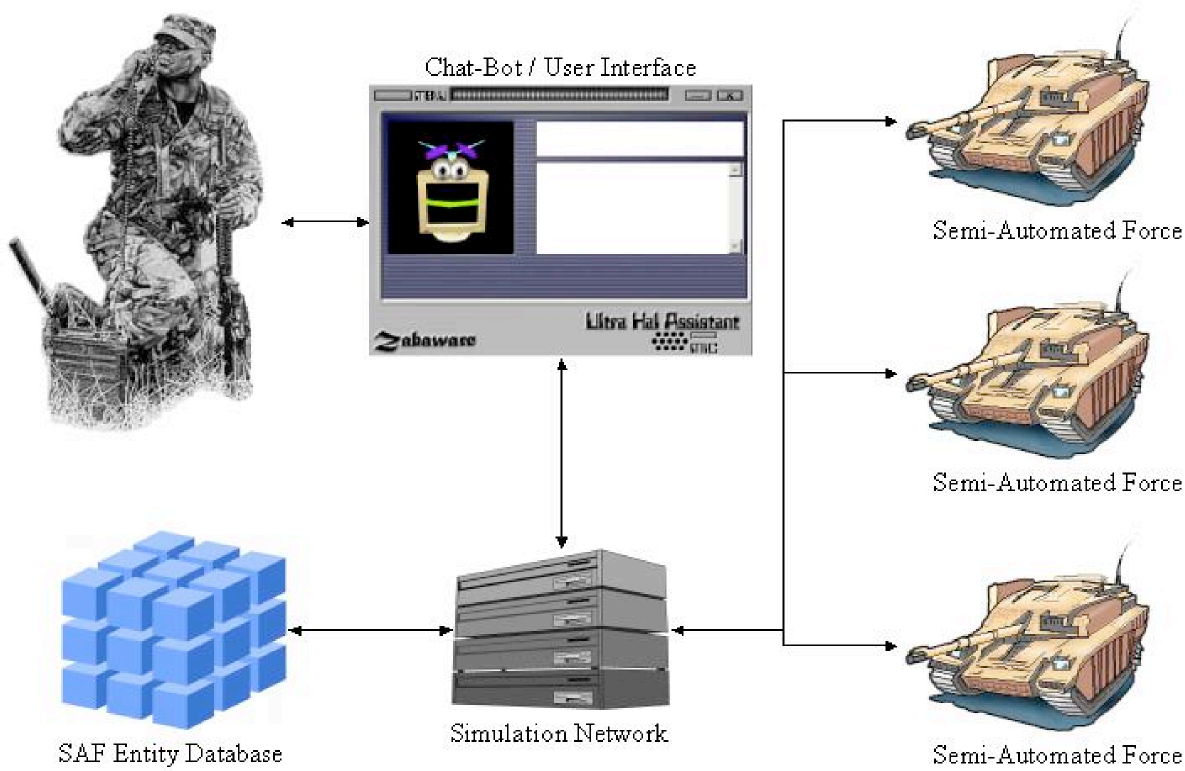

Figure 4 Chat-Bot to SAF Interface Flow Through

Connecting the Chat-Bot to the SAF AI

The Chat-Bot is fairly flexible in how it deals with SAFs. The Chat-Bot can be configured to pass data directly to a given SAF or it can store data in a database to be accessed by multiple SAFs. These configurations allow the Chat-Bot to be adapted to most modern simulations. In some cases a driver program or interface may need to be written for the Chat-Bot to deal with specific types of SAFs, but the data in general and the interfaces with the user should remain constant.

The AI of the Chat-Bot can be configured to directly call functions on a SAF sending the commands directly to the unit. This works best on a one to one scale with the Chat-Bot representing only one SAF. As the Chat-Bot can act as multiple actors the database storage technique can be the most effective for handling multiple SAFs. In this technique the data for each SAF is stored in a specific area of the database. When the SAF needs to pass data back and forth to the User it reads and writes data from its specific area. This allows the Chat-Bot to handle traffic for multiple entities without using up large amounts of system memory.

In cases where the SAF entities cannot deal with the database, then a driver or interface program would need to be adapted. Other techniques for connecting the Chat-Bot AI to the SAF could certainly be developed and are only limited by imagination and need. The interface could easily be tailored to the different simulation networks. This would allow for maximum efficiency if desired.

Network Simulation Techniques

Within the context of this type of training, there are multiple communication networks that need to be represented. These networks represent different areas of interest within the military communication infrastructure. Examples of this include a Command Network and a Supply and Support Network. These networks often have sub-networks based upon echelon. In addition to being logical, these networks are often physical as they quite often use separate, reserved radio frequencies for their communication traffic.

The use of these networks, like the format of the radio messages themselves, is well defined and quite independent of the other communication networks.

This well-defined and independent nature lends itself to the use of separate Chat-bots per predefined radio frequency each representing the entities likely to be encountered on that corresponding communication network. While these networks are quite independent, knowledge of dynamic "ground truth" within the simulated world would need to be represented to the appropriate extent. The Chat-Bots would access this type of situational information through a common database or through their interface to knowledge gained and stored by the SAF entities they represent.

In the case of either a part-task radio operator trainer or an interface to SAF, the switching of Chat-Bots representing the different communication networks would be achieved through the user interface. This user interface would require the "dialing up" of the proper frequencies through standard menus or graphical representations of actual equipment. The Chat-Bots would then respond in a doctrinally correct way to messages on the networks they represent. Messages sent to inappropriate networks would easily be caught by that network's Chat-Bot due to the invalid call signs that would be used.

CHALLENGES

While the current capabilities of Chat-Bots and the AIML are extensive and very adaptable to modern simulations there are still several challenges to be faced.

Limitations of the AIML

One of the biggest problems is in the limitation of the Artificial Intelligence Mark-up Language capabilities. The language is designed for a simple query and response kind of interaction with the user. To be more effective in simulations the language needs to be given more interactive capabilities. It needs to be able to initiate communications and be more pro-active in communicating with users. This can be accomplished by extensive work in generating AIML files, but will need some help by adapting the driver, or chat programs to be smarter and more simulation driven.

Speech Recognition and Text to Speech Generation

Another major problem for future use is in the areas of speech recognition and text to speech generation. While this can be done in a quite environment at a computer terminal the technology is not currently at a level that would allow use over a radio communications network. Any static in a received message would be difficult for the speech recognition software to interpret and would result in numerous incorrect responses. The difficulty in the text to speech generation is in the realism of communications. For the ultimate level of realism the user wouldn't be able to tell if they were talking to a real person or to a computer. Unfortunately the current technology is machine sounding. The speech doesn't flow smoothly and voice is obviously machine generated. Hopefully future developments in the fields of speech recognition and text to speech generation will solve these problems.

OTHER APPLICATIONS

The adaptation of the Chat-Bot Artificial Intelligence to future applications has a great deal of potential. Specifically the use of standardized radio message formats has many applications in the modeling and simulations fields.

Radio Operator Trainer

One application of the Chat-Bot technology that could easily be constructed using the current technology is a radio operator trainer. The Chat-Bot could be adapted to allow radio operators to practice sending and receiving message traffic just as they would on real radio systems. Call-ups, authentication, messages and sign-offs could all be practiced without the need for setting up radio systems or performing complicated radio exercises. This trainer would be easily distributable and would allow soldiers to stay proficient in radio communications procedures with a minimum of support required.

COMINT Enhancements in Simulations

One of the areas lacking in modern simulations is communications intelligence (COMINT). Unless the simulation is specifically designed to provide this type of data to the users it is typically non-existent. As explained in the earlier section SAF entities typically communicate and interact without any type of generated signal or message. They are simply not designed for this purpose.

Why is this information important? Intelligence systems are becoming increasingly important on today's battlefields and in planning for future military operations yet it is one of the most difficult areas to train. By using the developed Chat-Bot technology and attaching it to the AI of the SAF these missing messages can be generated and inserted into the simulation for the intelligence system operator to collect on.

The SAF operates as normal with the addition of the Chat-Bot. The Chat-Bot monitors the SAF and when triggered by the SAF's actions a message is generated and put out on the network. This can also be used between SAFs when they are interacting. These generated messages can then be collected by the intelligence system operator and reported as they would any collected intelligence.

This message traffic generation would significantly add to the training of the operator and give them more information to report on and aid the command staff in determining their courses of action.

Inter-Simulation SAF Communications

Another possible application of this technology is in inter-simulation communications. One of the problems faced today is connecting various types of existing simulations together to create a more comprehensive trainer. By using these standardized radio messages SAFs could communicate from one simulation to another without the necessity of adapting their network structure to multiple simulations and systems. It is even feasible that these simulations could interact over radio networks just as the real forces operating in the simulation. A radio operator could feasibly talk to SAF entities in multiple simulations over their radio network just as they would the real players.

SUMMARY

The field of Chat-Bot technology is rapidly burgeoning. By adapting this technology to military radio communications and developing interfaces to modern computer simulations the realism of the training environment for battlefield commanders and their staff can be greatly increased, and the line between real units and SAF units in a simulation can be made a little fuzzier. The potential for a wide variety of uses exists in these Chat-Bots. The technology currently exists for application development now, and the rapid expansion of this field ensures the increase in capability and greater realism in the future. With the development of prototypes hopefully interest will grow within the modeling and simulation communities.

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