

A Crisis Communication Network Based on Embodied Conversational Agents System with Mobile Services

Ong Sing Goh, Cemal Ardil, Chun Che Fung, Kok Wai Wong, Arnold Depickere

Abstract—In this paper, we proposed a new framework to incorporate an intelligent agent software robot into a crisis communication portal (CCNet) in order to send alert news to subscribed users via email and other mobile services such as Short Message Service (SMS), Multimedia Messaging Service (MMS) and General Packet Radio Services (GPRS). The content on the mobile services can be delivered either through mobile phone or Personal Digital Assistance (PDA). This research has shown that with our proposed framework, the embodied conversation agents system can handle questions intelligently with our multilayer architecture. At the same time, the extended framework can take care of delivery content through a more humanoid interface on mobile devices.

Keywords—Crisis Communication Network (CCNet), Embodied Conversational Agents (ECAs), Mobile Services, Artificial Intelligence Neural-network Identity (AINI)

I. INTRODUCTION

DURING the past decade, rapid advances in embodied conversational agents, spoken language technology, natural language processing, multimodal interfaces and mobile applications have stimulated interest in a new class of *conversational interfaces* [2], [3], [4], [5] and [6]. Many researchers have been involved in AI researches into natural language conversation [7], [8], [9], [10]. They have proposed different techniques and produced several natural language conversation systems. Every year they present their work by competing for the Turing Test [11].

This paper aims to address the issues of managing global crisis communication by introducing a crisis communication portal called Crisis Communication Network (CCNet). In particular, this paper focuses on two aspects of the system – an

ECA called Artificial Intelligence Neural-network Identity (AINI) which delivers essential contents of news grabbed from trusted first sources online documents and the application of the ECA in mobile services.

The purpose of AINI is to deliver essential information from trusted and updated sources and it is able to interact with its users by ECA. The idea is to rely on a human-like communication approach thereby providing a sense of comfort and familiarity.

In this paper, one of the aims is to extend our basic AINI framework to facilitate delivering content through mobile services. Mobile communication technologies reduce reliance on static communication methods (e.g. land-line phones), and increase confidence and perceived safety when moving[1]. The portability of new miniaturized devices, together with their ability to connect conveniently to networks in different places, makes mobile computing possible. As mobile services will be becoming more and more important, this has been the motivation of extending the basic framework to include mobile services.

Despite the recent growth in information and communication technology, many applications have minimum amount of intelligence in aid of human-computer communication. On the other hand, practical Artificial Intelligence (AI) technologies have gained wider acceptance and have been incorporated in many information technology (IT) applications. The aim of the development of the conversation robot is to provide a human-like communication environment. Such “humanized” communication approach is the current trend in the IT world regardless whether it is web-based or mobile-based.

To achieve the above objective, an intelligent agent software robot AINI has been developed. AINI has customized Artificial Intelligence Markup Language (AIML)[8] servable knowledge base being incorporated to serve as a real conversation software robot in the CCNet Portal. With the increasing availability of wireless and mobile technologies, the proposed CCNet portal also uses the latest technologies such as mobile chat and PDA chat, which in turn will be used to send text-based information and images of the latest information to subscribed users.

Manuscript received June 2006. This research funded by Research Excellence Grants Scheme, Murdoch University, Western Australia
Ong Sing Goh is with the Murdoch University, Perth, Western Australia (e-mail: os.goh@murdoch.edu.au)
Cemal Ardil is with the National Academy of Azerbaijan, Baku, Azerbaijan (e-mail: cemalardil@gmail.com)
Chun Che Fung is with the Murdoch University, Perth, Western Australia (e-mail: l.fung@murdoch.edu.au)
Kok Wai Wong is with the Murdoch University, Perth, Western Australia (e-mail: k.wong@murdoch.edu.au)
Arnold Depickere is with the Murdoch University, Perth, Western Australia (e-mail: a.depickere@murdoch.edu.au).

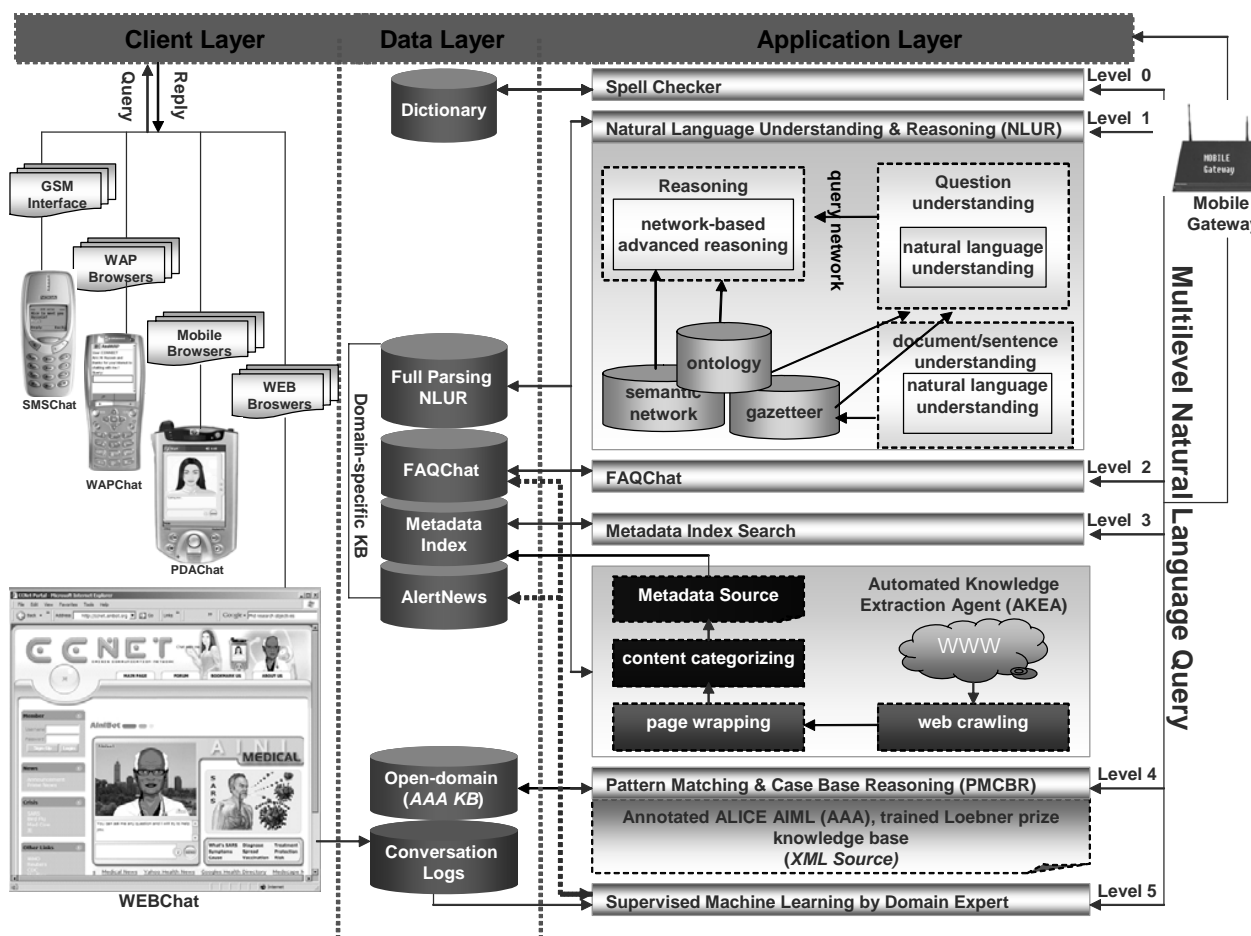


Fig. 1 AINI's Architecture in the CCNet Portal

II. AINI's ARCHITECTURE

This research project involves the establishment of a CCNet portal¹. The objective is to use the ECA, called Artificial Intelligent Neural-network Identity [12, 13] as the basic architecture. Our real-time prototype relies on distributed agent architecture designed specifically for the web and mobile technology. The software agent is based on a conversation engine using a multi-domain knowledge model and with multimodal human-computer communication interface. It also offers multilevel natural language query which communicates with one another via TCP/IP. In short, AINI is a conversation agent designed by the authors that is capable of having a meaningful conversation with the users. From another perspective, AINI can be considered as a software conversation robot, which uses a form of human-computer communication system which is a combination of natural language processing and multimodal communication.

A human user can communicate with the developed system using typed natural language conversation. The embodied conversation agent system will reply text-prompts or Text-to-Speech Synthesis together with appropriate facial-expressions.

For the purpose of this research, the application area chosen for designing the conversation agent is primarily in the context of SARs epidemic crisis using scripting and incorporation of artificial intelligence.

As illustrated in Fig. 1, AINI adopts a hybrid architecture that combines multi-domain knowledge bases, multimodal interface and multilevel natural language query. Given a question, AINI first performs question analysis by extracting pertinent information to be used in query formulation, such as Noun Phrases and Verb Phrases. AINI employs an Internet three-tier, thin client architecture that may be configured to work with any web application. It comprises of a data layer, application layer and client layer. This Internet specific architecture offers a flexible solution to the unique implementation requirements of the AINI system.

¹ The experiment portal can be access at <http://ainibot.murdoch.edu.au>

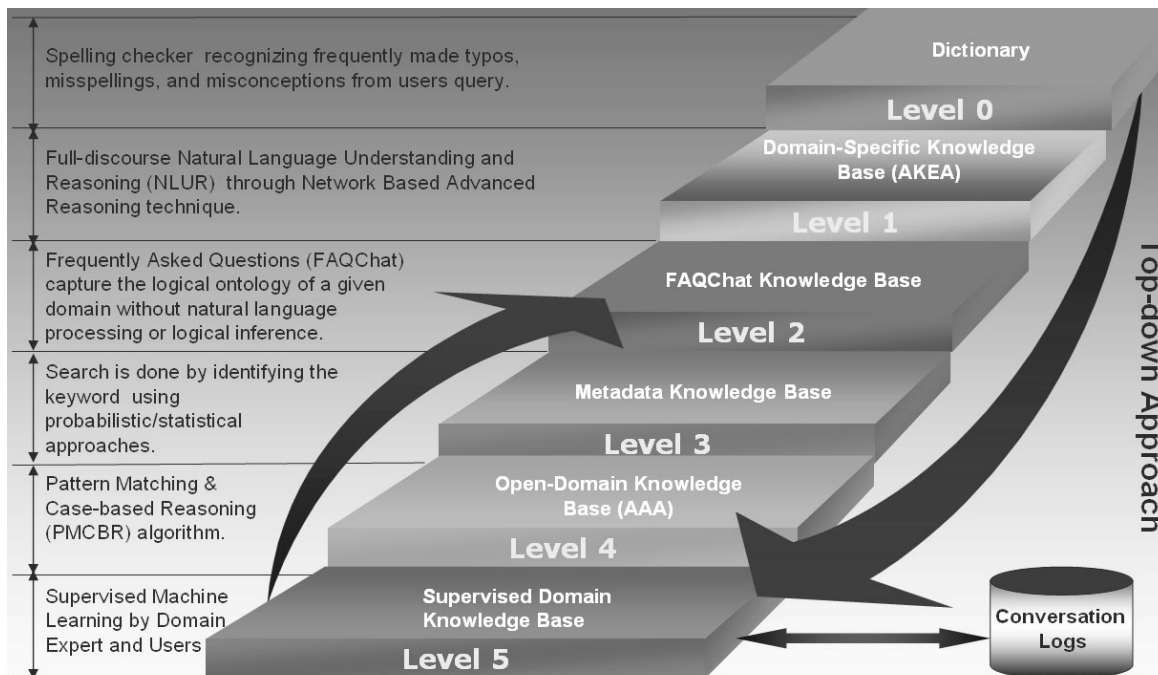


Fig. 2 Top-Down NL-Query Approach

A.. Data Layer

The data server layer serves as storage for permanent data required by the system, where the epidemic knowledge bases are stored. These databases are Dictionary, Domain-Specific, Open Domain and conversation logs. The dictionary is an *ispell* which was first ran on TOPS-20 systems at MIT-AI lab². Domain-Specific database is extracted by the Automated Knowledge Extraction Agent (AKEA) which consists of Full Parsing Natural Language Understanding and Reasoning (NLUR), FAQChat and Metadata Index. AKEA was designed to establish the knowledge base for a global crisis communication system called CCNet. CCNet was proposed during the height of the SARs epidemic in 2003[14].

The Open-Domain database is taken from the existing award winner Turing Test. This trained Knowledge Base is also called Annotated ALICE Artificial Intelligence Markup Language (AAA) [8, 15] where the conversation logs reside. These web-enabled databases are accessible via the SQL query standard for database connectivity using MySQL database.

B. Application Layer

The AINI Server and Mobile Gateway are located in the application layer. WAP and SMS gateway[16] serve as mobile gateway is used widely across the globe both for serving millions of short messages (SMS) and pushing WAP services. They function as the interconnection path between the client layer and data layer in the CCNet Portal. AINI's engine is a unique intelligent agent framework. All communication with AINI is performed through a natural interface that uses a

natural language processing and speech synthesized via a 3D animated character known as avatar. AINI's engine implements its sophisticated decision making network based on the information it encounters in the knowledge bases. These decision-making capabilities make use of the XML specifications. The input and output of each module is an XML-encoded data structure that keeps track of the current computational state. These modules are conceptualized as transformations over this XML data structure. The system accepts questions and requests from users, and processes the queries based on the information contained in AINI's knowledge base.

The application server layer handles the processing of logic and information requests. Here, one or more application servers are configured to compute the dialogue logic through the multilevel natural language query algorithm[17]. In this layer we simulated goal-driven or top-down natural language query (NL-Query) approach just like human's process their language. The top-down approach seems to be a good model for explaining how humans use their knowledge in conversation. From the literature search, we concluded that in the field of Natural Language Processing (NLP), it seems that the top-down approach is far the best approach. As shown in the Fig. 2, our top-down NL-query approach consists of 6 level of queries, namely Spell Checker (Level 0), Full-discourse NLUR (Level 1), FAQChat (Level 2), Metadata Index Search (Level 3), PMCBR (Level 4) and Supervised Machine Learning by Domain Expert (Level 5).

C. Client Layer

The user interface resides in the thin-client layer and is supporting web-based and mobile service interface. For the

² <http://www.mit.edu/afs/sipb/project/sipb-athena/src/ispell/>

web-based, its employs Multimodal Agent Markup Language (MAML) interpreter or Microsoft SAPI to handle the user interface. MAML is a prototype multimodal markup language based on XML that enables animated presentation agents or avatars. It involves a talking virtual lifelike 3D agent character that is capable of having a fairly meaningful conversation.

However for mobile devices as they have small screens, there are limitations on the amount of information that they can be presented at one time. Reading large amounts of information from such devices can require large amounts of

performance and lightweight client runtime that delivers powerful and consistent user experiences across major operating systems, browsers, mobile phones and devices. For the WAP services, the application was embedded WAP browsers from vendors such as Openwave³ and Nokia⁴.

The conversation engine is implemented by open-source architecture employing Kannel Mobile gateway [16], PHP, Perl scripting language, Apache Server and knowledge base stored in a MySQL server.

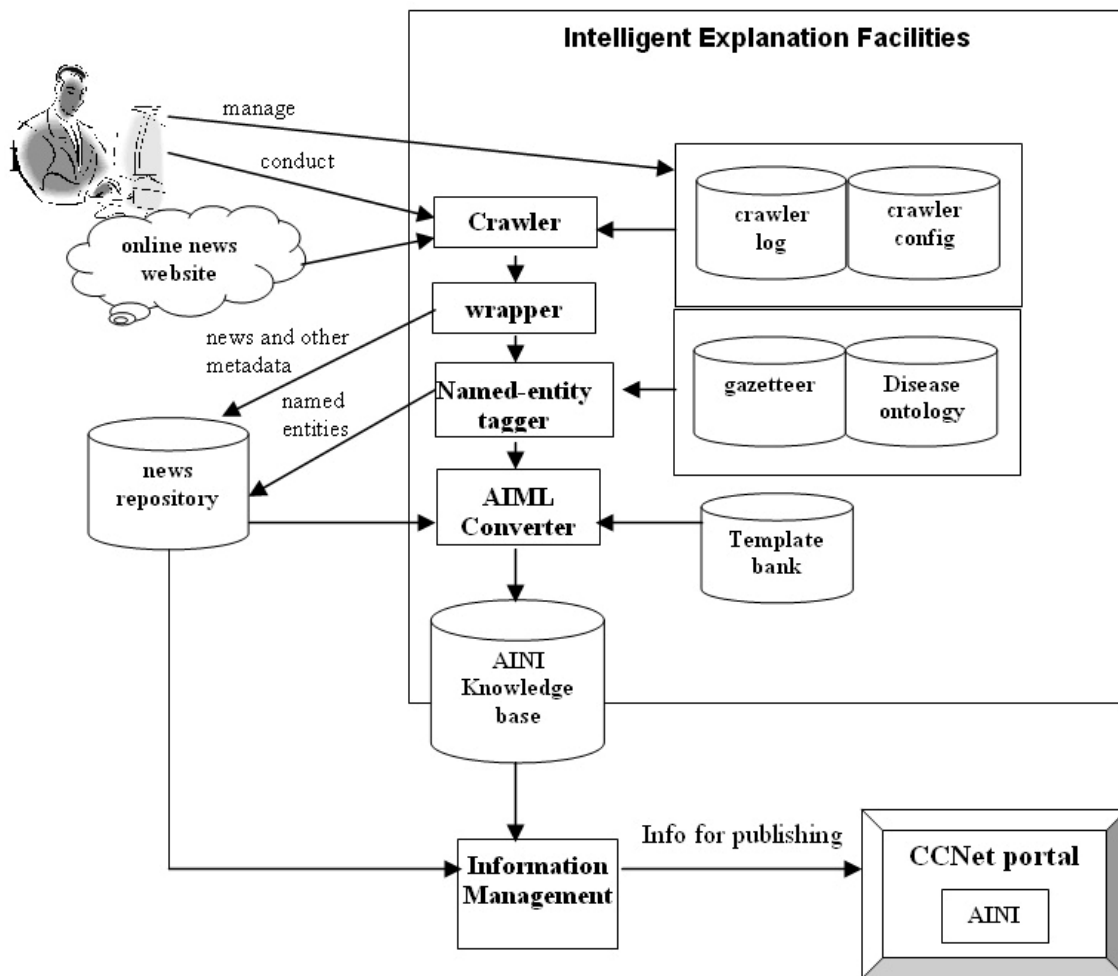


Fig. 3 AKEA Framework

scrolling and concentration. To reduce distraction, interactions, and potential information overload, a better way of presenting information might be through multilevel or hierarchical mechanisms[18]. Hence, chatting mode interface will be the better solution for mobile service. In addition, current wireless network service vendors have introduced a wide bandwidth telephone network, known as 3G communication [19], and it enhances the possibility of adapting a smartphone as a client in traditional distributed systems. On the PDA or SmartPhone, our system required Mobile Flash Player [20]. This Flash player is high

III. AINI's DOMAIN KNOWLEDGE MODEL

In our research, the domain model is the taxonomy of knowledge related to the topic of the presentation, or XML-like metadata model. This will reduce the workload of the domain administrator or domain expert to predict every input typed by the user. Instead, this allows the author to put more

³ <http://developer.openwave.com>

⁴ <http://www.nokiausa.com/support/software>

effort on scripting conversation within a specified domain or conversation Domain-specific.

We believe that the ultimate conversational human-computer interface uses and requires different kinds of approaches. Therefore, we have been working to develop a domain knowledge model for building conversation and interactive systems. For example, according to S. Kshirsagar and N. Magnenat-Thalmann [17], having a small conversation about the weather requires a lot less resources than a philosophical discussion about the meaning of life. In our research, we defined our conversation system as a collective of specific conversation units; every unit handles a specific conversation between user and computer. In our case, Domain-Specific knowledge base is created from the epidemic online document from selected websites⁵.

Domain knowledge is one of the dimensions that determines the focus or direction of a conversational system. An Open-domain will practice techniques based on probabilistic measures and has a wider range of information source. For a system that focuses on certain domains, it is more likely that the techniques are more logic-based and well-founded, with relatively limited sources as compared to an Open-domain. A domain-oriented conversational system deals with questions under a Domain-specific environment, and can be seen as a richer approach. This is because natural language processing systems can exploit domain knowledge and ontologies. Advanced reasoning such as providing explanations for answers, generalizing questions, etc is impossible in Open-domain systems. Open-domain question answering systems need to deal with questions about nearly everything and it is difficult to rely on ontological information due to the absence of wide and yet detailed world knowledge. On the other hand, these systems have much more data to exploit in the process of extracting the answers.

In our architecture, we have implemented a multi-domain model: an Open-domain knowledge base which is converted from the AAA knowledge base and a Domain-specific knowledge base. The Domain-specific knowledge base is the epidemic online document extracted by the AKEA. AKEA will be discussed in more details in following section. However, if the user converses out of the presentation topic, we define this domain category as the Unanswered-domain which the knowledge is currently not available and randomly generated. This is to determine whether the user is chatting within the domain of the presentation topic or the user is conversing differently from the domain knowledge model presented. By doing this, we have rectified the trait of the conversation agent or software robot, from a diverse conversation to a specific presentation topic. The web knowledge base is continuously updated with facts extracted from online epidemic news using information extraction (IE) and knowledge representation by AKEA. IE is the task of extracting relevant fragments of text from larger documents, to allow the fragments to be processed further in some automated way. For example, to answer a user's query, the ontology and

gazetteer will be implemented as domain-dependent modular components, allowing future improvements.

A. Automated Knowledge Extraction Agent (AKEA)

The Fig 3. shows the architecture of the CCNet knowledge extraction agent framework called AKEA. Four modules make up the agent with the crawler as the interface between the agent and the web. The crawler is like those used in conventional crawler-based search engines. The crawler resolves root domain names and follows subsequent links that is available on a page until a certain depth is defined by the user. These configurations are set in the crawler config database. For every page crawled, a copy is returned for further processing by the wrapper. The activities of the crawler are logged in by the crawler log database.

Online news documents returned by the crawler are in the hypertext format and consist of a variety of unwanted characters (Fig. 4). The wrapper prepares the raw news by separating the actual news content and other meta-information from hypertext characters. This process is also known as cleaning and the result is referred to as cleaned news (Fig. 5). Information such as date of news, news title, news content and many more is extracted and stored in the CCNet news repository.

```
<html>
<head>
<title>New meningitis threat being contained by web
of partnerships</title>
...
<p><font face="Times, Times New Roman, serif"
size="3">
8 APRIL 2004 | GENEVA -- A rare strain of
meningitis, which re-emerged recently in Burkina
Faso...</font></p>
...
```

Fig. 4 Example of online news returned by crawler

```
title: New meningitis threat being contained by web
of partnerships
url:
http://www.who.int/mediacentre/releases/2004/pr25/en
/
date: 8 April 2004
content: A rare strain of meningitis, which re-
emerged recently in Burkina Faso..
```

Fig. 5 Example of cleaned news returned by wrapper

The syntactic preprocessor performs the task of identifying the dependencies among words. Based on the dependencies, grammatical relationship (i.e. phrasal categories) like noun phrases, verb phrases and prepositional phrases are extracted using sentence parser for the English language like Link Grammar[21] and Minipar [22]. The named entities in noun phrases are assigned with tags such as disease, location and person using the weighted gazetteer approach. A reference list known as gazetteer is used by the preprocessor. These tags enable the agent to identify what type of entity the corresponding noun phrases are and in which level and node do these entities belong to in the ontology.

⁵ <http://www.info.gov.hk/info/sars/>
<http://www.sars.gov.sg>

Pronouns are also resolved whenever necessary. The named entities that have been tagged are inserted into the corresponding entry in the news repository. For example, using the cleaned news in Fig. 5, the syntactic preprocessor managed to identify two named entities namely meningitis and Burkina Faso. Using the gazetteer, the preprocessor will discover that meningitis is a type of disease and Burkina Faso is a country and tag them respectively using the ontology tag in the form of named_entity [ontology tag].

In the gazetteers, each entry has additional information like weight, ontology id and the acceptable preceding/foregoing grammatical relations in addition to the triggering information, category and entity name. For example, a returned noun phrase “Japanese Encephalitis disease”, could trigger ambiguity. This could be resolved by just using the weighting mechanism without the need for any hand-crafted rules.

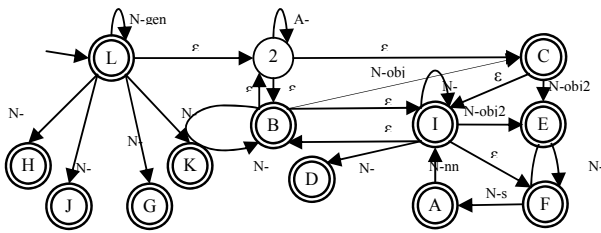


Fig. 6 Finite-state Automaton for noun phrases extraction

The algorithm adopted by our named-entity tagger employs finite-state automaton. The sentence to be named-entity tagged is first parsed for syntactic categories and grammatical relationships using the sentence parser of choice, Minipar. The output of parsing is then fed through the Finite-state Automaton (FSA) as shown in Fig. 6 to extract noun phrases. By inferring named-entity extraction criteria by [23], all named-entity are subsets of noun phrases and not merely proper nouns.

The information in the news repository is fed into two main components, namely the CCNet portal and the AIML converter. Information in the news repository is directly published to the CCNet portal without any further processing. Table 1 shows a sample entry in the news repository.

```
<pattern> [wh-token corresponding to the ontology tag]
_ [disease named_entity] _ </pattern>
<template> [first two lines of content]
<javascript>
window.open("[url]" , "" , "");
</javascript>
</template>
</pattern>
```

Fig. 7 Sample template A from the template bank

The AIML converter uses the template bank to transform the news repository entries into AIML representation, which will be populated into AINI’s knowledge base (Fig. 7). Substitutions will be made to the template using relevant values of each entry in the news repository. There are four

TABLE I
A SAMPLE ENTRY IN THE NEWS REPOSITORY

URL	DATE	TITLE	CONTENT	NAME ENTITY
http://www.who.int/mediacentre/releases/2004/pr25/en/	8 April 2004	New meningitis threat being contained by web of partnerships	A rare strain of meningitis, which re-emerged recently in Burkina Faso...	meningitis[disease] Burkina Faso[country]

fields in the template namely the wh-token corresponding to the ontology tag, first two lines of content, disease named entity and URL. The first and second requires some processing prior to replacement.

The ontology tag associated with each named entity is resolved to obtain the corresponding wh-token. Currently, the agent is capable of handling four types of wh-token: *where*, resolved from *location* named-entities, *when*, resolved from *date* named-entities, *who*, resolved from *agent* named-entities and *what*. The *what* token is resolvable from all ontological entities with additional tokens. For example, given the named entity *Burkina Faso* and its tag *country*, we can obtain the *where* token and *what* token with the *country* tag. This is possible because the question *where does meningitis...?* is similar to asking *what country does meningitis...?* As shown in the Fig. 8 and Fig. 9.

```
<pattern> where _ meningitis _ </pattern>
<template> A rare strain of meningitis, which re-emerged recently in Burkina Faso...
<javascript>
window.open("http://www.who.int/mediacentre/releases/2004/pr25/en/" , "" , "");
</javascript>
</template>
</pattern?>
```

Fig. 8 Instance 1 of template A using “where” token

```
<pattern> what country _ meningitis _ </pattern>
<template> A rare strain of meningitis, which re-emerged recently in Burkina Faso...
<javascript>
window.open("http://www.who.int/mediacentre/releases/2004/pr25/en/" , "" , "");
</javascript>
</template>
</pattern?>
```

Fig. 9 Instance 2 of template A using “what country” token

The second processing required prior to replacement is to truncate the news content to the first two lines to be used in AINI’s answers. The remaining news will be presented as part of a URL push.

The AIML converter follows precedence in converting named-entities and their ontology tag into AIML representation. All questions handled by AINI orbit the concept of disease and thus, all news content will surely contain disease named-entities. During conversion, priority

will be given to entities other than disease. Only when a news item that does not contain any other entities (i.e. there is no information about location, person or date) is encountered, then the converter will resolve the sole disease named-entity to the *what* token.

As an example, by referring to the sample entry in Table 1, a disease named-entity and country named-entity exists. Due to the priority given to non-disease named-entity, the country named-entity is resolved to *where* token and *what country* token, creating two instances of the template. The remaining three fields are then filled accordingly with the disease named entity (i.e. meningitis), the truncated news content (i.e. A rare strain of meningitis, which re-emerged recently in Burkina Faso...) and URL (i.e. <http://www.who.int/mediacentre/releases/2004/pr25/en/>).

Finally, these instances will be populated into AINI's knowledge base for learning and used by the AINI's chat interface in the CCNet portal for natural language question answering system.

B. AlertNews Knowledge Base

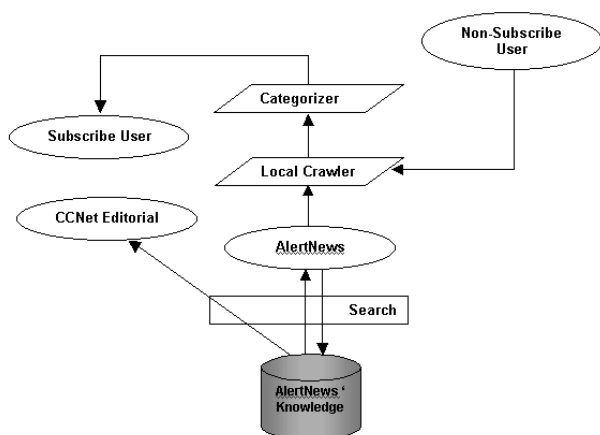


Fig. 10 AlertNews Knowledge base Model

The AlertNews knowledge base provides news and information to users who use mobile chat. As mentioned earlier, the mobile chat comprises of the SMS, MMS and GPRS technologies with special features such as on-subscribe, on-demand and on-alert news of AlertNews. There are three types of users for this system, which are the subscribed users, the non-subscribed users and the CCNet editorial. The subscribed users are those with the interest in getting information on any latest crisis and are registered with the CCNet portal. They can post news, alert message etc by subscribing to the AlertNews. Meanwhile, non-subscribed users can only receive latest news besides having chat sessions with AINI either through web or mobile services. The CCNet editorial can also gain benefit by receiving latest AlertNews as a group member of the CCNet portal. Information is extracted from the knowledge base of AINI with extra capability of providing the latest information in the alert form under the AlertNews component. The AlertNews architecture is shown in Fig. 10.

IV. CONVERSATION MODULE

AINI's conversation module which uses Artificial Intelligence and NLP is an important underlying technology for the CCNet portal. By using a human-like software robot, users will have the impression of interacting with another human being who responds to their commands or queries. Therefore, the main objective of AINI is to intelligently offer related information on various topics (e.g. SARs), where the service provided is in a virtual environment where no real live agents or specialists are physically involved. This requires AINI to use natural language parsing i.e. AIML and the AINI engine to search the predefined knowledge base as well as other data sources located in different systems via networking.

A. WebChat

The web chat sessions allow the users to interact in real-time with the software robot at the website. These web sessions can either be text-based or voice-based with a 3D animated character and Text-to-Speech technology. Users are able to customize the interface, input questions and receive text responses directly from a website as shown in Fig. 11. Besides, users can go through all the information on the website for the topics they are interested in. At the same time, they can place questions for more guidance on other topics.

A collaborative browser allows a portal to guide the users through the website of the organization by automatically "pushing" URLs and information from other websites to the user's browser. This not only facilitates communication between the software robot and users, but also allows the



Fig. 11 Webchat with personalization Interface for Human Interaction with AINI

intelligence software robot to help users to locate specific information on their websites. This is because AINI is able to intelligently react to the user's commands.

Users interact with AINI through the normal Internet ports, which are connected to AINI's knowledge base that provides WebGuide, WebTips and WebSearch engines [24]. The purpose of WebGuide is to guide users through the entire

portal. It enables AINI to offer help without waiting for the surfer to ask. The WebTips engine, on the other hand, provides tips or hints to users. It is an intuitive feature that recommends links within the site. The WebSearch system is integrated to other search engines. It is a web tool, which can search for local sites as well as the Internet, online databases and other applications.

B. MobileChat

Conversation chat applications were the first and most successful community applications for mobile services such as SMS, WAP and GPRS extended by Web services. Users can freely select the ECA they prefer to access. Hence, they can

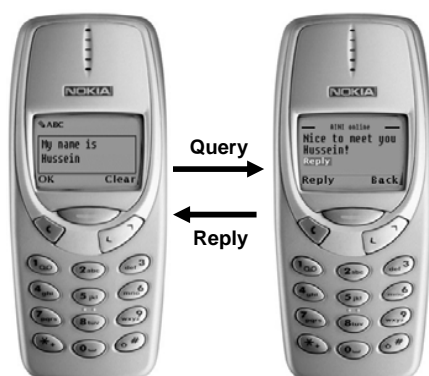


Fig. 12 SMSChat Interface

chat anywhere, at any time, with any device.

Mobile chatting module is implemented in a series of logical phases. We predict that text based agent-to-mobile chats with agent-to-Internet and Internet-to-mobile chats are going to be a most popular and implemented in the future. We add personalized characters with ECAs, and more game-like chatting environments to Mobile users.

i. SMSChat and WAPChat

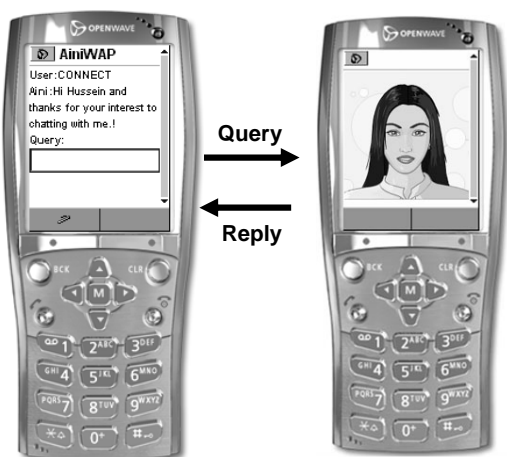


Fig. 13 WAPChat Interface

All the services are integrated as one mobile chat component for providing the latest alerts and information to users. Thus, the mobile chat is an alternative way where users can chat with AINI using SMS, MMS or GPRS services. The SMSChat services are the text-based chatting system which will receive alert news either on-demand or on-alert from the CCNet Portal. MMS is an SMS type service but with added image, voice, animation and many more features. Therefore, depending on the display devices in use, the users will be able to view images of viruses, bacteria, infected cells and even X-Ray images. Meanwhile, the WAP technology provides mobile web browsing functionality for accessing news and any other forms of data services on the CCNet Portal by connecting WAP gateway with given a URL. WAPChat and SMSChat provide Text-based interactive information services and applications from the screens of their mobile phones as shown in the Fig. 12 and Fig. 13.



Fig. 14 PDACHat Interface

ii. PDACHat

The idea of developing AINI into Personal Digital Assistance (PDA)⁶ is an interesting approach to having a more human and personalized interface between a computer and human [25] [26]. The PDACHat with AINI performs functions similar to web chats but in mobile environment. It is a prototype designed to blend mobile technology with natural language to help humans interact more naturally with mobile devices. The current PDACHat prototype are implemented with the knowledge base was designed using WiFi technology and powered by Microsoft Windows Mobile Technology [27] embedded with Pocket Internet Explorer on the HP iPAQ Pocket PC as shown in the Fig. 14. While the computer-generated avatar of the ECAs is displayed on the PDA using Micromedia Flash for Pocket PC⁷, the system uses a WiFi wireless connection to a server.

⁶ PDACHat prototype available online at http://ainibot.murdoch.edu.au/ccnet/ainibot_pda.php

⁷ <http://www.adobe.com/software/flashplayer/pocketpc>

V. SELECTED SMSChat CONVERSATION LOG

Multiple domain knowledge merged into AINI's single domain knowledge would give the users the best conversation.

We predefined the Open-domain and Domain-specific in the data layer, while the Unanswered-domain is taken from the question which the knowledge are not available in database. Even though the conversation agent lets the users to direct the conversation in the Random-domain, however the agent will continue to remind and recall the users back to the current topic of the presentation. This is to convey and direct the users' attention back to its original Open-domain or Domain-specific state. However, the priority will be on the Domain-specific. Therefore, the conversation agent will always give higher priority to Domain-specific questions in an attempt to keep the user focused on the topic of the presentation. An example of domain knowledge model conversation between "Kim" and "AINI" is shown in Figure 16.

To access these conversation and e-services through a mobile phone, users need to enter the given URL into WAP-enabled browsers on the mobile phone that has internet access. On the mobile phone which unable to access WAP, the alternative is to use SMS protocol as shown in Fig. 15. However, do note that the actual steps varies with different mobile make and model.



Fig. 15 Step-by-step SMSChat with AINI

From the Fig. 16, the conversation between *Kim* and *AINI* took place in the presentation on the topic of the SARs epidemic crisis. From the above conversation, transition state in the line 1-4 used Open-domain and line 5-10 used Domain-specific. However in the line 11-13, user has control the conversation although the agent reminds the user of the topic of the current presentation. The transition state in line 14-15 is under the Random-domain state and the dialog set is taken from a pre-defined dialog set. The dialog contains "I would do a search for it.", "Did I misunderstand your meaning?", "That's an interesting question. I'll come back to that in a minute.", etc phrase will be monitored and submitted into the

unanswered database. The domain expert is freely to modify and enhanced the unanswered database set and then forwarded to the a Open-domain or Domain-specific, it's depend on the context or topic domain presentation.

VI. DISCUSSION AND CONCLUSION

In conclusion, it can be anticipated that ECAs will play an important role in popularizing the concept of conversational agents for mobile services. This research paves the way for more humanoid user interface based on human language technologies.

- 1.User : Hi
- 2.AINI : Hello there. What is your name
- 3.User : My name is Kim.
- 4.AINI : Nice to meet Kim!
- 5.Kim : You still remember when was SARs first carried out into the world?
- 6.AINI : Yes. SARs was first carried out into the world at large on 21 February, at Metropole Hotel, Hong Kong.
- 7.Kim : When did Singapore mark on the SARs-free anniversary?
- 8.AINI : Monday, 24 May 2004
- 9.Kim : Thanks for your information. When WHO declare world-free SARs?
- 10.AINI : On July 5, 2003, the World Health Organization declared The world free of ongoing SARs Transmission.
- 11.Kim : Ok, now why not we talk about H5N1 Bird flu.
- 12.AINI : I'm not sure how this related to SARs? Why don't you ask me more specific on SARs?
- 13.Kim : No, I am more interested on the current pandemic, H5N1?
- 14.AINI : OK. Which search engine would you like to use? Google, Yahoo, Wikipedia, or Ebay.
- 15.Kim : google.

<AINI forwarded the URL related to the H5N1 to KIM using URL Push Technique and conversation continue. In the future, the Bird Flu H5N1 pandemic knowledge will be added by AKEA ...>

Fig. 16 SMSChat Conversation Log

Based on this experiment, the ECAs for mobile services has shown interesting application using the natural conversation agent for mobile chatting. In this paper, we only worked on selected epidemic crisis websites when perform knowledge extraction for Domain-specific knowledge on the server. Although we simulate the proxy conversation logs that contain clients' requests, there is a possibility that new simulation result from other traces is different from the result referred to in this paper.

It is believed that this research provides a novel framework for experimentation with various Web-enabled and mobile-enabled question answering techniques. The implementation is currently under ongoing development. In

the future, we will endeavor to continually refine the existing technology and to develop new knowledge base models that can be applied to new and emerging domains.

ACKNOWLEDGEMENT

The Human Interaction Interface (HCI) supported by Oddcast Inc (<http://www.oddcast.com>) and Cepstral LLC (<https://www.cepstral.com>).

REFERENCES

- [1] L. Palen, M. Salzman, and E. Youngs, "Going wireless: behavior & practice of new mobile phone users," presented at the 2000 ACM conference on Computer Supported Cooperative Work, Philadelphia, 2000.
- [2] J. Rickel and W. L. Johnson, "Animated agents for procedural training in virtual reality: Perception, cognition and motor control.," *Applied Artificial Intelligence Journal*, vol. 13, pp. 343-382, 1998.
- [3] J. Cassell, J. Sullivan, S. Prevost, and E. Churchill, *Embodied Conversational Agents*. Cambridge, MA: MIT Press, 2000.
- [4] C. M. Karat, J. Vergo, and D. Nahamoo, "Conversational interface technologies," in *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications*, J. Jacko and A. Sears, Eds. Mahwah, NJ: Lawrence Erlbaum Assoc., 2003, pp. 169-186.
- [5] J. Lai and N. Yanlelovich, "Conversational speech interfaces," in *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications*, J. Jacko and A. Sears, Eds. Mahwah, NJ: Lawrence Erlbaum Assoc, 2003, pp. 698-713.
- [6] S. L. Oviatt, C. Darves, and R. Coulston, "Toward Adaptive Conversational Interfaces: Modelling Speech Convergence with Animated Personas," *ACM Transactions on Computer-Human Interaction (TOCHI)*, vol. 11, September 2004.
- [7] J. Weizenbaum, "ELIZA - A computer program for the study of natural language communication between man and machine," *Communications of the ACM*, vol. 9, pp. 36-45, 1966.
- [8] Alice, (2005), Artificial Linguistic Internet Computer Entity, [Online]. Available: <http://www.alicebot.org>
- [9] B. Alfonsi, "'Sassy' Chatbot Wins with Wit," in *IEEE Intelligent Systems*, 2006, pp. 6-7.
- [10] J. Hutchens and M. D. Alder, "Introducing MegaHAL," presented at The Human-Computer Communication Workshop, 1998.
- [11] Turing Test, (2005), Loebner Prize, [Online]. Available: <http://www.loebner.net/Prizef/loebner-prize.html>
- [12] O. S. Goh, C. C. Fung, and M. P. Lee, "Intelligent Agents for an Internet-based Global Crisis Communication System," *Journal of Technology Management and Entrepreneurship*, vol. 2, pp. 65-78, 2005.
- [13] O. S. Goh, C. Ardil, W. Wong, and C. C. Fung, "A Black-box Approach for Response Quality Evaluation Conversational Agent System," *International Journal of Computational Intelligence*, vol. 3, pp. 195-203, 2006.
- [14] O. S. Goh, C. C. Fung, A. Depickere, K. W. Wong, and W. Wilson, "Domain Knowledge Model for Embodied Conversation Agent," presented at the 3rd International Conference on Computational Intelligence, Robotics and Autonomous Systems (CIRAS 2005), Singapore, 2005.
- [15] H. Loebner, (2003), Loebner Prize Gold Medal, [Online]. Available: <http://www.loebner.net/Prizef/loebner-prize.html>
- [16] Kannel, (2005), Kannel: Open Source WAP and SMS gateway, [Online]. Available: <http://www.kannel.org/>
- [17] O. S. Goh, A. Depickere, C. C. Fung, and K. W. Wong, "Top-down Natural Language Query Approach for Embodied Conversational Agent," presented at the International MultiConference of Engineers and Computer Scientists, Hong Kong, 2006.
- [18] S. Brewster, "Overcoming the Lack of Screen Spaces on Mobile Computers," vol. 6, pp. 188-205., 2002.
- [19] GSMWorld, (2006), 3GSM Statistics, [Online]. Available: <http://www.gsmworld.com/technology/3g/statistics.shtml>
- [20] Adobe, (2006), Mobile and Devices, [Online]. Available: www.macromedia.com/mobile/
- [21] D. Sleator and D. Temperley, "Parsing English with a link grammar," presented at the 3rd International Workshop on Parsing Technologies, Prague, Czech Republic, 1993.
- [22] D. Lin, "Dependency-based evaluation of MINIPAR," presented at the 1st International Conference on Language Resources and Evaluation., Spain, 1998.
- [23] M. Collins and Y. Singer, "Unsupervised models for named entity classification," presented at Joint SIGDAT Conference on Empirical Methods in NLP and Very Large Corpora, University of Maryland, USA, 1999.
- [24] O. S. Goh, S. Sahib, and R. Elangsegaran, "An Intelligent Virtual Financial Advisor System (IVFAS)," presented at 2nd International Conference on Neural Network and Computational Intelligence (NCI 2004), Zurich, Switzerland, 2004.
- [25] HighBeam, (2003), Software robot for PDAs, [Online]. Available: <http://www.highbeam.com/doc/1P1:84894246/Software+robot+for+PD+As.html>
- [26] The American Association for Artificial Intelligence (AAAI), Natural Language Processing, AI software interactive robot gets recognition, [Online]. <http://www.aaai.org/AITopics/newstopics/nlp1.html>
- [27] Microsoft, (2005), Microsoft Windows Mobile, [Online]. Available: <http://www.microsoft.com/windowsmobile/>