likely to determine the quality of the computer user's interactions.

An agent interface is an intelligent agent that is represented by one type of visible interface, and users are able to communicate with the agent through the interface [3]. In a situation where visible interfaces are symbolised in graphic user interface (GUI) forms, these visual representations are mostly anthropomorphic characters [4].

In order to improve HCI performance towards human-human interactions, computers are required to possess more human-like capabilities [5]. For example, computers are represented by visual characters as well as being designed with emotional facial expressions in order to express thoughts and communicate with humans naturally. Anthropomorphic agents generally are the computer systems displayed in human forms, and are also a type of affective computing.

According to Russell [6], affect as classified by psychologists generally covers feelings and emotions. As a result, it is patently clear that affect is intimately involved with human emotions. Humans are not entirely rational or logical beings, given that feelings, moods, emotions, and other types of affective factors have a significant influence on people's thoughts and behaviours.

Affective factors not only affect humans in terms of their behaviour and thoughts, as they are also affected by external objects, events and other individuals. Norman [7] suggested that "pleasing things work better", given users are attracted by beautiful products and express greater willingness to use those products. In fact, even a single external objective event can clearly alter humans' affective states [6]. These represent some of the reasons why Zhang and Li [8] pointed out that utility and accessibility were not the only factors that IT designers should pay attention to, as affective factors should be given due consideration.

In summary, according to the above studies, it is not particularly problematic to establish that the appearance and expressive manner of agents affect humans. However, limited research has focused on the visual form of agents. Gulz and Haake [9] addressed two possible explanations as to why visual appearance is commonly neglected in research on embodied agents, given "it cannot be readily approached with existing research methodology" and "the influence of look on emotional and intellectual processes is not readily accepted, although empirically well established". In addition, a paucity of investigations have been conducted on affective interfaces with agents. However, agent interfaces continue to play a significant role in user engagement and overall feelings. As a result, designers and researchers should grant additional attention to improving design of the interfaces with ECAs.

3 Emotional Expressions of CompanionBots

During HCIs, emotions play an essential role in the design of the agent interface [13] as humans interact with computers as though they were social actors [14]. Furthermore, emotion is an important element to develop the credibility of intelligent agents interacting with humans [15][16]. According to [13], agents need an emotional model to express their emotions. In truth, agents are also likely to need to able to detect the emotional mode of users, although this aspect does not form the focus of this study.

It is widely known that body language, including gestures, facial expressions and body movements, is an essential component of emotional human-computer interactions. This study only addresses emotional facial expressions for ECAs because facial expressions provide natural and constant feedback regarding the status of the communication to users and therefore plays a critical role in the design of agent interfaces [13][15]. Additionally, it has been demonstrated that agents with social facial expressions, such as smiling, are able to trigger some human brain regions to improve HCIs into human-human interactions [17].

In terms of the emotional categories of facial expressions, Ortony, Clore and Collins [11] have established the OCC model as the standard model for emotion synthesis. The OCC model categorises various emotional categories based on positive or negative reactions to events, actions and objects. In fact, 22 emotional categories have been classified in the model and therefore the model offers a sufficient level of complexity and detail to cover most situations an emotional intelligent agent might have to tackle.

As a result of these capabilities, numerous pieces of research have adopted the OCC model to generate emotions for their intelligent agents. Nevertheless, it is problematic for intelligent agents to present 22 different emotions when they interact with humans because agents do not possess the ability to express 22 different emotions clearly and identifiably on their faces. Hence, Ortony [18] acknowledges that the OCC model might be too complex for an emotional agent. These limitations led to the creation of ten emotional categories that consist of five positive categories (joy, hope, relief, pride, gratitude and love) and five negative categories (distress, fear, disappointment remorse, anger and hate) for developing emotional agents.

Although this shortened categorisation may facilitate emotional expression, ten emotional categories may remain an excessive amount for an agent to convey individual emotion clearly. As a consequence, a significant amount of studies have applied the Ekman, Friesen and Ellsworth's [12] six basic emotions to develop their emotional agents. Fridlund, Ekman and Oster [19] reaffirmed these six basic emotions. The six basic emotions (anger, happiness, fear, surprise, disgust and sadness) can be communicated efficiently and recognised across a number of cultures [20]. These six emotions can be distinguished from other emotions, although fear and surprise are not always capable of being distinguished from each other [21]. Accordingly, CompanionBots in this website adopted these six basic emotions to design their facial expressions.

In fact, exaggerated expressions of characters are necessary to elicit powerful emotional responses from audiences [22]. In addition to the exaggerated facial expressions of agents, Baylor and Ryu [23] discovered that animation is beneficial for pedagogical agents. Lee and Nass [24] demonstrated that animated agents are more attractive and trustworthy than stick images and text boxes. Each CompanionBots possesses seven different facial expressions, including one neutral face and six basic emotional faces exhibiting anger, happiness, fear, surprise, disgust and sadness. The facial expression design also adopts exaggeration and animation as the design guidelines.

Similar to the previous two surveys [1][2], the Emotional Keyword Filter has also been applied in this website to generate the exchange of the CompanionBot expressions. These ten CompanionBots alter their emotional expressions based on emotional keywords. The emotional keyword filter program has been developed for this multi-agent website in order to alter facial expressions of the CompanionBots during the keyboard conversations. In truth, the emotional keyword filter program detects the textual responses of CompanionBots and then modifies the emotional expressions of the CompanionBots.

4 Requirements and Specifications

The requirements and specifications in this section have been categorised into the user and the client-server architecture. The client-server architecture is classified as the client (the front-end of the website), designed to be as simple, reliable and light-weight as possible (regarding to user system resources), and the server (the back-end of the website), which is used to store the source code and perform dialogue handlings. Additionally, the observable content (e.g. page layouts and agent interfaces) is referred to as the front-end, which works on the Windows Server 2003 operating system with Microsoft MSSQL Server 2005 Express Edition and .Net Framework 2.0. In fact, the back-end comprises three AIML-Bot format files that process the textual output to the front-end operations under the Windows Server 2003 operating system.

The website facilitates user to browse via their choice of web browsers, including Internet Explorer, Firefox, Safari and Chrome by means of computers or smart mobile devices. The optimal screen resolution available for the website is 1280x800, albeit it remains compatible for other screen resolutions. For higher screen resolution (such as computers equipped with larger screens), extendable backgrounds ensure that the observable content remains in the centre of the screens. In the case of poor screen resolution (for example portable devices equipped with smaller screens), devices are able to adjust the best browser resolution through a zoom-in or zoom-out function. Thus, users have the capacity to adjust their browser resolutions to fit better recognisable presence when they utilise portable devices to browse this website.

5 System Architecture and Interface Design

In the back-end, the conversational database contains three AIML-Bots, namely the IELTS-Bot, the PI-Bot and the AAA-Bots. In fact, the IELTS-Bot was developed for [2] to allow subjects to prepare for the IELTS speaking test online. This website also adopted the IELTS-Bots as the conversational database for users to practice sample IELTS speaking tests. Additionally, the PI-Bot was designed for the CompanionBots in the character interface experiment to respond to some questions in relation to the personal information of the CompanionBots. The Annotated ALICE AIML Files (AAA Files, named AAA-Bots in this research) is a revised version of the free ALICE source. In reality, the AAA Files contain 59 AIML that are mostly compatible with all AIML 1.01 compliant software. The AAA is specifically reorganised to facilitate BotMasters to clone ALICE's brain and create customised bot personalities, without having to expend much effort in editing the original ALICE content [10].

The chat flow of CompanionBots is depicted in Figure 1. In the textual response phase, users input sentences in the conversational user interface. In fact, the IELTS-Bot will generate a response according to the sentence that subjects input if the sentence is related to the knowledge of IELTS speaking test. Alternatively, PI-Bot will answer the question if the sentence concerns personal information about the CompanionBots. In all other circumstances, the AAA-Bots will answer other general questions or generate a random response. In addition, the AAA-Bots adopted in this website is a revised version of the free ALICE source that has been adopted to generate a textual response excluding personal information and IELTS specific knowledge. Subsequent to generating a textual response, the 'Emotional Keyword Filter' selects one facial expression according to the textual response. Finally, both the textual response and facial expression are displayed in the conversational user interface in order to elicit further responses from users.

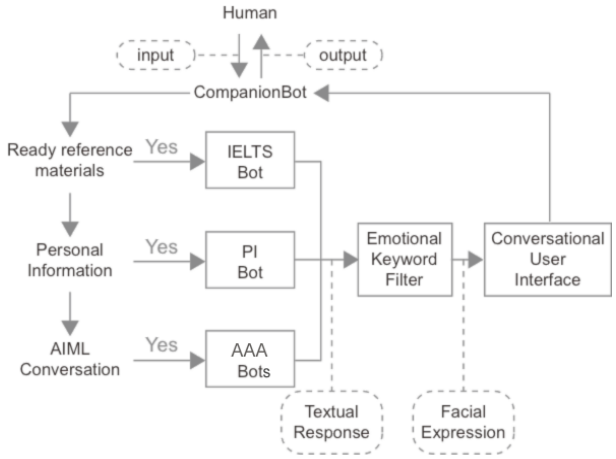

Figure 1 The chat flow of the CompanionBots.

The content of the website has been segmented into three

distinct categories, namely chatting with CompanionBots, Emotional agents and Experiments. In the Chatting with CompanionBots category, three character classification pages exist, namely the human classification page, the animal classification page and the creative creature classification page. In reality, each character classification page contains two to four CompanionBots for users to select for augmented language practice. Additionally, when users click any CompanionBot in the character classification page, the webpage links to one chatting page and users may have more keyboard conversations with the CompanionBots on the chatting page. Furthermore, in the Emotional agents category, all the animated facial expressions of the CompanionBots are listed in the Emotions of CompanionBots page while evaluation of agent facial expressions from the OCC mode's 22 emotions [11] to the six basic emotions [12] are provided in the Evaluation of agent emotions page. Similarly, all the emotional keywords that initiate a change of expression for the CompanionBots are shown on the Emotional keywords page. In the Experiments category, the aims, variables, procedures and results of both the previous surveys [1][2] are addressed in the Hardware interface experiment and Character interface experiment pages.

This website was designed for inexperienced English learners to practice language online, and the interactions between users and agents formed a vital component tested through the learning tasks. Therefore, the website interface was designed to stimulate a study environment, such as the inclusion of a book to present learning content, vocabulary cards by the side, and a cup of coffee on the table. In terms of the interface structure of this website (see Figure 2), every webpage featured the website title, which allows users to navigate to the homepage of the site. This feature is situated at the top of the page, while a copyright announcement is located at the bottom of each webpage. Furthermore, three tags are positioned on the right fringe of the book. In fact, users have the ability to rapidly link to the three character classification pages via these three tags. Similarly, the Home tag, on the left fringe of the book, provides users with a link to the homepage by clicking the Home tag.

Figure 2 Interface structure of the multi-agent website.

Figure 3 indicates the conversational user interface page of this website. In truth, this interface is an enhanced version of the conversational user interface of the previous survey [2]. Moving the input frame next to the characters' facial expressions, and users are likely to pay more attention to the exchange of emotional expressions. Additionally, adding textual input tips, including the IELTS-Bot sample question in the input frame and the emotional exchange tips in the left-bottom corner, in the interface to remind users to operate these utilities effectively.

Figure 3 The conversational user interface page.

6 Implications

This multi-agent website applied numerous design guidelines from the existing interface design and some results from previous experiments [1][2]. This website combined AI techniques, affective factor design for language learning and affective interface design to develop learning companion agents for novice English learners in order to practice their language skills online.

In fact, several lessons can be learned from this research that are applicable to the practical, sociological and research dimensions of building affective interfaces of ECAs.

Practical implications include implications for human-computer interface design and experimental design. One of the most intriguing findings from these experiments concerns the implications for interface design, which discovered that following just a brief introduction all subjects managed to utilise the agent interfaces without any problems, possibly due to the popularity of instant messaging (IM) and intuitive usage of natural language. Another important lesson is that, while realism and aesthetics are highly prized in the interface design of ECAs, character classification representations and emotional expressions of ECAs are similarly important for keeping users engaged with their tasks. Additionally, this study has shown that ECAs with affective interfaces may provide a positive role in terms of socialisation. In fact, ECAs with affective interfaces have the potential to provide virtual social support when users lack real social support, such as experienced when in a foreign country. Some positive impacts of ECAs exist in socialisation just like real humans attempting to capture someone's attention [25], and according to the old maxim: 'better a little fire to warm us than a great one to burn us'. ECAs with affective interfaces might be able to satisfy users with psychological support. However, other sociological concerns are that if users rely excessively on these agents for the virtual social support and learning company, this may decrease individuals' social skills. This underscores the need to ensure that ECAs with affective

interfaces are as rich as possible, and used carefully [26].

In the psychological area, ECA affective interfaces have shown that applying psychology to technology in order to create computers that appear more human. In terms of the design aspect, this research demonstrates the original intention of most designers, designing better products for users, also known as user-centred design, remains critical.

7 Discussion

A reasonable amount of work has been conducted over the past few years on models of agent interfaces and affective factors. However, minimal studies have been applied to the understanding and modelling of the affective interfaces of ECAs during learning tasks. As a consequence, this study represents an underrepresented field of study addressing the affective influences of ECAs when ECAs are represented by various character classifications in language practice tasks.

In terms of AI, complex real-time dialogue is not necessary for small talk between HCIs, although it is crucial for conversation practice in language practice tasks. More than 50 dialogue-planning files seemed insufficient for English experts to process English conversations. In truth, the complexity of dialogue planning should be designed based on the content and purpose that the ECAs intend to perform.

In relation to learning, one feature of ECAs requiring consideration is the application of correct information for successfully completing the learning tasks. Another dilemma involves the provision of sufficient information based on the content and purpose of the learning tasks. In this field, users typically interact with agents in the learning tasks in order to absorb specific knowledge, thus, the information that agents provide should be beneficial for the users as well as being correct and current. Furthermore, sufficient information related to learning topics is essential for agents to effectively interact with users during the learning processes and attract users to engage in the tasks.

In terms of ethical concerns, the affective interfaces of ECAs, as with any technology, have the potential to be abused. ECAs that are represented by affective interfaces may earn users' trust during the interactions, which may lead to some prospective ethical problems. One major worry is that personal confidential information may be released to these ECAs. This is a vital issue, given that after a period of interactions, users generally believe agents because agents are computers that, unlike humans, resist gossip with others. However, if agents release any of the users' personal data for improper or commercial purposes, this is likely to cause a series of ethical conundrums. In addition, the trust towards agents might be misused by scammers or marketers. For example, when users ask for product suggestions, agents might be programmed to provide biased information, resulting in reduced user trust towards agents. It is exceptionally important for agents to earn users' trust and any type of abuse, such as user trust, is unethical.

A final issue emanating from this study is the judicious employment of the affective influences of agent interfaces. The affective interfaces of ECAs are designed to gain positive affective influences on users, and it is against the purpose of affective interfaces of agents if the agents intentionally alter the affective states of users and further damage their learning outcomes. In fact, the aim of agents in the learning tasks is to assist users. That said, the appropriate use of affective influences of agents on users should be carefully considered.

In this research, ECAs were designed as learning companions, albeit ECAs in learning tasks may also be suited as all-purpose learning assistants and intelligent personal tutors. Furthermore, researchers and designers might be interested in some issues in relation to learning interactions and outcomes, which were affected by different mission-carried agents as well as some subjects of further affective alterations of humans during HCIs in the course of undertaking learning tasks.

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