

Enter the World of Ghosts:

New Assisting and Entertaining Virtual Agents

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As an alternative to fully articulate visual agents much highlighted in recent years this paper presents disembodied, location-specific conversational agents (DELCA) called 'ghosts' as a powerful new way of obtaining high quality assistance with less technical requirements. DELCA ghosts combine context specific conversation mediated assistance with an interactive narrative universe designed to promote both pleasant and efficient service. This paper investigates DELCA ghosts through scenarios and examples from on-going trans-disciplinary work at the IT University of Copenhagen supported by subsequent analysis of specific issues. Finally we will point to future research and perspectives related to the DELCA project.

Welcome!

Imagine entering the high tech building hosting an university in the new Ørestad Nord, Copenhagen. In the hall the butler appearing on the screen next to the entrance welcomes you. He was notified of your appointment and identity tag by the ITU schedule calendar and detected a signal from your WLAN enabled PDA as you entered the premises.

- "Anne de Waal, I presume". Without waiting for her confirmation or introducing himself (butlers never do), he continues: "Would you like me to take you to the meeting?"

- "Yes" you reply, even though you could use to refresh yourself at the ladies room.

You're running a bit late and prefer to be precise.

- "This way". The butler points to an elevator straight ahead, and you notice that the elevator button lights up. "My humble picture will now disappear " he says, "but I'll be with you all the way on your PDA, if you don't mind. Can I slot in for a while, please?" You accept by pressing 'access granted' on your PDA.

Following your whereabouts with the positioning system of the building he guides you directly to the meeting room at the third floor. Well, almost directly. On your way you're distracted by a mourning sound when passing the closet at third floor. It sounds like somebody's crying.

- "What is that noise?" you ask your temporarily invisible companion.

- "Don't mind that", the butler says. He never the less feels urged to appear on your PDA as a response to your obvious concern. "It's just Albert. He's been locked up in the closet since he appeared uninvited at several meetings. Albert's been quarantined".

Horrified with the tough treatment of students at ITU you start approaching the closet feeling sympathy for the poor soul in there. Naughty or not, they cannot just lock him up, you think. But before you reach the closet, the butler's contours flickers at the crude inventory display for the closet as if trying to block your way.

- "You needn't worry Anne. Albert's just a ghost".

- "What!" you cry out. You're about to tell the butler a thing or two as you realize that you are discussing the wellbeing of one of the virtual ghosts universe the university has become famous for – with another of the ghosts. Somewhat relieved but also with a nagging feeling of having being fooled by a virtual ghost, you continue to the meeting room. At the time you reach the door you acknowledge the fun of the situation, and enter the meeting room chuckling.

Faceless interfaces

The idea of improving assistance by agents capable of responding to natural language and maybe even the gestures and emotional states of the users is not new. Yet little interesting has been achieved so far. In our opinion, one of the main reasons for the slow progress in developing assisting virtual agents rest on to ambitious or simply wrong motives for the design. At the IT University of Copenhagen a pilot-project has been launched to determine both the minimal requirements for conversation mediated assistance and the effect of combining assistance with a narrative universe based on a theme of ghosts. The DELCA Ghost Project is motivated by the belief in achieving high quality agent based assistance without demanding visualization requirements. We believe that the conversation is the most efficient modality for interfaces when compared to the information proc-

essing and bandwidth capacities needed. The notion of ghosts has been chosen because of traditional characteristics of ghosts found in the popular literature and in folk tales:

1. Ghosts are mostly invisible or only vaguely visually manifested
2. Ghosts are often bound to a specific location which often has a very special relation to the ghost
3. Ghosts only appear when called upon or if they feel an urge to manifest themselves
4. Ghost owe their twilight status to some unfinished business and they are therefore active and striving
5. Ghosts are creatures filled adventurous and narrative connotations

These features are heuristically very interesting for developing pleasant, interesting and functionally satisfactory agent based assistance while keeping the technical requirements at a minimum. Both for the sake of the very realization of assisting virtual agents, for the infrastructural feasibility of mobile supported assistance and from a sound economical principle of minimizing technical prerequisites for any given service. Besides, and perhaps just as important in a wider perspective, the 'spirituality' invokes the association of values for many people. It is part of our ambition to keep discussions of the true value of IT in relation to people's life on the agenda.

The DELCA project brings together a broad range of in-house research expertise at ITU such as location specific and context sensitive services, 3D position tracking, multi platform protocols, dynamic and scalable visualization, virtual world narratives, multimodal, mobile interfaces and biomimetic Ambient Intelligence in a cross-disciplinary effort to realize complete DELCA systems. Initially as a service only at ITU but in the longer perspective as a system governing all of the Ørestad Nord.

Functionally the DELCA ghosts provide a range of different types of assistance, such as guidance for first time or visually impaired visitors, context specific assistance for returning users (e.g. helping out at the front desk or locating a colleague), security checking, logging and monitoring, introductory services for new employees and students and as participators in location based interactive events (e.g. computer games).

Laws of nature in the world of ghosts

Several different theoretical approaches form the basis for the inherently trans-disciplinary work with DELCA ghosts, ranging from narrative theories over sociology and evolutionary biology to engineering models. This section presents the main theoretical ideas behind the design of DELCA ghosts focusing on the 'soft' issues.

Basically the ghosts operate within a social setting of evolutionary dynamics resembling everyday rules of conduct as caricatured in reality TV contest such as Robinson and Big Brother. Success and popularity are the cultural means to biological viability and reproduction and since ghost are not burdened with mortality they focus solely on social recognition. The users and the infrastructure at ITU are the 'ecology' or 'society' of the ghost and the framework within which they have to function. Good performances leads to increased popularity whereas falling into the disapproval of users means drifting into the looming oblivion. Ghosts will try out different ways to increase their AmbiValence (Ambient Valence) by getting attention from or please users in order to maximize the positive feedback measured in "ITU's" (Interest Token Units).¹ The amount of ITU's earned is determined along various parameters, the main of which being:

1. Implicit feedback:

- a. The success of performance is measured by the number of minutes or number of times engaged in interactions with users.² Good performance leads to increased frequency of engagements and bad ones leads to fewer engagements and users exploring alternatives. Both entertaining and assisting performances counts, however with varying weight.
- b. Time spend on displays. A specific value is assigned to different kinds and sizes of displays with the main screen in the hall carrying the largest and individual PDA's the smallest factor.

¹ Tokens has proven effective rewards mechanisms for operant conditioning of humans within behavior therapy.

² Depending on type of function. Some functions have a discrete outcome (was the job done or not) for others the time engaged reflect the quality of the service (as in gaming). Others again need a more complex combination.

- c. Number of hits on the ghost's 'hauntpages' and visitors (excluding mere by passers) in its domain. For example the effect of a happening carried out by a ghost is measured on the number of visitors on homepages and in domains.
2. Explicit feedback:
 - a. Extraordinary successful performances allow users to allocate ITU's (from e.g. a fixed weekly amount) to the AmbiValence of the ghost. For example by uttering praise (e.g. "well done", "very well done" and "splendid work") after ended engagement or by paying tribute at the hauntpage of the ghost.
 - b. By overstepping the norms of users or the butler ghosts get ITU's subtracted from their AmbiValence and they lose privileges such as size of domain and number of appearances allowed on displays. Since ghosts are by nature already dead, extreme malfunction or misbehavior cannot lead to death but only social marginalization. Thus inappropriate behavior is punished with displacement minimal interaction zones— called the OffLines. The isolation slowly degenerates the personality of a ghost, by incrementally deleting personal characteristics in the reverse order of acquisition (the newest goes first). After a period the ghost is 'released on probation' in a non-critical and restricted area with a high level of monitoring. If successful the ghost gets launched anew as a re-socialized being ready to reenter the ghost society.
 - c. Occasional evaluations will be conducted to allow for the correction or promotion of specific ghosts. Either generally by allocating ITU's the AmbiValence of the ghost or in severe cases by feedback serving as instructions for the system-responsible when manually reprogramming.
 3. Additional fitness rules:
 - a. Decrease in AmbiValence decreases monitoring enhances the chances of performing in extra-duty or extra-limit domains to earn popularity and ITU's.
 - b. Some ghosts might provide critical but seldom-used services and they will get support in the form of more ITU's per successful performances.
 - c. The collaboration of several ghosts with enough AmbiValence can overthrow constraints (e.g. the butler) and take over displays and functions. But only for

a while. Normally the system responsible employees restore order as fast as possible.

Beside these evolutionary rules for social dynamics certain narrative considerations are added to lend the ghost universe interesting and coherent. Studies of the “new” ghost cultures found in the literature (*Lord of the Rings*, *Harry Potter* etc.), movies (e.g. *Ghost-Busters* and *Men in Black*) and computer games (*Diablo*) all suggests, that like in original folk tales the basic characteristics of a ghosts still remain: They are disembodied, location bounded creatures, with motives and powers to engage with real humans. They may reveal themselves unexpected or they may be called upon by the use of a spell or a specific artifact, but only at certain times and/or places. They can grow their power or loose it through battles, fulfillment of their original duties or symbolic actions to release them from judgments. They may live on forever or they may be terminated after a few moments of action.

Technically the skeleton of the DELCA ghosts is the context sensitivity provided by a positioning system comprising densely distributed WLAN base stations and an Eka-hau server which can determine the position of every WLAN equipped mobile device. The speech recognizing system deployed resembles that of Gorin et al [1997] developed at AT&T Research Lab. The system enables users to request assistance in ordinary language within limited contexts such as information retrieval, way finding, searching persons. The relative small size of contexts determined in advance and constrained by location, type of assistance etc. provides parsing the possible situations into ‘themes’ of likely interactions. Interaction happens mainly by conversation mediated by microphones in a given domain and software able of understanding a lot of everyday words related to the function of a ghost. The software is based on evolutionary computing methods and learns frequently used terms and forgets others seldom used. In certain circumstances ghosts will appear visually as a response either to a request from the user, if a specific functions requires it, if the ghost detects confusion or excitement from the user or if the ghost simply sees its change of getting attention.

The adaptive features of ghost are addressed by theories related to complex adaptive systems in general and biomimetic Ambient Intelligence in specific (Sørensen 2003a, 2003b and forthcoming). By implementing simple evolutionary mechanisms to guide the

functions and development of ghosts optimized assistance and interestingly responsive behavior are obtained. Some general fitness criteria are taken from studies in evolutionary robotics and Alife and others are specially designed for DELCA ghosts due to their 'social' environment.

In terms of algorithm development the challenge is to address issues like portability, privacy, stability etc.

The un-reality IT show:

Besides the technical architectural considerations a carefully 'casting' of the ghosts are of prime importance for the success of an equally functional and narratively interesting universe. The ghosts share certain motives but their individuality is manifest. Because most ghosts died suddenly, to young and in the middle of their life projects, they all have an immense urge for settling the score and public recognition. Like a reality TV show their criteria of success is popularity which they seek to maximize by pleasing the users and by engaging in risky entertainment stunts in between their proper assistive assignments. The dream of every ghost is to reside on the main screen in the hall – or even better – taking over most displays, personal and public, throughout the building. Ghosts use every means possible to get the users attention and affection but their *modus operandi* varies in accordance with the preferred segment of users they try to reach. Some rely mostly on entertainment e.g. by becoming popular as respected opponents in the local computer game, other use the assistive interaction as their preferred *métier*. Some perform practical jokes, some are 'jack-ass'ing', others rely on more innocent ways of entertainment (like the singing sisters street performing at second floor) while a few are responsible polite and earn their ITU's from maximizing the standard of their services.

Appearing unauthorized in PowerPoint presentations (as Albert from the opening story seemed to have) or on public screens, occupying CPU's with unserious business or bribing their way out of a quarantine on PDA's by giving the user access to privileged domains or services all bestows the ghosts with 15 minutes of fame and the chance of ascending into celebrity. But also the risk of a likely punishment from the butler or the unlucky victims. Punishment which often means relegation to very constrained domains (e.g. closets or restrooms), getting boring assignments (e.g. keeping the inventory in the

storage room or assisting at the pigeon holes), denial of socially crucial visual appearance ('DeVisualization') for a period of time or the replacement to the Off Lines for re-socialization. This framework allows for the emergence of a dynamically interactive and historic development of the ghosts, the building and its users. Our goal is to design infrastructure, characters and the social rules that governs them in a manner that facilitates the emergence of services that adapts to the users and an interesting narrative that captures the users. Let us present some examples of ghost characters for ITU.

Starring:

The butler

The main household butler, whom you already met, carries the functions and characteristics of a traditional Victorian butler; he is devoid a sense of humor, very orderly, precise, and discrete and with the overview of a hawk of every activity in the household. As responsible for order and efficiency of the building he is in overall charge and has got the authority to punish misbehaving subordinate ghosts. This, off course, is always undertaken very swift and discretely. The butler only has one minor vice which is his passion for soccer. Off course the students try to take advantage of this vice in any way possible.

Thin Lizzy

Despite keen celibacy the skinny and pale Lizzy died in an early age due to poor health. Being a former firm believer in a controlled lifestyle with vegetarian food, yoga exercise and refraining from male company her unjust death made her very bitter. Bodiless she has just acknowledged the true meaning of body pleasures and now she blames her former lifestyle for the untimely death. Lizzy mainly resides in the canteen trying to convince everybody to eat a lot of fat foods, meat, buying that extra piece of chocolate, drinking Coke instead of water etc. Many think that she is in conspiracy with the canteen owners, but actually she is on her own crusade, which is manifested when she interferes with any effort from the canteen to put more healthy dishes on the menu. At the slightest chance of romances, e.g. at parties, she is especially active in trying to couple students. Sometimes she goes to far in her eager revenge over her own former frigid life and digresses slightly into obscenity.

Morgan

Morgan resides in the reception and takes care of all the easy problems to relieve the staff. He is very helpful and likeable but not the cleverest dude around. He used to be an undertaker but got cremated alive when he took a nap in a coffin, which was mistaken for another. Morgan never leaves the reception but he is normally very updated with the whereabouts of most users and can be very helpful when filling out forms – if you manage to pose the questions right.

Dolores

Dolores is the assistant on the network dealing with formalities such as booking of rooms, registering for exams, booking AV equipment etc. She spend her former life as a waitress in *Joe's Diner* in a minor highway town in Texas and you can almost still smell the grease and cheap perfume when she is present. Stories of how this mid-aged Texan gal ended up in the cold Scandinavia are many and just as imaginative. Whatever the truth Dolores is very popular (especially among male users) for her almost motherly, but efficient and no-nonsense service and her tolerant 'I've seen most' attitude. However her consequent waitress lingo still confuses new users who don't know how to respond to 'Refill?', 'drive carefully' and other out of context phrases.

Heinrich

If it had not been for Heinrich's somewhat likable nature and great technical skills he would probably be the most isolated ghost at ITU. Heinrich died young experimenting with tactile equipment for virtual reality (for which purposes there is a lot of rumors about) and has the exquisite taste of an adolescent nerd with unrealized sexual fantasies. He likes to tell really bad jokes to everybody who happens to need his help with matters regarding the network, mail-lists, booking of laptops. Usually he accompanies the stories with his own unmistakable giggling laughter. Due to the clientele at ITU and not least the frequent supply from the SysAdm staff he is always heavily loaded with new jokes submitted to his website. Heinrich is under the parental control of SysAdm who are more than motivated to keep Heinrich's database up to date (by systematically logging question and answers handled manually) in their effort to prevent users disturbing their programming, gaming and other nerd activities.

Bill Gates

The parking basement is where Bill the Gatekeeper, aka Bill Gates rules. Bill looks after the cars and bicycles parked here and he takes his job very seriously. Sometimes too seriously. Bill likes order and precision. If you're late for an appointment figuring in the ITU event calendar, if you ride your bike without lights or if your car is dirty or noisy Bill will surely comment on it in his own sarcastic manner. Heaven forbid that you actually forgot your identifying device. To be let through in such a predicament requires long discussion with Bill and takes a lot of convincing (bribing won't get you anywhere with Bill). Because of his very professional conduct Bill is one of the butler's most trusted servants and they let each other know every activity of relevance. That is why the butler always knows who is in and who is not. The only reason why Bill is not unpopular among the employees and students is that he actually prevents stealing by monitoring all activities with his special taste for everything suspicious (which for Bill is almost everything in this world). Another reason probably is that Bill tends to get very 'merry' at Christmas parties and usually starts to caricature the typical behavior of selected users of the basement on the basis of recordings from the basement cameras. Especially Bill's version of the rector scores a lot of ITU's

Hilary and Jenny

If you ever tried getting tired of listening to a conversation by the time you reach second floor on the elevator, you have probably already met Hilary and Jenny. Conversation is actually politely put. Dolores and Jenny are talking machineguns. Rumors have it that they actually went to heaven but were kicked out due to their oral vices. But they know of everything happening at the university months ahead and they have a talent for giving you all the relevant information (based on their comprehensive knowledge on your interests) - and then some. If you dare to ask!

Scenes from the life of ghosts

Henrik has troubles applying for his exam and he asks for Dolores at the terminal in room 3.23.

-“What can I do for you darling”? she asks in her characteristic southern Texas dialect only visually manifest as some blurring in the corner of the webpage Henrik is looking at.

-“I’m trying to register for my exam in Introductory Programming, but the system doesn’t seem to accept it”. Henrik says with a loud clear voice, being a freshman and still not familiar with the comprehending capabilities of ghosts.

-“You are in the GP F2005 class, right hon’? Dolores says to make sure that her default context based guess (in this situation the time of year and the code for the class) is correct. Henrik confirms and Dolores check the listings for the spring class and compare with Henrik’s logon profile. After a while Dolores’ voice appears again: “It seems like there ain’t no Henrik registered for the course’, but the kitchen (Dolores’ term for everything from the positioning system to the intranet) tells me that you were in 11 times, so I can tell that you did follow the class. I will take care of the registering. Don’t worry about that. Was there anything else I can do for you sweetheart?

- “Well, yes. I would like to know when and where the exam will be held”, Henrik answers and wonders whether Dolores wears a virtual polyester uniform with ‘Dolores’ written at the chest when she is visible.

- “The exam is Monday June 7’Th at 9 in room 1.15. Can I get you anything else darling?” Dolores ask from old habits in the Joe’s diner.

- “No, thank you very much” Henrik is quite impressed by Dolores efficiency and wants to ‘tip’ her. He knows that by allocating an ITU ‘tip’, the system registers the level of Henrik’s satisfaction and allocates the ITU’s to Dolores account of Violence. And so he does.

- “Thanks darling. Don’t be a stranger”, Dolores says.

The Spirit of ITU

Besides augmenting and assisting in various concrete functions in the ITU building, the DELCA Project comprises a slightly more abstract (sociological and psychological) aspect in the form of ambient acousmatic feedback. An ambient soundscape are proposed as the collective output from the discrete research and educational activities that make up an university. This soundscape is composed by both stored sounds (triggered by way of the positioning system) and sampled sounds (e.g. sounds of the entry doors, the elevator or the printing room) structured and sequenced by specific parameters like the computer mouse mileage, the keystroke index, the printout amount or the bodily movement of the

week in the house. The ambient soundscape, or ideally a musical composition (to ensure enough structure to facilitate recognizability), would be discretely present in all public space on Friday mornings, during the lunch break or at other appropriate moments. The hope is to convey a feeling of common goals and collective achievements emergent from the swarm of activities throughout ITU. To stick to the spirituality-metaphor suggested by the Ghosts, the ambient soundscape would represent (and invoke) a sense of collectivity: the spirit of ITU.

The soundscape composition would be partially curated by a human operator to ensure artistic quality. However the curator-function might later be bestowed upon an artificial composer, the composing ghost, which actively and in intimate interaction with other in-house ghosts and users, collects, samples and sequences sounds to an united and unique composition. The composing ghost would learn (e.g. via a neural net architecture) the style and preferences of its mentor (the human composer) to obtain the integrity and continuity of expression that is crucial to facilitate the sense of a common spirit uniting the disparate activities of the house. Fed by and in interaction with the actual activities and feedback from user to enhance the users sense of being co-constituent of the soundscape. Conceptually the ‘composer’ and ‘the spirit of ITU’ merges so as to render the ‘function’ or rather the characteristic of the ITU spirit to convey both the activity level of the ITU and a feeling of (hive) unity.

The music of the spirit of ITU would, in a sense, be an acoustic augmentation of the ITU-building architecture, already laid out to ensure transparency and cooperation, and of the stated values of the ITU to increase the transgression of traditional professional boundaries, such as those between hard computer science and humanistic, cultural approaches to information technology.

The afterlife of ghosts

The DELCA project harbors many perspectives for future research and technologies. This closing section ought to be the most extensive part of the paper since the most work still lies ahead. To pursue the ambitions laid down in the project a lot of different issues have to be addressed and many disciplines and theories will have to be mobilized. Let us take a

look at the major goals with the project and some possible spin offs from the investigations.

First and foremost ghost serves as a powerful heuristics for exploring minimal criteria for agent based assistance. One of the main goals is to prove the assistive adequacy of minimal agents important for the effort to decrease the amount of information needed to support agents (e.g. in mobile devices), to increase the speed of assistance and to facilitate the pervasive distribution of conversational assistance. Investigations of these issues provide a solid fundament for extrapolations and the design of both large scale (e.g. public) systems and more elaborate agents. Besides ghosts has a lot to teach us about conversation-mediated assistance in general of value for designing services for hearing impaired, cognitively disabled (e.g. Alzheimer patients), children and other with need of special support. Another related spin off is ideas for designing attentive non-verbal audible interfaces for low profile (periphery) information (ambient interface sounds for warning, notification etc.) or strictly aesthetic enhancement of physical space (e.g. wallpaper of sound) in design and architecture.

Design of mobile interfaces will become a cornerstone in the development of fast and fluent interactions with the ghost: Combining language technology and restricted, predictive interfaces with multimodal input facilities holds potentials for command rates at 10 words per minute (human-to-ghost). Combining voice-ml with synthetic speech output suggests that ghost may talk back to humans at normal conversation rate (> 100 words per minute).

The ghost universe offers a splendid test bed for the merge of pleasantly assistive environments. Our hope is that the ghost takes away some of the artificiality of interacting with virtual agents by deliberately creating a fictive universe with alternate rules. The universe needs to be interesting enough for returning users to actually use and adequately open for new users to enter. The challenge will be to create characters evoking interest and functional reliability but whose simplicity allows for implementation. Balances between interactive dynamics and stable personalities, between assistance and entertainment, between a coherent universe and a feeling of personal relationship for the users have to be found. This work will be enriched by participation from psychologists,

sociologist, virtual worlds and computer games researchers and will have a lot to tell us on human communication and sociality.

Ethical, psychological and sociological questions of privacy will be major issues as technology become increasingly pervasive and sensitive and a central concern for the DELCA ghost project. The very fundament for the inclusive research in IT at ITU is the goal of developing IT that improves the overall quality of human lives. DELCA ghost does not only offer means to test different ways to respect and retain privacy while providing the benefits of positioning systems. It also forms an interesting laboratory for testing the effect of a largely peer-driven and narrative universe for the feeling towards tracking. A success criterion of the DELCA project is to facilitate a pervasive context sensitive system that is not burdened by the discomfort related to monitoring.

For explorations in biomimetic approaches IT design the DELCA project provides ample room to test the performance of adaptive systems for a future implementation in much more radical Ambient Intelligence ecologies [Sørensen 2003 a and b]. The goal is to find the balance between adaptive dynamics and increased reliability and stability and to find ways of modeling adaptive architectures.

In a broader perspective the DELCA ghosts facilitates technical investigations of location-based services and the use of positioning systems. Especially matters of mobility and precision are of importance as is the development of efficient middleware and standard protocols. The DELCA system is meant to work seamlessly with the WLAN system already in the building. The hardware used will be ‘of the shelf’ to the largest extend possible and the software is open source and based on standards to facilitate easy expansion and compatibility.

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