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Natural Human-Robot Interconnection Capabilities With Verbal And Non Verbal Aspects

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***Abstract* - In this paper, there is an overview of human–robot interactive communication is presented, showing verbal and non-verbal aspects and development of intelligent robots with sensory motor skills and perception, decision-making capabilities and learning, An extensive survey of human–robot interactive communication is provided. Verbal and non-verbal aspects of human–robot interaction are covered. Ten special desiderata that human–robot systems should fulfill are proposed. Following a historical introduction and motivation towards fluid human–robot communication and ten desiderata are presented, which provide an organizational axis both of recent as well as for future research related to human–robot communication. Then, the ten desiderata with natural language dialogue and speech recognition are examined, climaxing in a unifying discussion, with a forward-looking conclusion.**

Keywords- Verbal, Non-verbal, Human–robot interaction, Human–robot communication, Survey.

I. INTRODUCTION : HISTORICAL OVERVIEW.

The concept of robot has a very long history, starting in mythology and folklore, and the first mechanical predecessors (ie.automata) have been constructed in Ancient Times. For example, in Greek mythology, God Hephaestus is reputed to have made mechanical servants from gold. Furthermore, there was a rich tradition of designing and building mechanical, hydraulic automata also exists. The Islamic world conjointly plays very important role in development of automata; Al-Jazari, an Arab inventor has constructed number of automatic machines, and is even reputed to have devised the first programmable humanoid robot in 1206 AD. The word ‘‘robot’’, a Slavic word means servitude, was first used for this context by the Czech author Karel Capek in 1921.

However, regarding robots with natural-language conversational abilities, it was not until the 1990s that the first pioneering system started to appear. Despite the long history of mythology and an automata, with the fact that even the mythological handmaidens of Hephaestus were reputed to given a voice and the fact that the first general-purpose electronic speech synthesizer developed by Noriko Omeda in Japan in 1968. It was not until the early 1990s that conversational robots such as MAIA, RHINO, AESOP appeared. These robots can cover a range of intended application domains; for example, MAIA intended to move objects from one place to another and deliver them, while RHINO is a museum guide and kind of robot, and AESOP a surgical robot. It could perceive human feet waving a ‘‘tour wanted’’ signal, and then it would just use pre-determined phrase during the tour itself. A little bit more advanced system was TJ. TJ could verbally respond to simple command, like ‘‘go left’’, albeit via keyboard. RHINO, on the opposite hand, could respond to tour-start commands, but then, again, it offered pre-programmed tour with fixed programmer-defined verbal descriptions. About mobile assistant robots with conversational capabilities within the nineties, a classic system is MAIA, obeying simple commands, and carrying, moving objects around places, as well as the mobile office assistant which could not only deliver parcels but can also guide visitors.

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II. MOTIVATION: INTERACTIVE ROBOTS WITH NATURAL LANGUAGE CAPABILITIES.

There are at least two avenues towards discussing this fundamental, and both will be attempted here. The first avenue will attempt to start from first principles and derive a rationale towards equipping robot with natural languages. The second, more traditional and safest avenue, will start from a concrete, yet partially transient, base: existing application domains.

Traditionally, there used to be a clear separation between design and deployment steps for robots. Application-specific robots for instance, manufacturing robots, such as, (a) designed by expert designers, (b) possibly tailor-programmed and periodically reprogrammed by specialist engineers at their installation site, and (c) commune with their environment as well as with specialized operators throughout actual operation. However, not only the phenomenal simplicity but also the accompanying inflexibility and cost of this traditional setting

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are changing in current scenarios. For example, one might want to have broader-domain and less application-specific robots, necessitating more generic designs, and less effort by the programmer-engineers on site, in order to cover the different contexts of operation. Even the better, one might want to depend less on specialized operators, and to have robots interact and collaborate with non-expert humans with a little amount if any prior training. Ideally, even the actual traditional programming and re-programming might also be transferred over to non-expert humans; and instead of programming in a technical language, to be replaced by intuitive tuition by demonstration, imitation and explanation.

This is exactly where natural languages and other different forms of fluid and natural human–robot communication come in the picture: Unspecialized non-expert humans are used to teaching and interacting with other humans via mixture of natural languages and non verbal signs. Therefore, it makes sense to capitalize on this existing skill of non-expert humans by building robots that do not need humans to adapt to them in a special way, and which can fluidly integrate with other humans, interacting with them and being taught by them in a natural fashion, almost as if they were other humans themselves. Hence, based on the above observations, the following is one typical line of motivation towards justifying efforts for equipping robots with natural language potentialities.

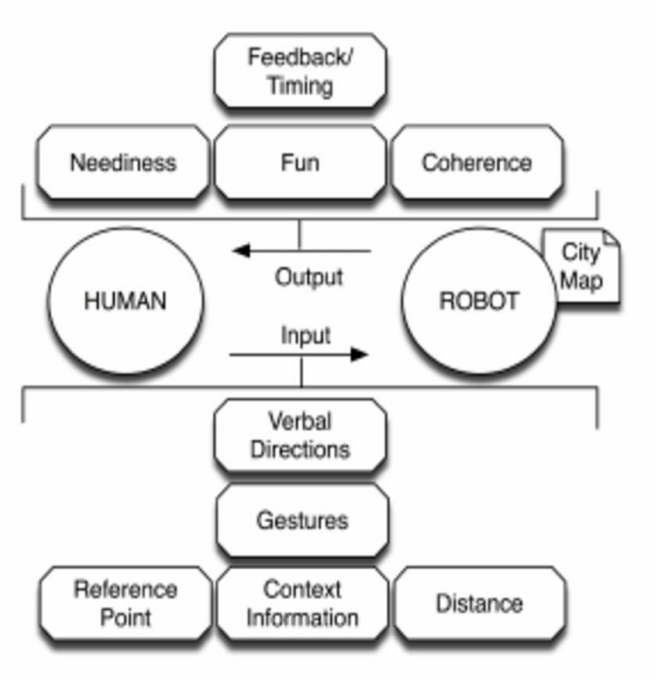

FIGURE: A COMMUNICATION STRUCTURE FOR SUCCESSFUL HUMAN-ROBOT INTERACTION.

Why not build robots that can fluidly converse with humans in natural language, also supporting crucial non-verbal communication aspects, in order to maximize communication effectiveness, and enable their quick and effective application? Thus, having represented the typical line of reasoning approaching towards the employment of mobilization robots with tongue capabilities, and having discussed a space of possibilities regarding role allocation between human and robot.

Let us now move to the second, more concrete, albeit less general avenue towards rational conversational robots: namely, specific applications, existing or potential. Such applications, where natural human–robot interaction capabilities with verbal and non-verbal aspects would be desirable, such as: flexible manufacturing robots; lab or household robotic assistants; assistive robotics and companions for special groups of people ; persuasive robotics (for example, robotic receptionists, robotic educational assistants, shopping mall robots, museum robots, tour guides, environmental monitoring robots).

Now, having examined justifications towards the requirement of tongue and alternative human-like communication capabilities in robots across 2 avenues, allow us to proceed more and become additional specific regarding the natural language, truly but what capabilities do we actually need & required ?

III. HUMAN- ROBOT INTERCONNECTION THROUGH NATURAL LANGUAGE DIALOGUE.

As it was noted, spoken tongue dialogue is the only sensible approach a non-expert user has for specifying and teaching a task to a robot. To implement this sort of communication, the automata can have to be ready to generate additionally on interpret spoken natural language sentences.

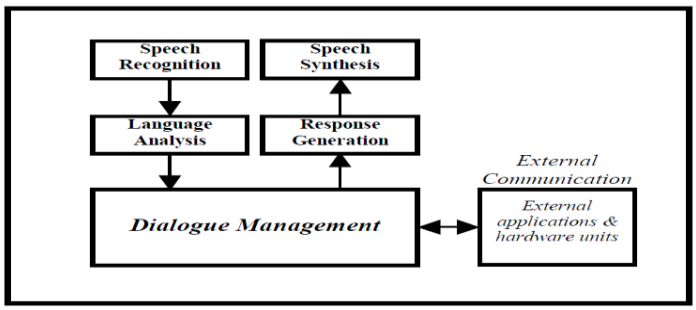

FIGURE: COMMUNICATION VIA SPOKEN DIALOGUE SYSTEMS.

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Natural Language (NL) Processing the CPK NLP suite (Brondsted, 1999ab) is being used for NL Understanding. The C API provides mechanisms for loading external grammar files, activating and deactivating sub grammars and for performing parsing. In order to understand under-specified sentences, the system needs to keep track of salient information. Examples of salient information are people, objects and events being talked about.

There are various interesting aspects to discuss concerning NL Generation. The Formulator module encounter as input an HRCL message from Carl's Dialogue Manager produces a semantic frame and, finally, a NL sentence. Processes available for the Formulator range in sophistication from inflexible canned methods to maximally flexible feature combination methods. Canned systems directly print a string of words without any change. To improve the interconnection & communication, messages should vary incorporating randomness in the choice of each message component. This can be done using a random message generator supervised & leaded by a grammar as used in the CPK NLPsuite SGEN programs.

Performative :	Meaning :
ask(S,R,C)	S wants R to provide one instantiation of sentence C
ask_if(S,R,C)	S wants to know if R thinks sentence C is true
tell(S,R,C)	S thinks sentence C is true and tells that to R
deny(S,R,C)	S does not know if sentence C is true and tells that to R
insert(S,R,C)	S asks R to consider sentence C true
delete(S,R,C)	S asks R to no longer consider sentence C true
achieve(S,R,C)	S asks R to perform action C in its physical environment
error(S,R)	S informs R that S cannot not understand R's previous message
sorry(S,R)	S informs R that S understands R's previous message but cannot provide a response
standby(S,R,C)	S wants R to announce its readiness to provide response to message C and standby
ready(S,R)	S is ready to respond to a message previously sent by R
next(S,R)	S wants R's next response to a message previously sent by S
rest(S,R)	S wants R's remaining responses to a message previously sent by S
discard(S,R)	S does not want R's remaining responses to a message previously sent by S
register(S,R)	S announces its presence to R
dialogue(S,R,C)	S proposes to R a (sub-)dialogue about subject C
dialogue_accept(S,R)	S accepts to participate in a (sub-)dialogue previously proposed by R
dialogue_reject(S,R)	S rejects to participate in a (sub-)dialogue previously proposed by R
dialogue_end(S,R,C)	S proposes to R to end a (sub-)dialogue about subject C
dialogue_end_accept(S,R)	S accepts to end a (sub-)dialogue as proposed by R
dialogue_end_reject(S,R)	S rejects to end a (sub-)dialogue as proposed by R

TABLE: HRCL PERFORMATIVES (S =SENDER; R =RECEIVER; C = CONTENT)

An audio interface needs the short term memory of the listener. The capacity of memorizing, however, is rather limited; therefore messages can't convey too much information at a time. Unlike graphical interfaces, a speech-only interface is not persistent. Functionality of the application is hidden, and the boundaries of what can and cannot be done are invisible. Techniques such as: incremental and expanded prompts; tapering, shortening the interactions as user gains experience; and hints, can be used to make the interaction more natural. For doing this, the Formulator requires to keep record of past messages used in the current conversation. Other question that can be addressed in the Formulator is to give implicit feedback to the user about speech-recognition results. Because we have far from perfect recognition of speech, it is in some occasions very useful to transmit to the user what the system recognized. For instance, the robot is standing near the stairs and the user tells him to turn back, but due to misrecognition, the system understands the command to go forward. But then, using knowledge and its sensor information, the robot "decides" for the need of explicit confirmation asking the user to confirm the order. This is like a sub-conscious reaction in a danger situation. If the mechanism does not embrace within the confirmation message what was the perceived order, the user as no way of knowing what is being confirmed.

This mechanism will use the boldness live of the recognition process. In a dialogue system, ARISE, if the confidence is high, implicit confirmation is applied; otherwise explicit confirmation is used.

IV. DESIDERATA - WHAT MIGHT ONE NEED FROM A CONVERSATIONAL ROBOT?

An initial list of desiderata is presented below, which is neither totally exhaustive nor absolutely orthogonal; however, it serves as a good starting point for discussing the state of the art, as well as the potentials of each of the items:

[D1] Breaking the ‘‘simple commands only’’ barrier.
[D2] Multiple speech acts.
[D3] Mixed initiative dialogue.
[D4] Situated language and the symbol grounding problem.
[D5] Affective interaction.
[D6] Motor correlates and Non-Verbal Communication.
[D7] Purposeful speech and planning.
[D8] Multi-level learning.
[D9] Utilization of online resources and services.
[D10] Miscellaneous abilities:
I) Multiple conversational partners II) Multilingual capabilities and multimodal natural language

The shown order of the sequence of desiderata, was chosen based on their priorities of conversational robot, as it provides partly building up of key points, also allowing for some tangential deviations. Not all the desiderata are necessarily of an equal difficulty and an arguably D1, D3–4, and D7–8 have so far proven to be particularly tough. One of the main reasons in this situation has to do with the divide between the two worlds that interactive robots usually live in: the symbolic/discrete world of logical representations and language on the one hand, and the continuous and noisy world of sensory motor data on the other. And it is not only the uncertainty that arises from the unreliability of the sensory motor end that contributes to the difficulties, but also the reality that the sensor data tends to be structured in such ways that are not easily align able to the requirements of symbolic representations.

V. CONCLUSION

An overview of research in human–robot interconnection communication was presented, covering verbal as well as non-verbal aspects. Following a historical introduction reaching from roots in antiquity to well into the nineties, and motivation towards fluid human–robot interactive communication, interconnection via spoken dialogue system, ten desiderata were proposed, which gives an organizational axis both of recent and of future research on human–robot interconnection communication. With this, it is possible to teach the robot simple basic behaviors through natural language and for representing formally the spoken messages exchanged between human and robot, we propose the HRCL language. In conclusion, although almost twenty-five years in human–robot interactive communication exist, and significant progress has been achieved in many fronts, many sub-problems towards fluid verbal and non-verbal human–robot interconnection communication remain yet unsolved, and present thoroughly promising and exciting path, different routes towards research in the near future.

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