# Towards a Social Robot that Incrementally Justifies Personal-Space Intrusion

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## Motivation

Imagine a hospital service robot that has just adopted the goal to rescue a patient on the other corridor. On its way to the patient the robot encounters a human being standing in the hallway. The robot's planned path leads right across the human's personal space. Knowing that personal-space intrusion should be avoided on the one hand and knowing about the urgency of the task on the other hand, the robot decides to continue on its planned path while verbally explaining to the human that it needs to pass urgently to rescue a patient.
The robot thus invites the human to commit to its goal: Because the human understands the robot's goal, she may either decide to step aside or even to assist the robot Thus the robot communicating its reasons entails the invitation for a *joint commitment* (cf., [2]).

**Fig. 1(a)** Robot enters personal space

**Fig. 1(b)** Person steps away

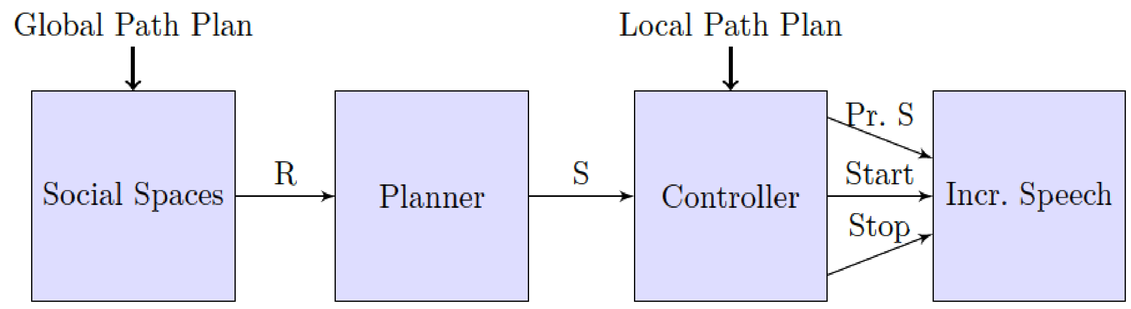



**Fig. 2** Architecture integrating personal space and incremental speech production (see [1])

## Personal Space

The *social spaces component* represents a personal space as an entity that is produced by a (single) human and the human provides reasons for action to robots. In the example domain depicted in Figures 1(a) and 1(b) the human provides a reason against the robot driving along the planned path. This reason-driven view is inspired by practical philosophy on morality [4] and motivated by the fact that reasons can be used both for deliberate decision making and for generating justifications or apologies social agents owe to others. Moreover, the patient provides the robot with a reason in favor of driving along the planned route.

## Verbal Planner

Let reason r1 be the fact that the personal space should not be intruded and reason r2 the fact that some patient has to be rescued in the other corridor. The verbal planner maps r2 to an apology and r1 to a justification. As a result the component outputs S := "Excuse me, I need to pass urgently to rescue a patient in the other corridor. Thank you."
S may become quite long the more reasons are at stake and hence we propose to order reasons by importance and to insert additional chunking information that the incremental speech production may use to skip parts of the resulting utterance for brevity

## Controller

The controller component interfaces the verbal planner and the incremental speech synthesis. It is implemented as a finite state machine that sends commands to the incremental speech synthesis component depending on whether the robot benters personal space, is within personal space, or leaves personal space.

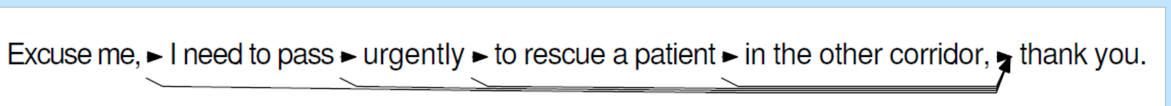
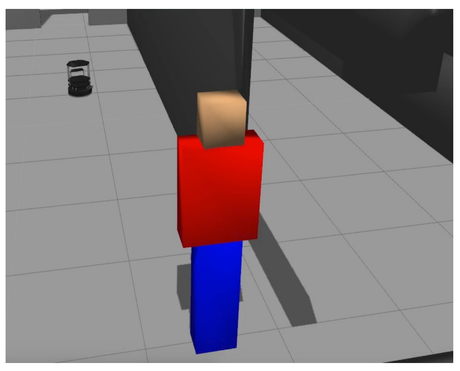


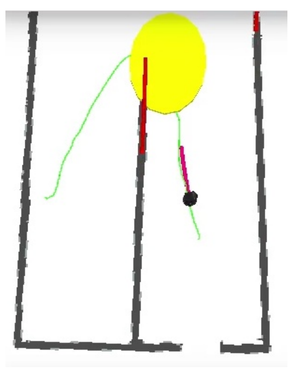

**Fig. 3** Utterance plan generated by the verbal planner component

## Incremental Speech

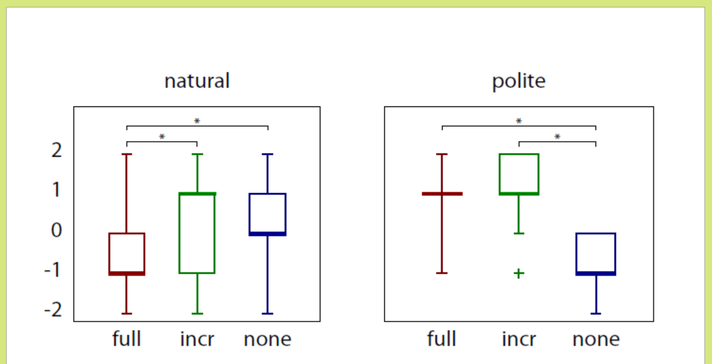
Given the utterance plan S of the verbal planner, the incremental speech production component prepares a flexible utterance tree that provide for the alternatives of the original plan (in our case: skipping parts of the explanation).

## User Study Design





## Results




## Discussion

When giving the reason for personal space intrusion the robot is rated as significantly more polite compared to not explaining why it needs to disturb the human. However, the robot is rated as significantly less natural if it does not obey the Gricean Maxim of quantity [3] and utters the full reason even though the human has already reacted and stepped aside. Thus, to be both polite and natural, the robot needs the ability to explain itself to the extent that is necessary in the situation.

[1] Baumann, T., Lindner, F.: Incremental speech production for polite and natural personal-space intrusion. In: ICSR 2015: Procs. of the 7th IEEE Int. Conf. on Social Robotics (2015)
[2] Gilbert, M.: Joint Commitment: How We Make the Social World. Oxford University Press (2013)
[3] Grice, P.: Logic and conversation. In: Cole, P., Morgan, J. (eds.) Syntax and semantics, vol. 3: Speech Acts, pp. 41–58. Academic Press, New York (1975)
[4] Raz, J.: From Normativity to Responsibility. Oxford University Press (2011)