The Robot Brain Server: Design of a Human-Artificial Systems Partnership

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Abstract. The global demand on technological services that make people independent of others is growing. Social robots seem an outstanding candidate to offer services for self-management and companionship because they can deliver abstract information in an understandable way and are treated as trusted partners. Recently, I initiated the Robot Brain Server (RBS) project, which handles the data, data security, and Artificial Intelligence that drives the robots. RBS takes a hybrid-centered design approach in which software developers work with the public at large to produce a new generation of artificial cognitive service systems to support specialists in care, education, hospitality, and other service professions.

Keywords: Social Robots · System Design · Data Security · Co-creation

1 Introduction

World-wide, more services and higher standards of service are demanded from a declining workforce in scattered societies [1]. Regarding care and education, this is one of the most severe challenges that contemporary societies face today (China and Japan included) [2]. More people need more specialized attention but with contracting populations [3], there are just not enough hands around. Technology seems a solution, providing apps, web sites, and online services but users do not see the forest for the trees due to the information overload [4].

In earlier research, we successfully explored the deployment of social robots in eldercare [5] and education [6] with robots sometimes outperforming humans on emotionally sensitive tasks such as easing loneliness [5] or bad-news delivery [7]. Most striking outreach project was the documentary *Alice Cares*, showing Robokind Alice R50 in interaction with three older ladies [8].

Social robots evoke strong affective responses in human beings and are capable of emotional support [9], teaching [10], information dissemination [11], and entertainment [12]. If done well, they can make up for the lack of a social community with the advantage that robots are not prejudiced or judgmental; they are company without social repression [5].

However, professional help becomes scarcer and before we can fully employ robots to assist us in our societal endeavors, we need to investigate much deeper what kind of *service* design is required to meet the individual needs of people that are increasingly thrown back on their own resources. And next to that, we need to embark on a *server* design that supports those robot partners in delivering those services.

2 Service Design

In the last 30 years, the developed countries went through a transition from industry-oriented production to an economy of information and services, which cover about 70% of their gross domestic product while being formative for new businesses and new forms of employment [13, p. 354]. Hence, a number of service design-methods surfaced among which Multilevel Service Design (MSD) to construct complex service systems [14].

MSD is a 4-step method that starts with studying the user experience (Step 1). From our studies [5], we found that social robots are used foremost as confidante. Owing to the sensitive nature of disclosing personal information to the machine, privacy protection is key as well. Most notably, we found that other humans are *not* central to the need fulfilment of the individual. It is the *function* of other human beings that a person is interested in and if that function is not provided or not provided well enough by a human being, a robot may be preferred; also for keeping company.

Step 2 in MSD is to define a service concept in terms of the benefits that are offered to the user [14]. In our case, it is the benefit of 24/7 trusted companionship without having to rely on other people. It is also the benefit of the robot being a universal interface between the information overload [4] of the digital world (Cloud, Internet of Things (IoT)) and the human user's analogue world. Information from smart home devices does not come as sound signals or bar charts anymore; the robot communicates that information to the user through natural language, stating: "You are damaging your eyes. Shall I turn up the light a little?" Or the robot may translate a signal from a CO_2 meter as: "Can you open the window for me? Stale air here."

In Step 3 [14], the service system configures people, technologies, and other resources to sustain the concept supplied by Step 2. In the case of social robots, the technologies I propose are discussed in Section 3, after which the relevant human and other resources are discussed in Section 4.

3 Server Design

My novel approach is to use social robots as the universal interface between Cloud computing, data analytics, and embedded software on the one hand and the analogue world of the user on the other [15]. Robots retrieve their information from sensors, cameras, and microphones, sampling user data that can be uploaded – if the user so authorizes – to the Cloud, ready for analysis [16]. And once robots are connected to the Cloud, they can help translate data patterns into human-understandable speech.

However, social robots also function as trusted partners and if they have a connection to the Cloud and IoT, the user's privacy is easily breached. As thin clients, then,

robots are connected to a central Robot Brain Server (RBS) (Figure 1). Through Artificial Intelligence (AI) systems, RBS learns about the user and tends to the user in a personalized way, as a friend for life. The robots are no more than the physical manifestations of the RBS, which manages the data and the communication among the AI systems, which determine the robot's behaviors. Because people tend to disclose privacy-sensitive information to their beloved robots, RBS also handles authorization and security of personal information, which is stored in a private data vault that is placed at home. Semi-private information, for example, about social networks, is authorized to a limited set of people (e.g., spouse, caretaker), while general repositories can be freely accessed (e.g., holiday pictures).

RBS is built from the idea that data are closed and software is open. Therefore, computational activity is not visible to any outside party. Nobody sees that the user converses with his/her robot. Out of medical or commercial reasons, users may decide that others can use their data but default is that others cannot.

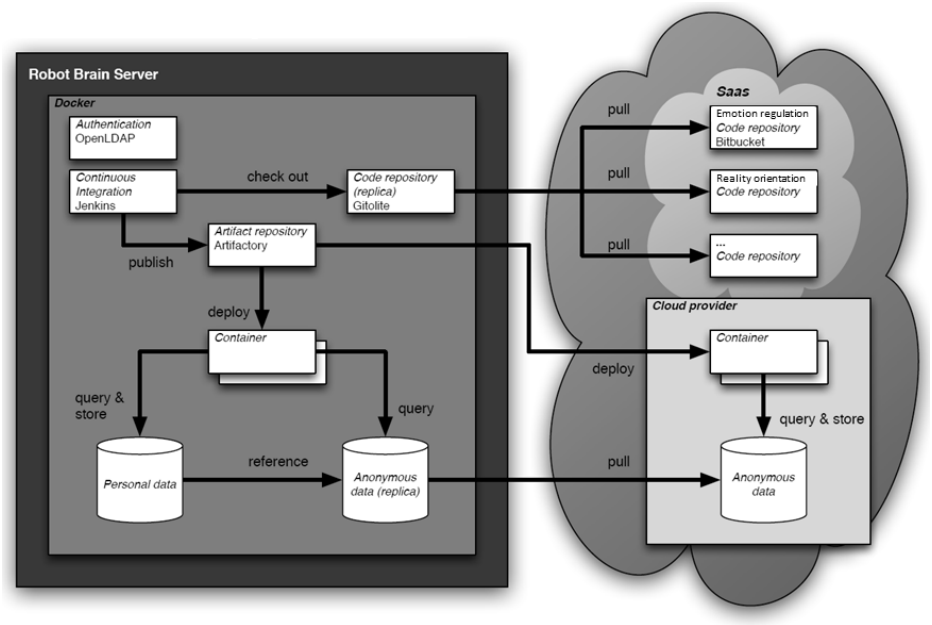

Fig. 1. Robot Brain Server – high-level architecture.

Regarding the RBS, we completed our AI systems for emotion generation and affect,[2] moral reasoning, creativity, reality orientation,[3] and learning[4] (Figure 1, Saas). For example, Silicon Coppélia [17] is capable of generating and regulating affective states and processes and the simulation of emotions in response to other agencies (human or artificial). The system gradually builds up one of four action tendencies with respect

[2] https://bitbucket.org/robopop/; git@bitbucket.org:robopop/silicon-coppelia.git
[3] https://github.com/robopop/; git@github.com:robopop/epistemics.git
[4] https://github.com/jeroenvanmaanen/leia; git@github.com:jeroenvanmaanen/leia.git

to the other agency (i.e. positive or negative approach, avoidance, or changing the other).

Moral Coppélia [18] is capable of moral reasoning and deciding on ethical dilemmas in the same way as medical ethical professionals do. It bases itself on the (standard) prioritization of ethical principles (in order of decreasing importance): non-maleficence, beneficence, user autonomy, and justice.

Epistemics of the Virtual [19] starts from a knowledge database and maintains and updates a belief system about those data. It can do so for multiple agencies and therefore has 'theory of mind.' It is capable of verification of truth (according to belief), fiction-reality distinction (is this real or play?), epistemic appraisal (realistic or not?), and metaphor recognition (literally meant or not?). Can be employed for reality-orientation and to detect, for instance, simulated illness.

Our AI is built in several ways (e.g., in Ptolemy) but each resides in a separate Docker container. This way, others can add their own work without damaging the integrity of the RBS. Then we built it with Jenkins (Java automation server), which publishes its artifacts to Artifactory (a repository manager). Both the Git server (where the repositories are), the Jenkins and Artifactory server do their authentication via a shared LDAP server that runs on the Robot Brain Server.

Currently, we are in the process to connect Jenkins to Gitolite (that hosts Git) so that Jenkins can retrieve code from the repository to build it. We still have to design Artifactory and connect it to Jenkins. After that, we will work on Cloud deployment of processes on anonymous data.

4 Collaborative Design

Step 4 in MSD [14] describes service encounters as the interaction between the parties that provide the service and the user. A service encounter is also called a touchpoint [ibid.], which in our case is the Social Robotics Pop-up Lab (ROBOpop).[5] Here, software engineers and service designers work with the public at large to create a new generation of artificial cognitive service systems for human professionals in care, education, hospitality, and the like. RBS is an open-source development project, adopting a hybrid-centered design approach: Apart from prospective users, RBS is co-developed by Microsoft under an Azure4Research Award to connect RBS to the Cloud. Authorization and security of personal information is developed together with Deloitte Privacy and Data Protection. This way, large corporates learn to refrain from short-term profit maximization that is based on user seduction. Instead, they start to engage in long-term business models based on well-earned customer trust.

All the AI code goes into open source repositories such as GitHub and Bitbucket under two licenses: GNU Affero GPL v3-and-up allows commercial use but users can study and modify the code. Apache V2 can be used as well but is supplemented by a disclaimer that closed code may contain spyware and malware.

To warrant the integrity of the code, ROBOpop is the keeper and watchdog of the free and open Robot Brain Server, its open AI and other relevant freeware/shareware.

[5] http://www.robopop.nl

Developers of Cloud technology or developers of robot services (e.g., conversation partner, data interpreter) may align their services with RBS but they cannot upsell RBS software. If users suspect spyware or malware in the RBS code that was delivered with a third party service, they can always download an uncorrupted version from ROBOpop Foundation for free.

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