What do people expect from robots?

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Abstract— **The study presented in this paper explores people perception of robots, with a particular focus on domestic use. We addressed issues related to positive and negative attitudes toward robots, needs for domestic robots as well as preferences in terms of appearance and interaction modalities. We used a combined qualitative and quantitative approach using interviews and questionnaires. In total, 240 people participated in our survey. Results indicate that a large proportion of participants have a very positive attitude towards robots. They expect concrete help for a variety of tasks from these devices. They prefer a small machine and they would like to interact with robots using speech.**

I. INTRODUCTION

Since the middle of the 20th century, robotics has become an essential component of the production industry, and this field keeps growing. However, the next major challenge for robotics concerns applications for domestic environments and personal use, thus involving closer interaction between robots and humans [3]. The field of service and personal robotics is rapidly expanding and predicted to grow even more in the future [14]. Researchers in the field envision that, sooner or later, robots will become part of our everyday life as appliances, servants and assistants, helpers and elder-care companions, and assisting in many other tasks [5], [14].

One of the main challenges this new trend presents will be people's acceptance of robots sharing their daily lives. But what do we know exactly about how this new kind of machine is perceived? In order to develop robots for personal use, the answers to some questions are still lacking. For instance, is people perception rather positive or negative and what influences this perception? Do people actually need robots and what for? What sort of appearance and interaction modality is most desirable? The survey presented in this paper is an attempt to address these critical questions. Results could then be used as a basis to propose guidelines for robots' designers and developers.

There have been only a few large-scale studies exploring social perception and acceptance of robots. In Japan, Nomura studied how robots mentally affect humans [10], [11], [12]. He developed a psychological scale to measure the negative attitudes toward robots and anxiety evoked in human-robot interaction. He designed several questionnaire-based studies gathering up to 2300 answers. He mainly showed that people's assumptions about robots influence their attitudes towards them.

In Switzerland, Arras and Cerqui [1] carried out a large-scale survey including more than 2000 people. They investigated questions related to the image of robotics, the potential acceptance of robots in daily life, and appearance preferences. The study showed that 70% of people have a neutral image of robotics, and 71% stated that they could imagine living with robots on a daily basis. This survey also showed that almost half of the sample would not like to have a robot with a humanoid appearance.

Khan conducted a study in Sweden with 134 people about their attitude toward intelligent service robots [8]. He explored issues related to tasks, interaction modalities, stereotypes and appearance. His main conclusions were that people were globally positive towards the idea of intelligent service robots, which were seen as "domestic machines" that can be "controlled" and do mainly household tasks.

In an exploratory study, Dautenhahn [4] investigated people perception and attitude toward the idea of a future robot companion for home involving 28 adults recruited from the University of Hertfordshire. The results showed that 40% of the participants were in favor of having a robot companion. They could easily see the potential role of robots as being an assistant, a machine, or a servant, but few wanted a robot as a friend. Household tasks were preferred to child or animal care tasks. Humanlike communication was desirable for a robot companion, whereas humanlike behaviour and appearance were less essential.

Other studies involving a human-centered approach with questionnaires or interviews are usually focused on a specific project, robot, or group of people. They are often exploratory in nature, and much smaller, and specific in scope and context.

Even though Dautenhahn [4] and Khan [8] tackled questions somewhat similar to ours, their samples were smaller. Therefore, our survey will nicely complete their studies. Only Nomura [11] and Arras and Cerqui [1] had much larger samples. However, Nomura had a very specific scope and distributed his questionnaire in a very specific context– a robotics' exhibition where people interacted with his robot "Robovie". The questionnaire designed by Arras and Cerqui contains only few items directly related to ours and their questions were much broader. Moreover, their study was not based on a qualitative approach like ours, as will be explained in the next section. The survey presented in this paper embraces a larger scope than most of the

studies found in literature. Instead of focusing on a specific experience, robot, or group of people, we aimed to explore the global attitudes of people toward robots.

This paper is organized as follows: section II describes our methodology; section III presents the results of our survey along with a discussion of each interesting item; and finally, section IV summarizes the main outcomes of our research.

II. METHODOLOGY

The design of a research questionnaire is a very delicate process that is sometimes overlooked when scholars quickly set up a survey to test the interaction modality of a robot. One of the main difficulties is to minimize the bias introduced by the experimenter in the way he asks questions. For instance, we often observe that the choices proposed in closed questions are based on researchers' assumptions. Moreover, open questions are often avoided since they are more difficult to process. Aware of these critical issues, we chose a combined qualitative/quantitative methodology. In order to avoid basing our questions on our personal postulations, we decided to start by gathering qualitative data about people's perceptions of robots through open-ended, semi-directed interviews. We targeted people from various backgrounds, genders, and ages, and interviewed a total of 11 people (7 women and 4 men, aged from 20 to 57). Guidelines for these interviews included questions related to people's positive and negative perceptions of robots; expectations for the future; previous contacts; potential needs for robots; appearance and interaction modality preferences.

Based on the results of these interviews, a questionnaire was developed. We chose to keep a certain number of open questions based on the guidelines used for the interviews. We added closed questions based on the results of the preliminary study. The questionnaire so designed was distributed at the Geneva Fair [7]– an annual home and art of living exhibition that took place from November 9th to 18th, 2007. This fair was chosen for several reasons: a wide variety and a high number of people (about 300,000 per year) visit such events and visitors were not attracted by robotics in particular, but rather by home devices in general. We installed a stand where a RoboX [13], [6] was drawing attention of people with a very simple interaction scenario. The stand was also displaying Alices' robots [2] evolving in a maze and posters presenting our labs, robots, and projects. A total of 240 people stopped at the stand to complete the questionnaire. They were French-speaking from the Geneva region (Switzerland and France), geographically situated in the center of Europe. Our sample is therefore drawn from a specific area and all results have to be interpreted with this particular aspect in mind. The sample characteristics are listed in TABLE I. The results of this study are presented and discussed in the next section.

TABLE I
SAMPLE CHARACTERISTICS (N:240)

Gender	Male	51%
	Female	49%
Age	10-20	15%
	20-40	31%
	40-65	43%
	65+	6%
Education Level	No education	3%
	In education	11%
	Apprenticeship degree	13%
	Vocational school degree	29%
	University degree	35%
	Other	9%

III. RESULTS & DISCUSSIONS

A. How do people perceive robots?

To understand how people perceive robots, we opted for a four-step solution. First, we tried to understand what a robot evokes in people's minds (Q1) and what they associate with the term "robot" (Q2). Second, we asked (Q3) if people would find positive and/or negative aspects (including fears Q4) in the development of robots both at personal and societal levels. Third, we inquired if people believed in this development and if they felt positive about it (Q5). Fourth, we investigated possible influences on this perception by asking questions about previous contacts with robots– either in reality or through diverse media (Q6).

1) What does "robot" evoke in human minds?

Q1 was a very open question that simply asked the first thing that comes to mind when the word "robot" is mentioned. Answers have been grouped by topic as follows: help and usefulness (20%), science fiction movies and characters (15%), future and technology (15%), automatism and automation (11%), food processor (4%), negative aspects (4%), artificial intelligence (2%), artificial being (2%), various (20%).

It is particularly interesting to note that very few participants thought about negative aspects, with only 4% mentioning job loss, danger, lack of trust, or inhumanity.

In [12], Nomura also explored what the word "robot" evokes in people's minds, but subjects had to chose between five possibilities: humanoid, pets, animals except pets, computers and factory robots. None of these items appears in our results. Even though Nomura's study took place in another country (i.e, Japan), this tends to show that it is important to allow participants some freedom in their answers. The risk of bias, already high in any study, is even higher if researchers force the choices too much.

Q2 asked for associations with the word robot. Results are displayed in Figure 1. The list contained robots' attributes, applications, as well as the positive and negative implications upon people's lives.

It is interesting to see the order of appearance of each element. First come global and societal applications such as
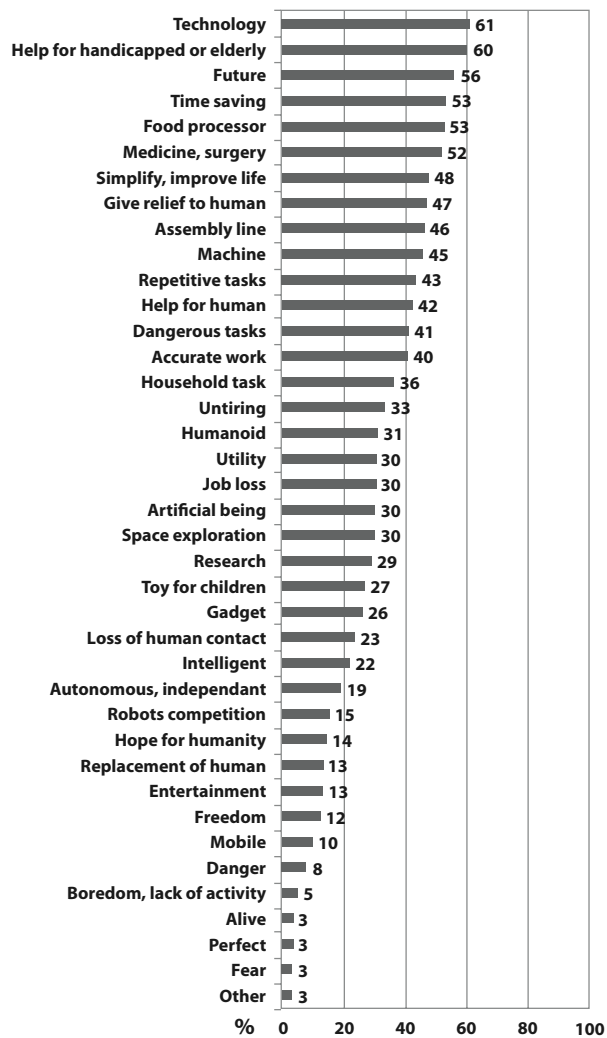
Fig. 1. Lists of words associated with the term "robot"

Fig. 2. What people find positive in the development of robot

technology, help for handicapped and elderly people, medicine and surgery, and assembly line. More personal applications like household tasks appear only later on. Concernings robot's attributes, we observe that people consider a robot to be a machine before a humanoid, an artificial being, or something "alive". Regarding the positive implications on people's lives, we see that concrete aspects like "time saving" or "simplify and improve life" were better rated than more conceptual ones such as "hope for humanity" or "freedom". Negative elements appear only in the second half of the list.

2) Are people positive or negative towards robots?

Q3 asked directly if people saw positive and/or negative aspects in the development of robots, and if yes, what they were thinking about. Participants had to answer at a personal level and at a societal level. Results show that a large proportion of the sample had a positive perception of robots (89% at the personal level and 84% at the societal level). The details of their answers have been grouped by topics and the results are presented in Figure 2.

This figure shows that subjects envisioned very pragmatic help as well as improvements to their lives such as free-time, comfort and well-being, security, entertainment, company,
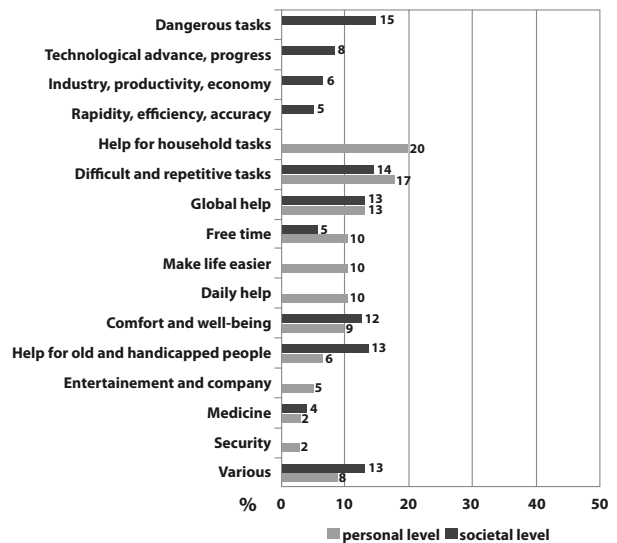
or an easier life. Differences between personal and societal levels are easy to understand: the elements that appear only at the personal level take place at home (household and daily tasks, security, entertainment, and company) whereas the elements appearing at the societal level are less private (progress and technological advances; industry, productivity, and economy). Attributes related to industrial robotics (rapidity, efficiency and accuracy, dangerous tasks) appear rather at the societal level. Help for the handicapped and elderly people is also seen as a societal problem where robots could offer a solution rather than as a personal element.

A relatively smaller proportion of the sample thinks that the development of robots has some negative aspects (35% at the personal level and 48% at the societal level). During the preliminary interviews, we realized that several people harbored some fears related to robots. Moreover, these fears were different from what was perceived as negative aspects. Therefore, we decided to add a separate item in the questionnaire which asked whether people had any fears related to robots and if yes, what kind of fears (Q4). 44% gave a positive answer. The details are listed in Figure 3 along with the details of negative aspects both at the personal and societal levels.

On this figure, we observe that none of the aspects got a very high score at the personal level, the highest being the loss of job at 14%. This element also received the highest rate at the societal level at 47%. The difference between these two percentages could be explained by the geographic origin of our sample, the Geneva area being an especially wealthy region with a very low level of unemployment. These people feel therefore more concerned about society than about themselves.

Another interesting feature of the results is the difference that arose between what is perceived as a negative element and what people are afraid of. For example, the autonomy of the robot is mentioned as a fear only. Replacement of humans has a higher rate in the fear question and the biggest

fear is loss of control and dysfunction of the robots. All these aspects seem to conjure a typical science fiction scenario where robots get out of control by gaining too much autonomy. As we will see in section 3.A.4, 65% of people have seen movies featuring robots. Therefore, it is highly probable that such scenarios have influenced them.
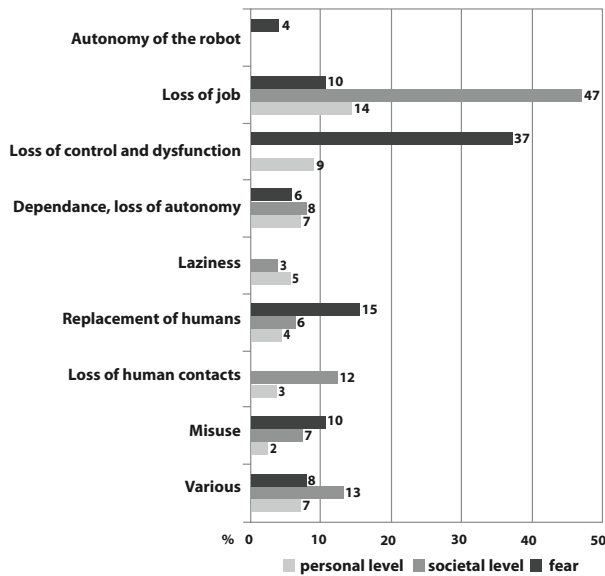

Fig. 3. What people find negative in the development of robot and what they are afraid of.

3) Soon living with robots?

In order to explore people's expectations and beliefs regarding the future development of robots, we asked two related questions (Q5.1 and Q5.2).

The first (Q5.1) asked if people thought that a domestic robot accomplishing the tasks they wish will arrive soon on the market. They had four possible answers: "no it is science fiction" (4%), "no, we are not there yet, but it will happen" (53%), "yes and I am looking forward to it" (36%) and "yes but I am not looking forward to it" (6%).

These results show that more than a half of our sample believed that the robot of their dreams will arrive on the market, even if they did not see this happening in the near future. A good percentage was very confident, thinking it will happen soon, and was positive about it. Very few subjects did not believe in this development or thought that it is not a good thing.

The related question (Q5.2) asked if they thought robots in general would be increasingly present in our homes and cities in the future. Results were as follows: more than a half of participants believed in this statement and were looking forward to it (55%), 22% thought that we are not there yet but that it will happen, 17% thought that it will happen but they are not looking forward to it, and only 1% did not believe in it at all.

Subjects were very confident and positive towards the idea of having more and more robots in cities and homes, even though the percentage of people that are not looking forward to it is a bit higher than in the previous question (Q5.1).

4) Already seen robots?

To understand how people are influenced in their perception of robots, it is important to identify how they have been in contact with robots, whether in reality or through the media (Q6). 50% of our sample stated that they have already seen robots in reality. 70% of participants had already seen robots on TV (29% in the news, 37% in broadcasting, 18% in series and cartoons). 65% had seen movies with robots, 38% in journals and magazines, and 23% in literature and novels.
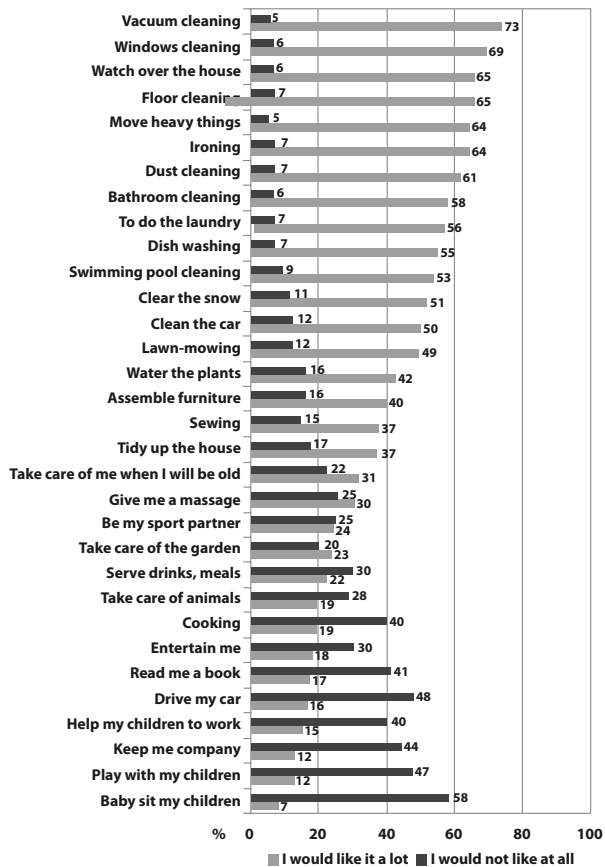
The percentage of subjects who previously came in contact with robots is very high. No one among the participants stated that they had never been in contact with robots in one way or another. On one hand, this might indicate that people who stopped by at our stand to complete this questionnaire already had some special interest in or ample opportunity to come in contact with robots. On the other hand, this tends to show that robotics is a topic appearing frequently in the media and that people have the opportunity to encounter robots in diversified contexts. Robots seem to have a good visibility and are not confined to the industrial or academic environment.

During the preliminary study, we noticed that almost all interviewees mentioned that they heard about development of robots in Japan. This element is interesting since robot developers in Japan focus on a different aspect of robotics (e.g., humanoid robotics) than the US or Europe. Consequently, we added a complementary question (Q7) asking which country, in their point of view, would be the most advanced in robotics research. Results show that 60% of participants thought that Japan is the most advanced country in robotics, which is a very high percentage compared to other answers (USA 16%, China 14%, Switzerland 13%, Asia 2%, Others 10%). This supports our hypothesis that the media give a lot of attention to robotics in Japan. Therefore, people might know more about the latest advances in robotics in this remote country than in their surroundings.

B. What should robots do?

The next question (Q8) proposed a list of tasks for which people had to answer whether they would like a robot to do it for them or not. Tasks listed include common household tasks, entertainment elements, as well as animal, child, and elderly care. Figure 4 shows the results of this question.

First of all we see that tasks typically involving some kind of relationship are poorly rated as compared with simple household tasks. This is consistent with the results of section 3.1.1 (Q3 and Q4) showing that one of the negative aspects associated with robots is the lack of human relationships. It is also consistent with the results of Dautenhahn [4] which showed that people would prefer a robot to be an assistant or machine than a friend or mate.

Chart (household tasks) — "I would like it a lot" / "I would not like at all":

- Vacuum cleaning: 5 / 73
- Windows cleaning: 6 / 69
- Watch over the house: 6 / 65
- Floor cleaning: 7 / 65
- Move heavy things: 5 / 64
- Ironing: 7 / 64
- Dust cleaning: 7 / 61
- Bathroom cleaning: 6 / 58
- To do the laundry: 7 / 56
- Dish washing: 7 / 55
- Swimming pool cleaning: 9 / 53
- Clear the snow: 11 / 51
- Clean the car: 12 / 50
- Lawn-mowing: 12 / 49
- Water the plants: 16 / 42
- Assemble furniture: 16 / 40
- Sewing: 15 / 37
- Tidy up the house: 17 / 37
- Take care of me when I will be old: 22 / 31
- Give me a massage: 25 / 30
- Be my sport partner: 25 / 24
- Take care of the garden: 20 / 23
- Serve drinks, meals: 30 / 22
- Take care of animals: 28 / 19
- Cooking: 40 / 19
- Entertain me: 30 / 18
- Read me a book: 41 / 17
- Drive my car: 48 / 16
- Help my children to work: 40 / 15
- Keep me company: 44 / 12
- Play with my children: 47 / 12
- Baby sit my children: 58 / 7

■ I would like it a lot   ■ I would not like at all

Considering only household tasks, it is apparent that some are better rated than others. For example, subjects would prefer a robot to do all the cleaning and ironing tasks, more than, for example, tidying up the house. From the preliminary study we can deduce that tidying up is perceived as a very personal task. Interviewees indeed mentioned that they would not like a robot or even a person to touch their things and move them from their place. In the same way, cooking, which could be seen as yet another boring household duty is rated very differently than cleaning tasks. Indeed, cooking has some creative and pleasant aspects to it that cleaning will probably never have. One reason for the different ratings may also be the frequency of the tasks and people might like robots to do the most repetitive tasks before others. This would be consistent with answers to Q3 in section 3.A.1 stating that a positive element of a robot is that it does difficult and repetitive tasks. An interesting aspect to highlight is that entertainment is not at all a priority compared to fastidious household tasks. This tends to show that variety in the perception of tasks should be taken into account while developing a roadmap for domestic robots' applications.

Globally, we can see that our sample has a very pragmatic approach to robotics, which is consistent with previous results. We should note here that this result might be only true for Europe or even for the area where our sample comes from. It is however consistent with Khan's conclusions, which state that a robot is primarily expected to conduct ordinary domestic, tedious, time consuming tasks (mainly cleaning the house and windows, washing dishes, and doing the laundry).

C. How robots should look like and interact?

A total of three questions regarding robots' appearance were asked in the questionnaire.

The first was very broad, only asking "In your mind, what does a robot look like?" (Q9). The two other items were specific to "domestic" robots, asking what a domestic robot should look like (Q10.1) and what it should absolutely not look like (Q10.2). Response categories were identical for the 3 items and participants were allowed to check several answers. Results are showed in Figure 5.
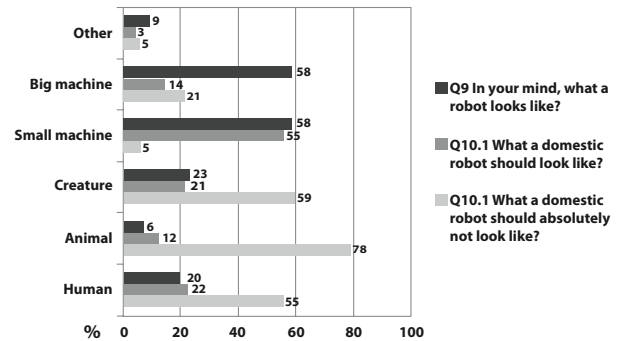

Fig. 5. What a robot should look like?

Legend:
- Q9 In your mind, what a robot looks like?
- Q10.1 What a domestic robot should look like?
- Q10.1 What a domestic robot should absolutely not look like?

- Other: 9 / 3 / 5
- Big machine: 58 / 14 / 21
- Small machine: 58 / 55 / 5
- Creature: 23 / 21 / 59
- Animal: 6 / 12 / 78
- Human: 20 / 22 / 55

Results shows that for the participants in our survey a robot looks like a machine, be it big or small. In spite of the apparent popularity of Japanese robots such as the Sony Aibo, the Furby and Asimo, other categories (creature, human, and animal) gathered only a small percentage.

Results to the question exploring what a domestic robot should look like (Q10.1) show that half of the sample would like a household robot to look like a small machine rather than a big one. Creature, human, and animal categories had again a low rating. The opposite question (Q10.2) indicates a very strong dislike of animal-like robots. At a reduced percentage, creature and human appearances were also strongly undesirable. The preferred appearance is therefore very clearly a small machine-like robot. Even if the detailed explanations of such a dislike of animal, creature and human-like robots is beyond the scope of this paper, it can be mentioned here that this result is consistent with a pragmatic view of robots highlighted in previous section as well as the poor score of the term "alive" in the association question (Q2, section 3.1). Again, this result is based on a sample coming from a specific region and the same questionnaire distributed, for instance, in Japan could obtain very dissimilar results.

The survey of Arras and Cerqui [1] asked people if they would prefer a robot with a humanoid appearance. 47% gave a negative answer, 19% said yes, and 35% were undecided which is consistent with our results: a humanoid appearance would not be preferred. Our study shows that this result can be extended to other living beings, i.e. animals and even creatures.

Regarding interaction modalities, people could choose among five categories to indicate their preferences (Q11). Results indicate that a large proportion (77%) would like to interact with a domestic robot using speech, the second preferred modality being the touch screen (34%). The "totally autonomous" option ("he knows what he has to do without my intervention") did not convince many people (only 12%). The simple "pressing buttons" alternative was not very seductive (10%), and the idea of using a computer even less (9%).

The fact that subjects wanted to interact with a robot using language was not surprising, as it is natural and instinctive for humans to communicate using speech. However, it could be seen as a contradiction given the fact that participants did not want a domestic robot to look like any living being, speech being a "living" communication mode. On the other hand, this is consistent with the results of Dautenhahn study [4], where a high percentage (71%) of the participants stated that they would want a robot companion to communicate in a human-like manner whereas human-like behaviour (36%) and appearance (29%) were less desirable. The low ratio of the autonomous option is consistent with the association question (Q2, section 3.1) where "autonomous and independent" was badly rated. This result might be due to the fear of losing control as shown in section 3.1 (Q4). It is also consistent with results of Khan's study which conclude that intelligent service robots are conceptualized as machines that can be controlled.

IV. CONCLUSION

Globally, our sample demonstrated a very positive attitude towards robots. However, this could be due to a lack of knowledge of our sample, which had no real possibility so far to think about the consequences of sharing their daily-lives with robots. Nevertheless, the participants in our study might be the first to buy robots since a good percentage of them were looking forward to being surrounded by robots and, sooner or later, to possess a robot that does the tasks they wish. Therefore, their answers are very interesting for the development of a roadmap for robots' designers and developers– at least for the European market. But what tasks would people like robots to do for them? Figure 4 will be an excellent basis for a roadmap of domestic robot applications. An interesting point is that people expect very pragmatic and daily help from robotic devices, entertainment and child/animal care being much less desirable. This should really be taken into account by robots developers. Another characteristic that should not be ignored is that not all household tasks are perceived in the same way, some being more desirable than others. This should definitely be explored further. A last point highlighted throughout the whole questionnaire is that robots should not substitute humans when other living beings are involved. For example, taking care of a child or an animal is not a task where people should be replaced by robots. Moreover, we observed that the replacement of people by robots, in particular in their job, is perceived as a problem. This should give rise to a deep interdisciplinary reflection on the impact of robots on people's everyday lives. We should definitely account for this impact while developing new technology in order to enable smoother societal changes due to technological advances. Regarding appearance, as other studies already showed, the humanoid option is not a good one and a domestic robot should look like a small machine, at least in Europe. Our study further showed that a robot for home environments should not look like any living beings, whether human, animal, or creature. However, interaction preference goes to a natural communication mode, i.e. speech. Finally, robot autonomy should not be too high and clear control from the user should always be maintained, regardless of the possibilities offered by technology. Indeed, answers to different items from the questionnaire highlighted the influence of science fiction movie scenarios and probably developed the fear of losing control over the machine. A last aspect that should be further explored and that could really improve our understanding of people perception of robots is a better comprehension of the factors influencing this perception, for example by developing a "robot familiarity scale" as shown in [9].

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