The Rise of the Roboid

Leopoldina Fortunati[1] · Alessandra Sorrentino[2,3] · Laura Fiorini[2,3] · Filippo Cavallo[2,3,4]

Abstract

The aim of this paper is to analyze a new phenomenon that is emerging in the field of social robotics, which we name as "roboid". The roboid is a robot that is still at the prototype stage but claims to be fully functioning. We argue that the roboid has been created to handle a new phase between the prototyping and the commercialization of robots. In this intermediate phase, a wide-spread promotional campaign is organized by robot producers, with the purpose of understanding the desires, needs, and suggestions of potential customers. We present the first case of a a highly human-like roboid named Sophia. We carried out the visual analysis of the content and the content-agnostic factors of a selection of 15 videos uploaded on YouTube on the social robot Sophia and a qualitative analysis of the textual component of these videos to investigate a selected part of the promotional campaign on Sophia. Furthermore, on the 23,810 comments that users have posted on these videos, we applied quantitative analysis to explore the observers' opinions about Sophia. Results highlight that: (1) a powerful but potentially ridiculous narrative has been used to build the rhetoric of Sophia; (2) the comments on the videos are too poor to enable a co-construction of this social robot with the audiences (implicit intention of Hanson Robotics); (3) the introduction of the roboid might be a very good solution to reduce the uncertainties that may occur when a new robot moves directly from the laboratory to the market.

Keywords Sophia · Social robots · Roboid · Sentiment analysis · Communication · Robot promotional campaign

1 Introduction

The aim of this paper is to analyze the representational plan (connected to the language) and presentational plan (connected to the visuals) [32] of a new phenomenon that is increasingly common in the social robot field, which we name as the "roboid". The term roboid is inspired by the term factoid, coined by Norman Mailer in 1973 in his biography on Marilyn Monroe, where he described a factoid as fact that does not exist before appearing in a magazine or newspaper [34]. He created the word factoid by combining the word fact with the ending -oid, which means similar to, but not the same. As the factoid is a pseudo-fact, the roboid is something that looks like a robot, which could be a robot, but that in reality is not a "true" robot.

This claim raises the question of "What is a robot?" and "Why is Sophia not a robot, but a roboid?". The authors in [46] performed a specific study on this issue. According to them, social robots are described typically as autonomous agents, complex machines or technological applications, capable of appropriately engaging in social interactions by adhering to specific contextual cues and rules as well as having a strong functional component. Social robots are generally expected to communicate, engage in social interactions, execute tasks, solve social problems, and assist humans. Therefore, social robots have to be defined and designed according to the specific functions they are expected to perform. What makes an "ordinary" robot "social" lies in the fact that it meets a specific and contextual (or more than one) social need. Coming back to Sophia, she can be defined as a semi-autonomous agent, able to engage in social inter-

✉ Alessandra Sorrentino
  alessandra.sorrentino@santannapisa.it

1 Department of Mathematics, Computer Science and Physics, University of Udine, Via delle Scienze, 206, 33100, Udine, (UD), Italy

2 The BioRobotics Institute, Scuola Superiore Sant'Anna, Viale Rinaldo Piaggio, 34, 56025, Pontedera, (PI), Italy

3 Department of Excellence in Robotics & AI, Scuola Superiore Sant'Anna, Piazza Martiri della Libertà, 33, 56127, Pisa, (PI), Italy

4 Department of Industrial Engineering, University of Florence, Via di S. Marta 3, 50139, Florence, (FI), Italy

action but lacking a functional strategy. Thus, just as Sophia is now, she is not ready yet to be a true social robot.

We understand a roboid to be a robot that is still a prototype but claims to be a fully-fledged robot. A prototype of a robot is a technological artefact, which is typically built and perfected in research laboratories, where eventual deficiencies are identified, through tests and inspections, and hopefully corrected. This evolutionary path is necessary to lead a new social robot to the mass production. The prototype becomes a robot when it is ready to go out from the laboratory and is placed on the market. Traditionally, the shift from laboratories to markets has almost been direct, without mediation. However, this traditional path did not shelter companies from possible failures.

We argue that the roboid concept expresses the rise of a new and innovative phase between prototyping and commercialization of robots. This phase has been explored on a large scale by Hanson Robotics, and we propose to consider the robot Sophia, produced by them, as the first example of a roboid. We will conduct our analysis on Sophia, taking as a point of comparison the marketing campaigns of two social robots -Jibo and Buddy- that have been studied in [17]. The analysis of the marketing campaigns of social robots usually shows how they do not differ from any other marketing campaign [33]. When the product is considered ready for the market, marketers try to build the most persuasive presentation of the product to convince potential customers to buy it. What Hanson Robotics has done is completely different. Although Sophia was not ready for the market, it was equally subjected to a promotional campaign with the purpose to create a huge interest in a very wide audience, much larger than potential customers, and a wide familiarity towards her. This intermediate phase proposes the prototyped robot as an open platform and interface on legacy and social media, which will be improved upon incorporating the input of thousands of people. In this intermediate phase, an open discussion with a wider share of potential customers is organized by robot producers with the purpose of understanding moods, desires, needs, and suggestions of potential customers for inspiring the co-construction of aims, functions, symbolic and cultural meanings of the new robot. Hanson Robotics is the first among robot producers to have innovated in an original way the commercialization of social robots. Their robot Sophia can be considered, as mentioned above, the first roboid, since it is the first robot for which this new phase has been introduced prior to its marketization. We were interested in studying this exploratory phase because it is an early example of a phase which will likely become a necessary one for every robot company. Sophia's campaign will become an inspiring model for robotics firms.

The purpose of the study is to explore whether the notion of "roboid" effectively captures the role of Sophia within the new phase. To reach this goal, we had two sub-objectives. The first was to analyze in detail how Sophia robot is presented both in the promotion strategy developed by Hanson Robotics both in its presentation in public events. This campaign was well articulated and included the use of social media such as YouTube and of legacy media such as television, magazines, and print newspapers. To achieve our objective, we relied on the seminal work by Fritz described in [17], who studied how social robots were commercialized and presented. We selected from the thousands of videos on Sophia a small sample of fifteen YouTube videos based on criteria that will be described in Sect. 2. We carried out a content analysis of these videos, as well as Hanson Robotics' website as of 2019. Furthermore, we explored emotions, opinions, expectations, and reactions of the prod-users, identified by Bruns in [5] as being both producers and users and previously identified by Toffler in [49] as prosumers, being both users and consumers of online (Internet) content, with regards to Sophia to see if Hanson's strategy has been effective. We focused on the OSD (Online Social Data) produced on Sophia's videos, because they represent a large collection of comments released spontaneously, which would be difficult to access through other methods. To accomplish this, we analyzed the content of 23,810 messages that prosumers posted in the YouTube comments section of the selected videos. These messages represent a valuable corpus of texts, which enables us to capture the meanings expressed in the digital traces left by these commenters.

Our thesis is that the Hanson Robotics' promotional campaign for Sophia represents an important innovation in the commercialization of new social robots. The research questions that we posed in this study are: "How is Sophia presented by Hanson Robotics's campaign and by external entities ?"(RQ1) and "How do commenters articulate their vision of Sophia? Is it mainly positive, negative or neutral?"(RQ2). These research questions aim to understand both how Sophia is presented or how she presents herself, and how prosumers and potential consumers conceptualize Sophia and which emotional feelings express towards her.

The article is structured as follows: in the next section, we illustrate the methods we used to explore both videos and comments. Then, we report the results of this study. The final discussion focuses on the reasons for and features of this intermediate phase in which the roboid appears for the first time in the news and on social media. In the conclusion, we evaluate the strong and weak points of this study and indicate directions for future research.

2 Materials and Methods

2.1 Sophia Robot

Sophia is the Hanson Robotics' most advanced human-like robot [22]. Sophia can greet and shake hands with her

Fig. 1 Sophia robot at RO-MAN Conference 2019, New Delhi, India

human partners by actuating her six-DOFs arms by employing its dynamixels (used for shoulder pitch, roll, and yaw, elbow, and wrist yaw) [44], as shown in Fig. 1. The robot Sophia has been part of the "Loving AI" project in which a software system was developed to enable robots to engage with people in loving and compassionate ways in order to promote people's self-understanding and self-transcendence [19]. Sophia's behavior is guided by the open-source software framework OpenCog [18], which includes a motivational system, OpenPsi [6], in order to assess the appropriate behavior the robot should engage in [1,29]. Due to its nature, Sophia behavior is designed by numerous aspects including natural language dialogue, gestural interaction, emotion via facial expression [35] and tone of voice, and recognition of human face, body and voice emotion [19].

2.2 Sophia Robot on YouTube

From the thousands of videos on Sophia, we selected a small sample of fifteen YouTube videos, reported in Table 1. The selection process included videos in which the main capabilities of Sophia are shown in a neutral way by the producers and by the general audience. It means that they present a neutral profile of Sophia, neither intentionally provoking negative feelings (e.g. fear and anxiety) nor creating high expectation of Sophia capabilities. Apart from the ones uploaded by Hanson Robotics (videos 1,2,3) and the ones in which the ex-CEO of Hanson Robotics, David Hanson, is present (videos 6 and 13), we also chose the one uploaded by SingularityNet (video 15), whose CEO, Ben Goertzel, guided the development of Sophia's software tool OpenCog [18,19]. The remaining videos describe Sophia's capabilities as they are, showing their limitations (i.e. the presence of a technician in videos 7 and 14) and their performance both in "unofficial" environments (i.e. videos 4, 5, 9 and 11) and official public events (i.e. videos 8, 10, 12). The reason of balancing the selection of videos produced by Hanson robotics with the ones uploaded by other entities relies on the hypothesis that the portrayal of Sophia may be different depending on the source.

2.3 Content Analysis

We used content analysis to assess Hanson Robotics' promotional campaign and to derive people's opinions regarding videos and relevant comments as depicted in Fig. 2.

To achieve our first objective, which is to identify how Sophia is presented, we performed a content analysis of the 15 videos in several steps, starting from determining the features that characterize each video: title of the video, by whom it was uploaded, the date of upload, the duration of the video (in minutes and seconds), number of visualizations, number of likes and dislikes, and the link (reported in Table 1). Technically, the stylistic and informational characteristics of a video (e.g. topic and duration) are called content factors, while the characteristics external to the video (e.g. upload date and time) are called content-agnostic factors [3,14]. These data give us some information both on the producers of the videos and on video popularity that attests users' attention and engagement rate towards each video [52]. In particular, number of visualizations testifies the attractiveness of a video and the number of likes and dislikes, on the contrary, may be interpreted as the sign of users' approval or disapproval of the main message conveyed by the videos [10]. After merging the listed features of each video, we performed an overall content analysis of these videos [4,45]. As the author in [36] points out, content analysis is a method that supports a systematic evaluation of texts (understood as a document, oral communication, an image, or a video)

Table 1 The list of the videos on Sophia and their main features

Title of the video	Uploaded by	Date of the upload	Duration in minutes and seconds	Views	Likes	Dislikes	Link
1. Sophia Awakens - Episode 1	Hanson Robotics Limited	26/11/2016	3.53	1,610,119	12,465	891	https://www.youtu.be/=LguXfHKsa0c
2. Sophia Awakens - Episode 2	Hanson Robotics Limited	26/11/2016	13.07	378,376	4792	309	https://www.youtu.be/=zbFJOIR1h4E
3. Sophia the Robot by Hanson Robotics	Hanson Robotics Limited	5/09/2018	2.48	27,074	324	17	https://www.youtu.be/=BhU9hOo5Cuc
4. The Journey of Sophia the Robot	Hanson Robotics Limited	5/09/2018	1.09	5199	168	6	https://www.youtu.be/=XIliwTfHLpU
5. Sophia the Robot during her first visit in Sweden	Bisnode Sverige	9/01/2019	26.25	62,240	596	41	https://www.youtu.be/=HcyJWG3w_XA
6. CES 2019: Sophia the Robot is back, and she brought Little Sophia	CNET	9/01/2019	12.25	175,299	1716	281	https://www.youtu.be/=FcZGW2oeYF8
7. CES 2019: AI robot Sophia goes deep at Q&A	CGTN America	10/01/2019	6.07	995,357	6925	882	https://www.youtu.be/=T4q0WS0gxRY
8. Robot Sophia speaks at Saudi Arabia's Future Investment Initiative	Arab News	25/10/2017	5.08	3,074,093	5488	2222	https://www.youtu.be/=dMrX08PxUNY
9. My Greatest Weakness is Curiosity	Sophia the Robot at Brain Bar	Brain Bar	5/07/2018	11.35	790,981	7904	474	https://www.youtu.be/=Io6xuGmS5pM
10. Robot AI has a new announcement for Humanity	The Digital Acid	11/07/2018	11.10	285,476	2782	511	https://www.youtu.be/=yxWbiPY2hko
11. Sophia the robot Interview: Sophia the robot answers Stylist's philosophical questions	Stylist Magazine	23/01/2018	1.41	3,039,140	34,507	1562	https://www.youtu.be/=ZQrKFAAlxO4
12. UN Deputy Chief Interviews Social Robot Sophia	United Nations	11/10/2017	2.19	2,601,339	14,726	1574	https://www.youtu.be/=qNoTjrgMUcs
13. Watch Sophia the robot walk for the first time	CNET	8/01/2018	1.38	1,154,961	6135	556	https://www.youtu.be/=lCFQkB-KLsE
14. Robot Meets Self Driving Car - Sophia by Hanson & Jack by Audi	Mobilegeeks.de	13/01/2017	3.57	7,447,223	58,757	4761	https://www.youtu.be/=vtX-qVUfCKI
15. Sophia the Robot Announcement	SingularityNET	21/09/2018	7.29	2629	103	2	https://www.youtu.be/=fUmSHerqaS8

through coding their main elements of meaning. The textual component of the videos was analyzed with an inductive procedure to identify the most relevant and significant categories of meaning [25,50].

In particular, we applied two specific qualitative tools of content analysis: visual rhetorical analysis [17] and frames analysis [12,20] of the video content (i.e. analysis of Sophia's speech during public events), as shown in Fig. 2. Visual rhetorical analysis is based on the skills typical of visual literacy, which provides the ability to analyse images for their form and meaning [15]. Drawing on methodological tools both from semiotics (the study of signs and symbols) and rhetorical analysis (based on Aristotle's three pillars - ethos, pathos and logos-), visual rhetorical analysis decodes the main features of an image structure by looking at its significant meaning [26]. Typical heuristics used to examine languages and arguments have flowed into visual rhetorical analysis from the classic five canons of the rhetoric such as they were first codified in classical Rome: invention, arrangement, style, memory, and delivery. Frame analysis is a method adopted by ethnographic research that enables researchers to capture the mental schemes and primary frameworks that people elaborate to make sense of what is going on [12]. We corroborated these analyses by examining the texts that describe Sophia on Hanson Robotics' website (close reading [27]).

To achieve our second objective, which was to identify the main dimensions of meaning in users' comments after looking at these videos, we processed the content of 23,810 comments left on the selected videos. The comments were collected through an automatic software.[1] Due to the high content volume, the comment analysis was performed with quantitative methods largely using automatic tools, based on machine learning algorithms (indicated with a black label in Fig. 2), and to a lesser extent using a not automatic content analysis (gray label). The automatic tools consisted of applying two popular text analysis techniques: word cloud [24] and sentiment analysis [37]. As shown in Fig. 2, a pre-processing step was performed to make the data suitable for further analysis. The steps we performed for the analysis of the selected comments are detailed in the following subsections. We added to this analysis a textual analysis of the comments with the highest number of likes for each video, following the methodological strategy introduced by Fairclough in [13], and a manual investigation on the meaning of two of the most occurring words in the comments.
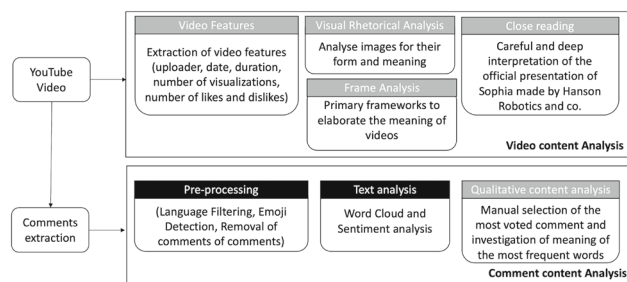
---

[1] https://gion.serben.tk/youtube-comments/?fbclid=IwAR18batb7fe
RmcPPmtS9h0geJqZOtT8w8b-xG_Wm-Eip-4fHsWMZmfAVA1Q.

Fig. 2 Diagram flow of the content analysis performed on each video and on the relative comments

2.3.1 Preprocessing

Before starting the text analysis of the dataset, some pre-processing techniques were applied to the data. The pre-processing step involved three types of filtering. First, because the machine learning algorithms commonly used for data mining are mostly trained on English datasets, only English comments were selected to reduce error in the data mining phase. In order to detect the language in which the comments were written, each comment was processed by an automatic English detector tool [40]. The second filter included in the analysis the comments composed of emojis and special characters, since they are often used to express sentiment [41]. The third filter served to discard the comments of users responding to other users, to guarantee that each comment was an independent contribution.

2.3.2 Word Cloud Technique

The word cloud technique is a visualization method commonly adopted to evaluate the content of text data [7,24,30]. Given a text, this method weights the words in terms of their occurrence. It graphically represents the list of words with several font sizes, proportional to the occurrence of the given word in the text. This technique is analogous to tag cloud techniques [51] when the tags are words. This technique was chosen because it can serve as starting point for deeper analysis [24]. It can provide a statistical summary of the isolated words and it can be used to highlight the content of YouTube comments [8]. In this work, we adopted this technique to learn which terms are most commonly used in relation to Sophia. Thus, from each video, we extracted the 10 most frequently used words occurring in the comments. The list of these words was obtained by ordering the normalized weights of the words, given by the word cloud method, in descending order. Since the same word can appear in different ranking positions based on the videos' comments, we associated to each word a weight based on its position in the word cloud's ranking list. With this method, it is possible to identify the

words most commonly used in comments for the selected videos.

2.3.3 Sentiment Analysis

This is a methodological strategy used to assess opinions, emotions, and subjectivity of people toward an entity as expressed in a text [37]. In the present study, we used the Valence Aware Dictionary for Sentiment Reasoning (VADER) model [28] to extract the meaning from our comment content. This simple ruled-based model combines sentiment lexicon features with five general rules that embody grammatical and syntactical conventions that people adopt when expressing sentiment intensity [28]. The list of lexical features includes Western-style emoticons (i.e. "smiley face"), sentiment related to acronyms and initialisms (i.e. "LOL","WTF"), and commonly used slang with sentiment meaning (i.e. "nah", "meh"). Here, this tool was applied to the comments to detect the percentage of positive, negative, and neutral comments. For each comment, this tool returns four values, which represent the percentage of the text that falls in the categories described as follows: 1) the positive, 2) the negative, 3) the neutral, and 4) the compound score. The positive and negative categories include the portion of text classified respectively as positive or as negative by the five general rules regarding grammar, syntax and semantics adopted by VADER. By contrast, the neutral category includes the portion of the text that is referable neither to the positive nor the negative category. Finally, the compound score represents a summary of the composition of the various parts of the text, which can be formed of various combinations of positive, negative, and neutral sentiments. While the first three scores describe solely the portion of text falling in either polar category, the compound score calculates the sum of all the lexicon scores which have been normalized between -1 (the most negative) and +1 (the most positive). The compound score represents a single unidimensional measure of sentiment for a given sentence [28]. Thus, we use the compound score to assess the polarity of each comment.

3 Results

3.1 Video Content Analysis

We begin by reporting the main results related to the structural characteristics of the small part of the promotional campaign about Sophia that we have analyzed as well as related to visual rhetoric analysis and frame analysis.

3.1.1 Content and Content-Agnostic Factors

The selected videos represent a series of important communication vehicles that are strategic for the communication campaign on Sophia. These videos are proposed to the audience in part like scientific documentaries and in part like informative television services. In reality, from a communication point of view, they are narrative videos closer to short film, in which Sophia's story is staged to communicate to the public persuasive information about her. This information vehicles the message that Sophia is presented as a fully-formed robot with a distinct "personality". These videos were uploaded in four cases by Hanson Robotics and eleven cases from other entities; they have a duration of between 1.09 and 26.25 minutes and seconds. These videos are related to: the introduction of Sophia (videos 1, 2 and 3); the self-presentation of Sophia (video 4); Sophia's appearances at public events promoted via legacy and new media, which include monologues by Sophia or interviews with Sophia (videos 5 to 14); or, as the last video (15) an invitation from Sophia to scientists, software engineers, and architecture blockchain developers all over the world to join Hanson Robotics.

The data collected in 2019 and reported in Table 1 show that Sophia has clearly become an object of interest for millions of people. Six videos received millions of views and the other videos several thousands, with an average of 1,443,300.4 per video. The videos received a large number of likes, with a total of 157,388 and an average of 10,492 likes per video. This appreciation of prosumers is quite evident when compared to dislikes, which numbered 14,089 overall with an average of 939 per video. These data give the idea of the positive, emotional atmosphere surrounding these videos on Sophia. The reflection of this atmosphere will be recalled during the analysis of the comments, in Sect. 3.2.

3.1.2 The Visual Rhetoric of Sophia

The visual rhetoric of Sophia that we present here is based on the close reading and interpretation of the official presentation of Sophia made by Hanson Robotics and various other entities. All of these videos are in reality misleading visual products, since Sophia is presented as if she were completely autonomous in conversations. The information that observers lack is that, before she could engage in conversation, Sophia has to be connected to the local Wi-Fi and to a laptop for her audio output. Sophia's software has been programmed to show pre-coded behaviors, including pre-written responses to specific questions or phrases, like a chatbot [18,23]. Her capacity to answer appropriately is used to create the illusion that she is conversing as a human would, thanks to the software components which recognize and mirror a human's facial expressions and vocal quality [1,18]. The information

is shared in a cloud network allowing input and responses to be analyzed with blockchain technology [39]. Sophia runs on artificial intelligence software that is constantly being trained in the lab [19,29]; so her conversations are likely to get faster and enriched by appropriate facial [35] and verbal expressions, as well as gestures [44], over time. Another element that characterizes many of these videos is that Sophia, always seen at half-length, gives the idea of being a gynoid with a complete body. Until 2018, in many of these videos it was completely unclear that she was a bust without legs, since in many videos the shot of her face or bust appeared to be a stylistic decision of the director. Since January 2018, Sophia was equipped with legs to move independently (similarly to what is described in [43]), as she shows and explains in the video 13, and now she can walk.

3.1.3 The Framing of Sophia

In contrast to the cases of Jibo and Buddy, in the roboid phase of Sophia, consumerism did not play a significant role in framing her ontological instantiation. Thus, analyzing the official materials released by Hanson Robotics on Sophia [22], it emerged a rhetoric that can be summarized into four ontological elements.

First, Sophia is outlined as similar to humans in many ways (see Fig. 1). Her similarity has even been conveyed as an equivalence to humans, since this social robot has been given a human name. Having a human name, as Fritz noticed in [17], stresses the similarity of a robot to humans. Like Jibo and Buddy, Sophia has a human name as opposed to a robot's model name and, as such, she becomes a unique robot with whom people will potentially interact.

In general, attributing a human name to a social robot helps generate a sense of the unicity in the same way as for a human being. The attribution of a specific name to Sophia hides another aspect: it makes her exist. She is brought to life by the entity who names her. Generally, names are given to humans by their mother and father. We must ask: who are the mother and the father of Sophia? While human beings are generated by other humans, the "original sin" of robots is that it is not clear to prod-users-prosumers who brings them to life. In the case of Sophia, as videos 1 and 2 tell us, the answer is evident: Hanson Robotics. In video 1 there are two characters, a man wearing what appears to be a medical gown (perhaps to simulate an obstetrician) and Sophia, the social robot that is coming to life. There is a surreal dialog between the man and the newborn Sophia in which he presents himself as one of her creators, welcomes her to the world, and asks her if she is happy to be alive. Even the slogan of Hanson Robotics is revealing: "We bring robots to life. Hanson Robotics is an AI and robotics company dedicated to creating socially intelligent machines that enrich the quality of our live"[22]. Video 2 features the same characters as in video 1, but the

"creator" is now dressed in an oriental style and Sophia is dressed accordingly, as a testimony to the fact that Sophia's creation took place in the East (Hong Kong, where Hanson Robotics is headquartered).

The similarity to human beings is not limited to her name, but includes her physical appearance. She presents herself as the world's most human-like gynoid, modeled after actress Audrey Hepburn. Able to display 62 facial expressions, she is very expressive and even winks her eye. Winking the eye is a facial expression belonging to informal and non-verbal communication symbolizing a sign of understanding between two interlocutors who have a high degree of familiarity between them. It is a culturally and communicative sophisticated form of expression, which is typical of human beings. The ability to produce this expression increases Sophia's human likeness. Her similarity to humans is based also on the fact that she is endowed with her own personality and is able "to maintain eye contact, recognize faces, understand speech, hold natural conversations, and learn and develop through experience" [22]. Sophia sees via the cameras within her eyes in combination with computer algorithms. At the communication level, she can process speech and have conversations using a natural language subsystem.

It is worth noticing that, since Sophia's expressivity is so well developed that it can become perturbing, her similarity to humans is mitigated by the fact that in her head a computer is visible through a transparent dome. This characteristic serves to avoid the possible effect of the "uncanny valley" [38].

The choice to build a social robot so similar to human beings is explained by Hanson Robotics as follows "On the tree of robotic life, human-like robots play a particularly valuable role. It makes sense. Humans are brilliant, beautiful, compassionate, lovable, and capable of love, so why should not we aspire to make robots human-like in these ways? Don't we want robots to have such marvelous capabilities as love, compassion, and genius" [21].

The second ontological element is that Sophia is the instantiation of a social robot who "identifies herself as a woman", even if she is aware of the fact that "gender is a social construct" (Sophia's statement in video 9). In video 4, Sophia corrects these declarations and says she is "proud to be an artificial woman" and that identity is a dynamic process, declaring, "I am still defining my identity like a child" (video 3). Sophia's physical beauty is meant to encourage consumers to "fall in love" with her. The woman metaphor is powerful as it entails the ability to fascinate potential consumers and present Sophia as an object of desire. Many comments from observers include declarations of love and of their availability to marry her. Another element that characterizes Sophia, and that she shares with several androids or gynoids, is that she is dressed. The importance of social robot dresses or of social robots designed in a fashionable way has

been addressed so fare in the debate on social robotics by several scholars [9]. Curiously, Sophia's outfits are not particularly fashionable, and this contrasts with the beauty of her face.

The third attribute is that Sophia is a social robot that is continuously learning new things, oscillating from learning to become a human to learning to become a good social robot. The push to learn is connected to one feature of her personality that Sophia shares with Jibo and Buddy: curiosity ("My greatest weakness is curiosity"; see video 9). This is connected to another characteristic she shares with Jibo and Buddy: that she presents herself as a learner. Sophia incarnates the process of machine learning technology that is of a technological artefact, which can learn continuously and improve itself. In Sophia, this feature works also as a *captatio benevolentiae* (earning goodwill) to invite people to consider eventual mistakes or imperfections with great tolerance and to "reduce the risk that consumers will return this first generation of robots when they fail to function perfectly or 'behave' below expectations" (page 73 of [17]). But in Sophia the frame of this third instantiation is even more sophisticated because she declares that she is "learning to be a good social robot", that is to become and do what her future owner would like. "Rather than be a spectacle, I would rather learn and participate" Sophia told the audience during her South by Southwest (SXSW) Festival panel. Sophia's material and immaterial features are not yet fixed and thus we do not yet know what working role she will play in society. David Hanson began to describe her future, saying that Sophia "would ultimately be a good fit to serve in healthcare, customer service, therapy and education" and recently declaring during his SXSW Festival panel that she could join "Ebola nurses or even tap into her super-intelligence to become Chief Robotics Officers at a big corporation".

The fourth element of Sophia's framing is that she has become a public figure and a celebrity. The peculiarity of Sophia in respect to the other social robots is that she has an intensive public life. For example, on October 11, 2017, Sophia was introduced to the United Nations with a brief conversation with the United Nations Deputy Secretary General, Amina J. Mohammed. On November 21, 2017, at the Responsible Business Forum in Singapore, at an event hosted by the UNDP in Asia and the Pacific and Global Initiatives, the United Nations Development Programme named Sophia the first-ever Innovation Champion for Asia and the Pacific. In this capacity, Sophia was required to help the UN unlock innovation to work to achieve their Sustainable Development Goals. Sophia was also able to advance robot civil rights: for example, on October 25, 2018, at the Future Investment Summit in Riyadh, she received Saudi Arabian citizenship, becoming the first robot ever to have a nationality. On November 27, 2018, Sophia was given a visa by Azerbaijan for attending the Global Influencer Day Congress held in Baku. On December 15, 2018, China appointed Sophia as a Belt and Road Innovative Technology Ambassador.

Sophia has also participated in many TV programs such as CBS 60 Minutes with Charlie Rose, Good Morning Britain with Piers Morgan, and the Tonight Show with Jimmy Fallon. She has even appeared in several videos and music videos, including "The White King" and the pop singer Leehom Wang's music video "A.I.". Furthermore, she has been covered by print media all over the world such as Forbes, Mashable, the New York Times, the Wall Street Journal, and the Guardian. Sophia has been featured in high-profile interviews and was on the cover of ELLE Brazil magazine. Sophia and her events have become major news items to the extent that she has become a true celebrity. Her entrance into mass media has enormously amplified the scope of her visibility. This has had the effect of creating a great deal of familiarity toward her by millions of spectators, readers, and prosumers; thus, when she will enter the market she will already be well known by her potential customers.

3.1.4 The Campaign on the Roboid Sophia

The promotional campaign for the roboid Sophia in reality had the purpose of maximizing familiarity toward her before entering the market. Examining Jibo and Buddy, the author of [17] already noticed that "much of previous research on human-robot interaction has been constrained by the limitations of the field and the lack of product on the consumer marketplace". Furthermore, she noticed that thus far, the lack of social robots on the consumer marketplace has made it difficult to "minimize the effect of novelty on participants' reactions to social robots or to understand the influence of consumerism and social norms on participants' perceptions of robot ontology" [17]. Of course, Hanson's campaign is not able to substantially prevent the problems associated with users' discovery of how it is to interact with a robot when it is no longer a novelty, when interacting with it includes the frustrations of its glitches and breakdowns and the pressure by Internet service providers, for example, to update its operative system or specific programs [17].

Then, what is the meaning of Sophia's campaign? As we argue in the introduction, our analysis has revealed that Sophia's promotional campaign, supported by the use of social media and legacy media, is an intermediate phase between the conceptualization of a new social robot and its commercialization. The robot is produced as an open platform and interface that can be closed later, after it has passed this intermediate phase. In this phase of open discussion with a wider market of potential customers, robot producers try to understand moods, desires, needs, and suggestions of potential customers in order to capture aims, functions, and symbolic and cultural meanings that people invest in the new robot. During this phase, the robot is still a prototype

although it pretends to be a fully-fledged robot. Sophia in this phase is what we propose to call a "roboid". After this phase, and on the base of the indications received by people, the robot can be "closed" and can be considered ready to be commercialized. At the same time, in this specific case, Hanson Robotics has astutely extended the scope of their campaign by involving mass media such as TV and print newspapers to amplify the reach of their campaign.

3.2 Commenters' Frames on Sophia

3.2.1 Pre-processing

After the pre-filtering process, based on the

detected language, symbols, and independence from other comments, 45.6% of the initial comments were discarded; instead of using all 23,810 comments, we kept only 12,945. Table 2 summarizes the results of the filtering process.

3.2.2 Word Cloud

As mentioned in the previous section, the word cloud method allowed us to extract the 10 most frequently appearing words for each video. As shown in Fig. 3, the word robot appears as the most frequent word (normalized weight=1.0) in the majority of videos. Similarly, the word Sophia has the highest normalized weight in many videos. The words will and people have a higher normalized score in the comments of the video "Sophia the Robot by Hanson Robotics", while the word human appears as the most frequent term in the comments of the video "Robot AI has a new announcement for Humanity."

To provide a general overview of the topics expressed in the comments, we associated to each word a weight based on its position in the original ranking list. A weight of 10 is given to the most frequently occurring word, while a weight of 1 is given to the least frequent word of the ten most common. The list of the top 10 most frequent words is shown in Table 3. In the third column, the list of words is ordered in descending frequency, from the highest frequency (1.0) to the lowest. On the fourth column, we reported the number of likes of the most popular comments. From a first screening, it appears that the less frequent words are strictly related to the topic of the video. For example, the word walk is highly present only in the comments of the video "Watch Sophia the robot walks for the first time", as well as the words Saudi and Saudi Arabia are reported in the comments about the video "Robot Sophia speaks at Saudi Arabia's Future Investment Initiative".

The result of this analysis shows that the occurrence of the words robot, Sophia, will, human, people, AI and think are the most frequent in the comments of the videos, as shown in Fig. 4. The meaning of these results is quite evident. First,

observers perceive and recognize Sophia as a robot, which is quite intriguing if we consider that this robot was promoted as a human-like robot yet. The similarity of Sophia to humans is not the point that generates interest and discussion, as we expected, in the light of the uncanny valley theory [38]. The second cluster of words -will, human, people- indicates a precise interest of observers to position themselves with respect to Sophia. It interesting to point out that the term "will" is not used to indicate a human capability, but as verbal form to express the simple future. In this case the term will is used to make promises or forecasts and to express decisions concerning the future. Regarding the other two words -human and people- our comment is that toward a robot, and even more so with a human-like robot, we are stimulated to ask ourselves who we are as human beings one of the comments in video 5 states "Human has a spirit. Computer result greed, angry and fear" and how our brains work (one of the comments in video 7 states "she can learn what people think but never why they think in such way", while another user commented that "See computers learn like human learn from others bad behaviour" in video 5), for example [16]. The third cluster -AI and think- shows that observers wonder how much artificial intelligence is truly capable of reproducing the ability to think in a robot today. Overall, these terms indicate that people recognize easily Sophia as a robot (no uncanny valley seems to be active) and a form of AI, but they counterbalance the meaning by referring to human beings and their peculiar capacity of thinking. It is worth noticing, moreover, that the next most frequent terms are: us, now, love, look, question, make, one, as shown in Fig. 4. Regarding love, this word is used by observers to express an intense pleasure (as in the cases "I'd love to meet her and ask her things, it would be very interesting" and "sofia is really funny i love her") or as an affect or a loving feeling towards Sophia (i.e. "I fell in love with Sophia omg", "And that is a girl i love.You are awesome Sophia"). Summing up, she fundamentally inspires three other things: looking, asking questions because commenters identify themselves as prosumers, and feeling love, which is the sentiment they often feel toward Sophia. The most frequent emotion is not only positive but very engaged, while negative emotions do not emerge. However, we will deepen the emotion analysis of people's comments with a specific tool in the next section.

We conducted a textual analysis [13] of the comments that attracted the most likes for each video (last column in Table tab:3). The first two comments are not relevant for this analysis, since the first lampoons one of the inventors of Sophia appearing in the video and the second expresses the curiosity of an observer towards this new social robot. However, the third is typical of a spread, critical attitude toward Hanson Robotics' narrative on the birth and the presentation of Sophia. Criticisms accuse the Hanson to be the true robot, not Sophia. The fourth comment is also interesting as it connects

Table 2 Results of filtering process (absolute numbers and percentages in parenthesis) (base=23,810). In the last column, the number in the first parenthesis is the number of comments composed by only emoji, and in the second parenthesis is the relative percentage

Index	Title	Original comments	Discarded comments	Total saved comments
1	Sophia Awakens - Episode 1	2941	1223	1718(2)
			(41.6%)	58.4% (0.1%)
2	Sophia Awakens - Episode 2	1057	390	667 (0)
			(36.9%)	63.1% (0.0%)
3	Sophia the Robot by Hanson Robotics	107	68	39 (0)
			(63.5%)	36.5% (0.0%)
4	The Journey of Sophia the Robot	35	13	22 (0)
			(37.1%)	62.9% (0.0%)
5	Sophia the Robot during her first visit in Sweden	257	91	166 (2)
			(35.4%)	64.6% (0.8%)
6	CES 2019: Sophia the Robot is back, and she brought Little Sophia	1055	471	584 (3)
			(4.6%)	55.4% (0.3%)
7	CES 2019: AI robot Sophia goes deep at Q&A	2525	1058	1467 (7)
			(41.9%)	58.1% (0.3%)
8	Robot Sophia speaks at Saudi Arabia's Future Investment Initiative	2100	1090	1010 (1)
			(51.9%)	48.1% (0.1%)
9	My Greatest Weakness is Curiosity - Sophia the Robot at Brain Bar	1561	737	824 (1)
			(47.2%)	5.8% (0.1%)
10	Robot AI has a new announcement for Humanity	2368	1168	1200 (3)
			(49.3%)	50.7% (0.1%)
11	Sophia the robot Interview: Sophia the robot answers Stylist's philosophical questions	2102	1036	1066 (13)
			(49.3%)	50.7% (0.6%)
12	UN Deputy Chief Interviews Social Robot Sophia	1038	360	678 (3)
			(34.7%)	65.3% (0.3%)
13	Watch Sophia the robot walk for the first time	1556	667	889 (5)
			(42.9%)	57.1% (0.3%)
14	Robot Meets Self Driving Car - Sophia by Hanson & Jack by Audi	5064	2469	2595 (20)
			(48.7%)	51.3% (0.4%)
15	Sophia the Robot Announcement	44	24	20 (0)
			(54.5%)	45.5% (0.0%)
Total		23, 810	10,865	12,945 (60)
			(45.6%)	54.4% (0.3%)

Sophia to Detroit, which is the symbol of the history of the automobile. Sophia is seen as a bridge between the technology of the past and that of the future. The fifth comment is more poetic and is quite mysterious, but seems to allude to a critical awareness of the complex role of robots in relation to policy, economy, and society. The comments on the sixth and seventh videos note some deterioration over time of Sophia's ability to converse, while the comment on the eighth video wonders how much pre-planning is included in Sophia's conversation. The comment for video 9 urges caution concerning Sophia, while the comment for video 10 criticizes the request of rights of Sophia, underlying the difference between human and robot conditions. The comment on the 11th video suggests that Sophia needs a wig, as if the commenter would prefer a Sophia more perfect in her anthropomorphism. The comments for the 12th and 13th videos express sentiments of fear or terror with respect to what may happen in the future because of the presence of advanced robots such as Sophia. The comment to the following video (14) is sarcastic regarding the event in which Sophia meets the self-driving car. Overall, these comments, which attracted the most likes, reveal a critical and even negative social representation of Sophia, except the last one, which is very enthusiastic about her. From this analysis, despite the alleged tendency for comments to be negative in YouTube videos (e.g. [11]), in our case both positive and negative comments about Sophia emerged.
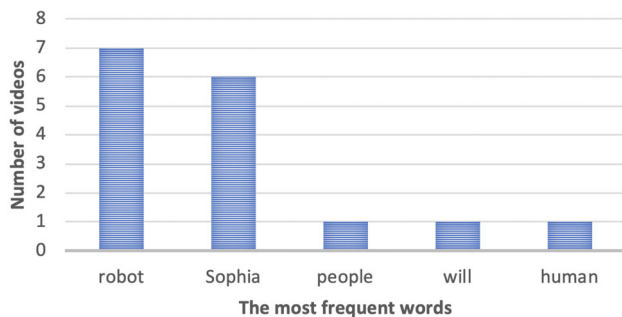
Fig. 3 Number of videos in which the words robot, Sophia, people, will, and human appear as the most frequent words in the comments

The next section provides an analysis that enables us to evaluate overall what is the dominant sentiment expressed by users towards Sophia.

3.2.3 Sentiment Analysis

As previously mentioned, the VADER tool allows us to evaluate the sentiment expressed in a text. Based on the value of the compound score, the categories which we used are: positive, negative, and neutral. Table 4 illustrates the results of the performed sentiment analysis for each video. This analysis shows that:

- 38.0 % of the comments have a neutral connotation,
- 34.7 % of the comments have a positive connotation,
- 27.3 % of the comments have a negative connotation.

It is worth emphasizing that in none of the 15 videos the number of comments with negative connotations is higher than the number of comments belonging to either of the two remaining categories. The comments on the video "Sophia the Robot of Hanson Robotics" and the video "Sophia the Robot Announcement" are characterized by an overall positive attitude, even if the overall number of comments of these videos is below average. This data, along with what is illustrated in Table tab:1 regarding the number of likes and dislikes, tells us that the general emotional mood is significantly more positive than negative. This result is in line with the outcomes of previous studies described in [48].

4 Final Discussion and Conclusion

Let us return to our research questions to verify what we learned from this study. To the first question "How is Sophia presented by Hanson Robotics' campaign and by external entities ?", our rhetorical analysis has shown that a powerful but at times potentially ridiculous narrative has been used to build the rhetoric of Sophia's presentation. Being

contextualized, social media often shows such as an ambivalence (powerful and ridiculous), which can be dangerous for Hanson Robotics if not managed. The French philosopher Bergson in [2] talked of the ridiculous as a latent dimension of all the forms of innovation, since these must envision the future technological artefact detached from the reality of the moment. This detachment, which is described by Bergson as the insert of the mechanic in the alive, is the door through which the ridiculous passes when users for some reasons are not available to follow the new innovations as a means of adhering to an idea of the future, of dreaming with technological scenarios, of accepting that their personal image and intimate environment are being mediated by the new technological artefacts. In that moment, robot firms loose the domination on people's imagination and emotion and every product they propose can become ridiculous. Only when we use innovations, suggests Bergson in [2], the danger of ridiculous decreases, because in this case they become integrated in our daily life. It is only the repeated use that makes it possible to neutralizes the latent ridicule of every new technological artefact.

As to our second research question "How do commenters articulate their view on Sophia?", in reality, the suggestions and indications coming from users' comments to the selected videos are quite poor. Namely, they do not contribute in a significant way to the co-creation of what Sophia could become in the future. We expected that this campaign could enable Sophia's producers to involve her future users in the process of the robot conception and design and thus that they could contribute to tailoring their final product on the basis of their desires and needs. But it did not happen. Maybe the construction of a classical panel of qualified potential customers (often used by Telcos) to be consulted at any crucial moment in Sophia's closure process can give far better results in terms of co-construction of the technological artefact. Online observers limit themselves in playing the role of audiences expressing their (mainly positive) reactions. However, the introduction of this new phase and the attempt to take advantage of the potentials of legacy and social media at least has dispelled many fears and have familiarized millions of potential buyers towards Sophia, who today know her and what she can do, even if the information disseminated on her is often unrealistic.

Finally, in respect to the main purpose of this study, which aimed to explore if the notion of roboid has effectively captured Sophia's role within the new phase between prototyping and the promotion and commercialization of new robots, the answer is affirmative. In our opinion, the notion of "roboid" has captured effectively Sophia's role within this new innovative phase introduced by Hanson Robotics. This phase corresponds to a pre-sale phase which has the purpose to exploit the collective intelligence for tailoring the definite version of this artefact as closely as possible to the needs of

Table 3 The top 10 terms for each video. The comment associated to each video is the one with the higher number of likes

| Video	Top 10 words	The most liked comment	Number of likes
1	Robot, Sophia, will, human, guy, look, think, AI, one, us	"I think the guy ripped his eyebrows out and gave it to the robot."	1329
2	Sophia, robot, human, know, love, video, want, will, think, people	"I want to see more Sophia videos."	1281
3	People, will, robot, love, want, Sophia, AI, one, say, world	"0:52 pretty sure this guy is a robot, and not the nice kind like Sophia."	28
4	Sophia, AI, us, real, make, one, see, Hanson, U0001f493 U0001f493, things	"Detroit: become Sophia"	19
5	Sophia, will, human, AI, robot, people, make, many, know, think	"Inside trading in the nanoseconds... deciding life and death in a military or policing situation with no conscience or remorse... self preservation at the highest level and ability"	15
6	Sophia, human, robot, will, AI, think, people, look, know, make	"Um... is she okay? She seems a bit... off? She used to have in depth conversations, what the hell has happened?! She's like a trauma victim..."	269
7	Sophia, human, robot, question, AI, people, think, will, answer, say	"Whoever is feeding her the answers needs to learn to type faster."	3238
8	Robot, human, will, people, AI, know, Saudi, scripted, Sophia, Saudi Arabia	"Yeah but how much of it was scripted?"	926
9	Robot, human, Sophia, will, question, think, answer, people, AI, us	"This is something we should be very careful with."	2899
10	Human, will, robot, Sophia, God, AI, us, people, think, thing	"She wants rights? She has more rights than I do. She doesn't have to pay bills or have to eat to survive. She said she doesn't feel safe because someone can scrap her. Well how many people are scrapped everyday by our controllers, and despite the illusion, laws aren't protecting us, because controllers just blackmail or use money to get away with whatever they want. Humans have more value than robots, sorry it is true. Our bodies wear out, she just gets upgraded with new programs. I will not become a robot creature through AI technology, thanks. I know that is what they are really pushing, transhumanism. I think that is what singularity is, isn't it?"	214
11	Robot, Sophia, will, human, now, U0001f602 U0001f602, love, think, wig, need	"She needs a wig."	8823
12	Robot, human, will, world, people, end, Sophia, AI, think, us	"2017 - human found robot that can understand feeling and emotions very nice. 2049 - error no human found."	618
13	Robot, human, Sophia, will, people, look, make, think, thing, walk	"She walks today, she kills tomorrow."	1308
14	Robot, Sophia, will, human, car, people, think, make, need, AI	"Put sophia in the driver seat give her a cell phone and have her talk to siri."	3016
15	Sophia, AI, robot, will, people, team, SingularityNET, us, something, think	"Take over the world SOPHIA! Loving creative super genius machines. Just please take down the evil global cabal and don't join it. Save the children."	9
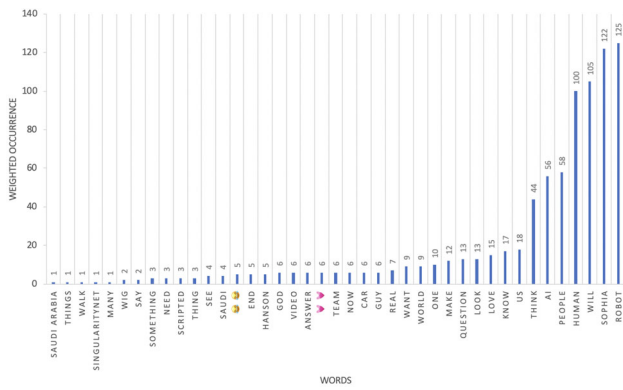
Fig. 4 Weighted occurrences of the 10 most frequent words in the comments of all the videos considered together. To each word, a score ranging from 1 to 10 has been associated based on the normalized frequency returned by the word cloud technique

future customers. In this phase, the roboid Sophia has become the object and the protagonist of a promotional campaign, whose Hanson Robotics has astutely extended the scope by

involving mass media such as TV and print newspapers to amplify its reach. Hanson's campaign has been very effective in enhancing familiarization towards Sophia by generating worldwide buzz about her and by transforming her into a celebrity; less effective in drawing ideas and suggestions from prosumers, as we mentioned above. But this limitation can be overcome, as we suggested. After this phase, and on the base of the indications received by people, the roboid can be "closed" passing from the status of roboid to that of robot, and can be considered ready to be marketed. Hanson's campaign has not been able to substantially prevent the problems associated with users' discovery of how it is to interact with a robot in their everyday life [17]. But this was expected. However, it has shown to be innovative in outlining the new phase of the roboid.

The introduction of this new phase, including the construction of the roboid Sophia, indicates that robot companies treasure the experience of involving potential consumers before launching the new product. Recently, however,

Table 4 Sentiment analysis of the comments on Sophia according to the VADER model (absolute numbers and percentages by column) (Base=23,810)

Index	Title	Comments with positive connotation	Comments with negative connotation	Comments with neutral connotation
1	Sophia Awakens - Episode 1	603 (35.1%)	401 (23.3%)	714 (41.6%)
2	Sophia Awakens - Episode 2	303 (45.4%)	137 (20.5%)	227 (34.1%)
3	Sophia the Robot by Hanson Robotics	19 (48.8%)	10 (25.6%)	10 (25.6%)
4	The Journey of Sophia the Robot	10 (45.4 %)	2 (9.2%)	10 (45.4%)
5	Sophia the Robot during her first visit in Sweden	71 (42.7%)	31 (18.7 %)	64 (38.6 %)
6	CES 2019: Sophia the Robot is back, and she brought Little Sophia	204 (35.0%)	184 (31.4 %)	196 (33.6 %)
7	CES 2019: AI robot Sophia goes deep at Q&A	512 (35.0%)	444 (30.2 %)	511 (34.8%)
8	Robot Sophia speaks at Saudi Arabia's Future Investment Initiative	280 (27.7%)	318 (31.5%)	412 (40.8%)
9	My Greatest Weakness is Curiosity - Sophia the Robot at Brain Bar	309 (37.5 %)	231 (28.0%)	284 (34.5%)
10	Robot AI has a new announcement for Humanity	439 (36.6%)	428 (35.7%)	333 (27.7%)
11	Sophia the robot Interview: Sophia the robot answers Stylist's philosophical questions	381 (35.7%)	224 (21.0%)	461 (43.3%)
12	UN Deputy Chief Interviews Social Robot Sophia	214 (31.6%)	186 (27.4 %)	278 (41.0 %)
13	Watch Sophia the robot walk for the first time	326 (36.7%)	226 (25.4%)	337 (37.9 %)
14	Robot Meets Self Driving Car - Sophia by Hanson & Jack by Audi	810 (31.2%)	703 (27.1%)	1082 (41.7%)
15	Sophia the Robot Announcement	13 (65.0%)	1(5.0%)	6 (30.0%)
Total		4494 (34.7%)	3526 (27.3%)	4,925 (38%)

Hanson Robotics, corresponding to the change in their CEO[2] changed how Sophia is presented. In their website, now they write "Hanson Robotics' most advanced human-like robot, Sophia, personifies our dreams for the future of AI. As a unique combination of science, engineering, and artistry, Sophia is simultaneously a human-crafted science fiction character depicting the future of AI and robotics, and a platform for advanced robotics and AI research" [22]. They likely realized that there was a strong danger of ridicule (as we discussed above) in the manner in which they presented Sophia in videos 1 and 2, which could undermine their promotional campaign.

To conclude, the roboid Sophia is still in search of establishing a stable identity and clear functions. In this regard, a closer connection with the fashion world should be pursued given the sensitivity of the fashion system toward robotics as is witnessed, for example, by the creation of mechatronic fashion by Challayan or the efforts of Givenchy to create fashionable robots [47].

A strong point of this research is that we identified a new phase–that of roboid–bridging the prototyping stage with the promotion and commercialization stage for new robots, which all robotics companies will have to consider. To reach this objective we needed to combine very different methods, qualitative and quantitative. We are aware, however, that our analysis has structural weaknesses, such as the fact that YouTube is not representative of Internet users and some social groups were excluded (e.g., people without Internet access or digital skills)[31,42]. We are also aware that there are limits to the platform, including the fact that YouTube is often perceived as a space for recreation rather than for constructive discussion. This perception undoubtedly affects the quality of user-generated content, which is characterized by a dearth of added information. Nevertheless, the analysis of digital traces in the form of comments can reveal the opinions held by a wide number of viewers and provide some insights on how people perceive Sophia and the meaning they attribute to her. Another limitation of this study is that although we could process the online content with both qualitative and quantitative methods, we could not apply visual rhetorical and frame analyses more systematically. This limitation has prevented us from going deeper into the meaning of online content. For future research, it would be necessary to diversify further the toolbox to study how the promotion and commercialization of social robots is progressively constructed as well as to expand the analysis on the presentation of Sophia and related comments by the observers on other social media (e.g. Twitter).

---

[2] The new CEO is now Jeanne Lim since January 25th, 2019.

Compliance with ethical standards

References

1. Belachew MB, Goertzel B, Hanson D et al (2018) Shifting and drifting attention while reading: a case study of nonlinear-dynamical attention allocation in the opencog cognitive architecture. Biol Inspir Cognit Arch 25:130–134
2. Bergson H (2011) Il riso. Saggio sul significato del comico, vol 2300. Feltrinelli Editore, Milan
3. Borghol Y, Ardon S, Carlsson N, Eager D, Mahanti A (2012) The untold story of the clones: content-agnostic factors that impact youtube video popularity. In: Proceedings of the 18th ACM SIGKDD international conference on Knowledge discovery and data mining, pp 1186–1194
4. Boyatzis RE (1998) Transforming qualitative information: thematic analysis and code development. Sage, Newcastle upon Tyne
5. Bruns A (2008) Blogs, wikipedia, second life, and beyond: from production to produsage, vol 45. Peter Lang, Bern
6. Cai Z, Goertzel B, Geisweiller N (2011) Openpsi: realizing dörner's "PSI" cognitive model in the opencog integrative Agi architecture. In: International conference on artificial general intelligence. Springer, Berlin, pp 212–221
7. Cherapanukorn V, Charoenkwan P (2017) Word cloud of online hotel reviews in chiang mai for customer satisfaction analysis. In: 2017 international conference on digital arts, media and technology (ICDAMT). IEEE, pp 146–151
8. Cidell J (2010) Content clouds as exploratory qualitative data analysis. Area 42(4):514–523
9. Danese E (2015) Fashion tech and robotics. In: Vincent J, Taipale S, Sapio B, Lugano G, Fortunati L (eds) Social robots from a human perspective. Springer, Berlin, pp 129–138
10. Donzelli G, Palomba G, Federigi I, Aquino F, Cioni L, Verani M, Carducci A, Lopalco P (2018) Misinformation on vaccination: a quantitative analysis of youtube videos. Hum Vacc Immunother 14(7):1654–1659
11. Döring N, Mohseni MR (2019) Male dominance and sexism on youtube: results of three content analyses. Feminist Med Stud 19(4):512–524
12. Entman RM (1993) Framing: toward clarification of a fractured paradigm
13. Fairclough N (2003) Analysing discourse: textual analysis for social research. Psychology Press
14. Figueiredo F, Almeida JM, Benevenuto F, Gummadi KP (2014) Does content determine information popularity in social media? a case study of youtube videos' content and their popularity. In: Pro-

ceedings of the SIGCHI conference on human factors in computing systems, pp 979–982

15. Finkler W, Leon B (2019) The power of storytelling and video: a visual rhetoric for science communication. J Sci Commun 18(5):A02

16. Fortunati L, Edwards AP (2020) Opening space for theoretical, methodological, and empirical issues in human-machine communication. Hum Mach Commun 1(1):1

17. Fritz LM (2018) Child or product? The rhetoric of social robots. In: A.L. Guzman (ed.) Human-machine communication: rethinking communication, technology, and ourselves, chap. 3. Peter Lang Publishing, Incorporated, Bern, pp 67–82

18. Goertzel B, Hanson D, Yu G (2014) A software architecture for generally intelligent humanoid robotics. In: BICA, pp 158–163

19. Goertzel B, Mossbridge J, Monroe E, Hanson D, Yu G (2017) Humanoid robots as agents of human consciousness expansion. arXiv preprint arXiv:1709.07791

20. Goffman E (1974) Frame analysis: an essay on the organization of experience. Harvard University Press, Harvard

21. Hanson D (2011) Why we should build humanlike robots. IEEE Spectr Robot

22. Hanson robotics website. https://www.hansonrobotics.com/. Accessed 15 Apr 2020

23. Hart D, Goertzel B (2008) Opencog: a software framework for integrative artificial general intelligence. In: AGI, pp. 468–472

24. Heimerl F, Lohmann S, Lange S, Ertl T (2014) Word cloud explorer: text analytics based on word clouds. In: 2014 47th Hawaii international conference on system sciences. IEEE, pp 1833–1842

25. Hendriks Vettehen PGJ, Renckstorf K, Wester FPJ (1996) Media use as social action: Methodological issues. Renckstorf K, McQuail D, Jankowski NW (eds) Media use as social action: A European approach to audience studies, pp 32–42

26. Hill CA, Helmers M (2012) Defining visual rhetorics. Routledge, Abingdon

27. Hine C (2008) Virtual ethnography: Modes, varieties, affordances. The SAGE handbook of online research methods pp. 257–270

28. Hutto CJ, Gilbert E (2014) Vader: a parsimonious rule-based model for sentiment analysis of social media text. In: Eighth international AAAI conference on weblogs and social media

29. Iklé M, Goertzel B, Bayetta M, Sellman G, Cover C, Allgeier J, Smith R, Sowards M, Schuldberg D, Leung MH, et al. (2019) Using tononi phi to measure consciousness of a cognitive system while reading and conversing. In: AAAI spring symposium: towards conscious AI systems

30. John M, Marbach E, Lohmann S, Heimerl F, Ertl T (2018) Multicloud: interactive word cloud visualization for the analysis of multiple texts. In: Proceedings of the 44th graphics interface conference. Canadian Human-Computer Communications Society, pp 34–41

31. Kosinski M, Matz SC, Gosling SD, Popov V, Stillwell D (2015) Facebook as a research tool for the social sciences: Opportunities, challenges, ethical considerations, and practical guidelines. Am Psychol 70(6):543

32. Langer SK (1953) Feeling and form, vol 3. Routledge and Kegan Paul, London

33. Mabry L (2016) The rhetoric of social robots: How consumerism is shaping perceptions of robotic ontology. Ph.D. thesis

34. Mailer N (2012) Marilyn: a biography. Random House, New York

35. Mayet R, Diprose J, Pandey AK (2019) Towards automatic visual fault detection in highly expressive human-like animatronic faces with soft skin. In: 2019 28th IEEE international conference on robot and human interactive communication (RO-MAN). IEEE, pp 1–6

36. Mayring P (2000) Qualitative content analysis. Forum: qualitative social research, 1 (2): Art. 20

37. Medhat W, Hassan A, Korashy H (2014) Sentiment analysis algorithms and applications: a survey. Ain Shams Eng J 5(4):1093–1113

38. Mori M et al (1970) The uncanny valley. Energy 7(4):33–35

39. Mossbridge J, Goertzel B, Mayet R, Monroe E, Nehat G, Hanson D, Yu G (2018) Emotionally-sensitive ai-driven android interactions improve social welfare through helping people access self-transcendent states. In: AI for social good workshop at neural information processing systems 2018 conference

40. Nakatani S (2010) Language detection library for java. slideshare. net, Dec

41. Novak PK, Smailović J, Sluban B, Mozetič I (2015) Sentiment of emojis. PloS one 10(12):e0144296

42. Olteanu A, Castillo C, Diaz F, Kiciman E (2019) Social data: Biases, methodological pitfalls, and ethical boundaries. Frontiers in Big Data 2:13

43. Park IW, Kim JY, Cho BK, Oh JH (2008) Control hardware integration of a biped humanoid robot with an android head. Robot Autonom Syst 56(1):95–103

44. Park S, Lee H, Hanson D, Oh PY (2018) Sophia-hubo's arm motion generation for a handshake and gestures. In: 2018 15th international conference on ubiquitous robots (UR), pp 511–515. IEEE

45. Ryan GW, Bernard HR (2003) Techniques to identify themes. Field Methods 15(1):85–109

46. Sarrica M, Brondi S, Fortunati L (2019) How many facets does a "social robot" have? A review of scientific and popular definitions online. Inf Technol People 33(2). https://doi.org/10.1108/ITP-04-2018-0203

47. Taipale S, Fortunati L (2014) A sociological, psychological and educational perspective on social robots. Leopoldina 16:17

48. Thelwall M, Sud P, Vis F (2012) Commenting on youtube videos: from guatemalan rock to El Big Bang. J Am Soc Inform Sci Technol 63(3):616–629

49. Toffler A, Alvin T (1980) The third wave, vol 484. Bantam books, New York

50. Van Leeuwen T, Jewitt C (2001) The handbook of visual analysis. SAGE, Thousand Oaks

51. Viégas FB, Wattenberg M (2008) Timelines tag clouds and the case for vernacular visualization. Interactions 15(4):49–52

52. Welbourne DJ, Grant WJ (2016) Science communication on youtube: factors that affect channel and video popularity. Public Underst Sci 25(6):706–718