Mundanely Miraculous: The Robot in Healthcare

Norman Makoto Su∗, **Leslie S. Liu**†, **and Amanda Lazar**†
∗School of Informatics and Computing
Indiana University Bloomington
normsu@indiana.edu

†Biomedical and Health Informatics
University of Washington
lsliu@uw.edu, alaz@uw.edu

ABSTRACT

As both hero and villain, robots have played prominent roles in media such as films and books. Now, robots are no longer hidden away from the public conscious in fictive worlds or real-life factories. Robots are becoming a real part of our everyday encounters in environments such as healthcare settings. In this paper, we describe a discourse analysis of 60 YouTube videos that showcase robots in healthcare activities. Our narrative weaves three discourses that construct visions of the healthcare robot: (1) the miraculous robot as the robot that enhances patient care; (2) the mundane robot as the innocuous robot that integrates into the workflow seamlessly; and (3) the preternatural robot as the robot that is miraculous but never mundane. We propose several contrary visions to this dominant narrative of healthcare robots as a framework for future fieldwork that, we argue, should investigate the institutions of robotics.

Author Keywords

Robots; telemedicine; service robots; YouTube; human-robot interaction; health informatics; critical theory; discourse analysis.

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION

HAL in *2001: A Space Odyssey* was an intelligent yet coldly calculating robot. The eponymous star of *WALL-E* was a love-forlorn robot with a trash compactor. Rosie was the motherly, warmhearted robot maid of *The Jetsons*. The replicants of *Blade Runner* were rebellious and reflective robots cognizant of their second-rate status in a world dominated by humans. Through these and other media depictions, the robot has left an indelible and variegated imprint on the public consciousness. Science fiction represents but one type of *discourse* on robots. This mishmash of robot texts reflects a complex and contradictory discourse [27] on technology's relationship to society [2].

The texts which surround our everyday lives and the methods by which their meaning is conveyed are powerful forms of knowledge [25]. Discursive strategies socially construct a reality that we intersubjectively [4] share on what robots are and should be; at the same time, it narrowly delimits what robots are not. Hence, our encounters with real-life robots are necessarily influenced by discourse. Scholars have found that scifi, traditional stories, religious texts, and cultural mores shape or reinforce attitudes towards robots [8, 19, 16, 28]; for example, users interacting with robots that do not meet their "expectations" may feel uncomfortable and have difficulty with accepting robots' professed benefits [8].

As real-life robots move out of factories and into our daily lives, human-computer interaction and computer supported cooperative work researchers have become interested in our social interactions with robots [14, 13]. Robots in various guises have become increasingly important in the *healthcare* industry. According to the IFR (International Federation of Robotics) [1], almost 16,000 service robots (robots that aid people in non-industrial settings) were sold in 2012 worldwide and 1,308 medical robots were sold in 2012. Manufacturers have been aggressively making and selling medical robots because they are the most costly service robots; sales in 2012 have totaled "$1,495 million, accounting for 44% of the total sales value of...service robots" [1]. In the healthcare domain, there exists a good body of work understanding our interactions with service robots [22, 29], therapy robots in nursing homes [20, 9], and telemedicine robots [23, 30].

In this paper, our focus will not be on the observed usability or sociotechnical problems of robots in healthcare, but, rather, the online discourse of robots in healthcare and the *institutions* within which these discourses are produced and promulgated. Because of their novelty in healthcare environments, striking appearance, and interactivity, video, we argue, is a particularly potent site of discourse for robots. Instead of having a preconception of what a healthcare robot was, we strove to understand the definition of a healthcare robot through the lens of online videos. Specifically, our study unpacks the discourse of 60 videos in YouTube. We ask: how do videos construct a particular reality for robots in medicine? What discursive strategies are utilized? How do institutions—robot manufacturers, researchers, and hospitals—legitimize robots?

Our paper makes the following contributions:

1. The first, to our knowledge, analysis of videos from online organizations, health media groups, and government/nonprofit agencies featuring transport, telepresence, and com-

panion robots in different healthcare environments: hospitals, clinics, and nursing homes.

2. Explication of a complex and contradictory discourse of robots: Some robots are both *miraculous*—drastically improving and augmenting healthcare capabilities—and assured to become *mundane*—a routine part of our everyday lives. By contrast, some robots are *preternatural*, miraculous, but encountered on their own terms to become an important and meaningful being in our health.

3. A set of contrary narratives that critique the dominant discourse in media of healthcare robots. These narratives seek to pry out what realities of robots are marginalized and issue a call for future studies to investigate the problems of disenfranchised actors/institutions in these utopian visions of healthcare robotics.

The structure of our paper is as follows. We first present related work on robots in media and in healthcare. We then describe our data collection of YouTube videos and our analytic perspective. Next, we present three types of discourse of robots in healthcare through these videos of robots in action. Lastly, we critique this discourse and discuss a proposal to study up (and down) institutions of robotics in healthcare.

RELATED WORK

We now discuss previous work on robots in two different fields: media and healthcare. In studies of media, there is a large body of research that has examined how our innate fascination with robots are manifested in forms like books, film, and television shows. In the healthcare field, scholars have categorized and studied the role of robots in providing better care to patients.

Robots in the Media

Researchers have examined media discussing and portraying robots and its effect on viewers. Many studies examining media portrayal of robots focus on science fiction. One point that has been repeatedly emphasized is the mixed messages of science fiction. In a review of concepts commonly put forth in science fiction movies, Bartneck [2] included both threatening ideas, such as the idea that robots will take over the world as well as the robot-friendly desire that humans have for robots to be similar to themselves. Similarly, Bruckenberger et al. [8] discussed the mixed message of science fiction, with ideas of robots taking over the world in some movies contrasting with depictions of a better future through the use of robots in others.

Media portrayals of robots appear to affect the perceptions of robots in the public. In a study evaluating the attitudes middle aged and older adults have towards robots in the healthcare setting, Broadbent et al. [7] found that previous exposure to literature and entertainment media affected participant's perceptions of robots. The mixed messages about robots expressed in science fiction exists in the public as well. In one focus group, participants expressed both the idea of robots as "iron idiots" while simultaneously expecting their abilities to exceed those of humans.

In addition to science fiction and media, robotics researchers also played a part in shaping (or attempting to shape) public perceptions of robots. Sabanovic et al. [28] examined researcher discourse on robots in Japan and found that roboticists create and position robots uncritically in ways that normalize robots and create a place for them by rewriting culture in a way that creates roles that only robots can fill.

Robots in Healthcare

Robots have had a presence in the healthcare environment for some time. In 1991, Preising et al. [26] provided an overview of robots in medicine, including laboratory, rehabilitation, and surgical robots in a literature review. In a more recent review of current and possible uses for robots in healthcare, Dahl & Boulos [11] divided robots into the following two classifications: surgical or rehabilitation robots and versatile robots supporting "softer" HRI tasks. Softer robots are further subdivided into sub-classifications including robots providing logistical assistance in hospitals, such as feeding and transport robots, and telepresence and companion robots.

There have been many studies of robots in healthcare settings including *transport robots* used to deliver medications and supplies, *telemedicine*, or telepresence, robots used to diagnose and interact with patients, and *companion* robots designed to provide companionship to older adults in care facilities. In a study of staff use and perception of a transport robot in a hospital, Ljungbald et al. [22] found four qualities ascribed towards the robot: alien, machine, worker, and work partner. In another study of transport robots in a hospital, Siino & Hinds [29] examined the role gender played in how female and male workers made sense of the robot. Telepresence robots have been examined as well. For example, Mariappan et al. [23] described a telemedicine robot used by surgeons to diagnose patients remotely, and Sucher et al. [30] interviewed patients and their families who had interacted with a telemedicine robot in an intensive care unit and found that the use of robots in this setting was viewed favorably. Robotic companions such as Paro, a soft robotic seal, in nursing homes have also been studied. In one study, Chang et al. [9] used Paro with older adults with dementia and found that with time, participants increased their usage and willingness to use Paro. Khosla et al. [20] examined the use of Matilda, a hard plastic robot combining emotional and functional aspects for older adults in residential care and found positive effects from its use with this population.

In sum, there have been few studies that have examined *in detail* the intersection of the two aforementioned areas. In our study, we examine precisely that intersection: the media portrayal of robots in healthcare.

METHODOLOGY

Because so much of what robots are is enmeshed with their physical form and interactions in environments, videos provide an ideal medium to assemble present and future visions of robots in healthcare settings. For example, videos allow organizations to construct a model of how robots will interact in with others with respect to everyday activities. Our discourse
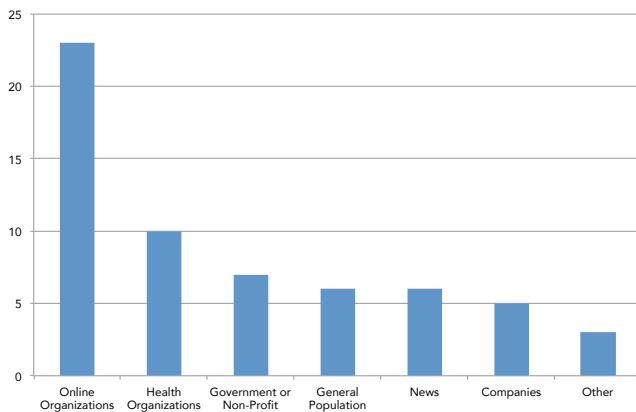
Figure 1. Number of Videos per Uploader Category (N=60).

analysis of healthcare robots in the media unpacks YouTube videos that precisely depict robots in action.

Our data collection methods follow previous work that have collected and analyzed videos through YouTube [21, 5]. Because we wanted to get a holistic view of the kinds of robots being used in healthcare, we carefully chose keywords that would generate a wide range of healthcare robots in YouTube's search mechanism. For example, the term "health" encompasses well-being, illnesses, and health activities done at home (e.g., measuring weight), whereas the term "medicine" focuses on seeing a doctor for a specific medical reason such as an illness. This was our rationale for using "robot health" instead of a more specialized search such as "robot medicine". To understand how robots were being used in a range of healthcare environments, we used key terms such as "hospital" and "clinic" (short-term acute care) as well as "nursing home" (long-term care).

Through YouTube's default search mechanism, we conducted four searches on March 10, 2014: "robot hospital" (108,000 results), "robot clinic" (31,200 results), "robot health" (116,000 results), and "robot nursing home" (10,200 results). From these results, our final dataset consisted of videos that satisfied all of the following inclusion criteria:

1. **Robots designed with the capacity to interact with people other than healthcare professionals.** For example, we excluded videos of the *da Vinci Surgical System*, which was presented as a surgical robot because its interactions are limited to healthcare professionals. We specifically selected robots who have the capacity to interact with people other than healthcare professionals because we wanted to examine the discourse of how robots that have a broader and direct impact on the public are portrayed to the public.

2. **Videos targeted towards a Western audience.** Non-English speaking videos (e.g., in Japanese) were not included in the dataset unless there were subtitles or a voiceover that explained the context of the video.

3. **Videos had to show the robot in use.** We wanted to see the visual aspects of the robot like how the robot worked or the interactions between the robot and other people.

For each of the four YouTube searches, we found that after roughly 15 videos matching our inclusion criteria, it was increasingly difficult to find unique videos (i.e., videos found from one search term that were not duplicated from another search term). We thus set a cutoff of 15 videos per search, resulting in a final data set of 60 unique videos.

Based on Yanco & Drury's [31] task type taxonomy for robots, we categorized videos as: (1) transport robots such as the Aethon TUG or SwissLog SpeciMinder: 22% of videos; (2) telepresence robots such as the InTouch Health RP-7 or RP-VITA: 45% of videos; (3) companion robots such as Paro or the NEC communication robots: 13% of videos; and (4) other task types such the RIBA-II, a lifting robot: 20% of videos. Videos were uploaded by a wide range of users (see Figure 1): (1) online organizations that curate content (e.g., robotic YouTube channels); (2) news organizations (e.g., Reuters or Associated Press); (3) government or non-profit organizations (e.g., cities or universities); (4) general population (e.g., hospital visitors); (5) health organizations (e.g., hospitals or clinics); (6) companies (e.g., private-sector companies); and (7) other (e.g., a user that uploaded a one-off video on a robot in healthcare).

YouTube also allowed users to specify a specific video category when uploading a video. The most popular self-selected category was Science & Technology (47%) followed by News & Politics (27%). While some studies have also analyzed YouTube comments [6], most of our videos had very few or no comments. There were on average 12 comments (SD=39.5) per video with a median of 1.

Analytic Perspective
Following data collection, all videos were transcribed not only for conversation but for relevant actions and non-verbal information. The first three videos of each search term (12 videos in total) were coded by all the researchers to develop cohesive codes as a group. The rest of the videos were then coded individually. Our coding was backgrounded by both a textual and visual [27] critical [10] approach drawing from discourse analysis [25]. Discourse analysis has been used successfully in HCI to, for example, examine the discourse of of users and non-users of smartphones [17]. Briefly, discourse analysis unpacks not only what texts say but how the texts say what they say; it "explores how texts are *made* meaningful through...processes and also how they contribute to the constitution of social reality by *making* meaning" [25][p.4].

FINDINGS: THE ROBOT IN HEALTHCARE
The YouTube videos weave a narrative that is both complex and contradictory. According to Rose [27][p. 155–157], discursive strategies are powerful because of their interpretive flexibility. Accounts of robots by hospitals, researchers, and industry present robots as both problematic and unproblematic to patients and healthcare environments. There are two contrasting narratives (combining three types of "mini-discourses" [27][p. 156]):

1. Institutions produce a discourse that transport and telemedicine robots are *miraculous robots*. That is, robots

are miracle workers and promise to increase healthcare capabilities on a global scale. Despite their being miraculous, we must also accept and acclimate ourselves to the inevitable pervasiveness of robots in healthcare. These miraculous robots are also *mundane robots*; they are a routine part of the rhythms of medical work.

2. Companion and therapy robots are *preternatural robots*. That is, robots are to be taken on their own terms as beings that provide humans with meaningful emotional connections. These robots are miraculous because they go far beyond what normal humans can achieve in healthcare. This class of robot will never be *mundane*.

In the following sections, quotes will be notated with the video from the YouTube search result from which the quote was found (# is an id from 1–15): {ho#}: robot hospital, {c#} robot clinic, {he#} robot health, and {nu#} robot nursing home.

The Miraculous Robot

With the healthcare robot, healthcare professionals are suddenly able to provide new and additional care to their patients. In this section, we discuss the various ways that the healthcare robot is able to drastically improve and augment our current healthcare capabilities.

Providing Expertise to Patients

For telemedicine robots, by far, the most dominant discourse is their ability to bring specialists to patients regardless of distance. Telemedicine robots are especially pertinent to time sensitive conditions—foremost, strokes. Our videos often illustrate the devastating speed at which a blood clot in the brain can lead to a stroke. Robots bring highly qualified experts who are able to accurately and quickly (within 3 to 5 minutes {he13}) diagnose patients to determine if a "higher level of care {c13}" is necessary:

> [C]onsultations by audio/video telemedicine can provide 96% accuracy in the diagnosis of the stroke syndrome and determine that the patient is eligible or not for acute stroke treatment including clot busting medication, tissue plasminogen activator. {c8}

> We're only transferring in 50% of those patients that were consulted on when you use the robot. And the diagnoses are more accurate. {he11}

Diagnoses are even better because of the "tool belt {c8}" of technologies provided by telemedicine robotic manufacturers. Remote doctors have applications that provide instant access to CAT/MRI scans, electronic health records, and vital signals.

Such discourse elevates the expert as indispensable to stroke patients. Local doctors are no match for a world expert. The CEO of iRobot explains:

> You've just had a stroke. Would you rather see...one of the world's experts in stroke who can actually make a complex diagnosis and get you the best treatment, or would you rather see the guy down the hall who happens to be available? I think that most people would say,

"I want to see the expert" even if that expert was only available via robot. And that's what RP-VITA is about. It's allowing patients to see specialists, and thus having access to more sophisticated treatments which lead to better outcomes. {he4}

These scare tactics effectively argue that the prevalence and complexity of time sensitive conditions like a stroke necessitate telemedicine robots.

Arguments for telemedicine robots and, implicitly, the need to connect experts with patients are made all the more convincing through patient *testimonials*. For example, an older adult patient named AJ Bates recounts her experience after a stroke hit:

> AJ: I couldn't talk. I couldn't write in cursive.

> Reporter: AJ's local hospital is well staffed, but it doesn't have doctors trained to use a clot busting drug called tPA.

> Reporter: But AJ did get the care she needed, thanks to technology that gave her access to [a] Mayo Clinic stroke specialist 200 miles away. {c9}

Robots do not merely connect patients with experts in emergency situations. Telemedicine robots provides patients with long-term care from experts that is nearly as good as interacting with colocated doctors. When one patient was recovering, his doctor was on leave but was still able to check in on him: "*He said, 'I'm over here, all the way in Virginia, I just want to take a look at you once.'...I...just stayed on the bed...while he did the whole thing with the robot.* {c12}" Robots allow doctors to conduct rounds with patients in multiple locations. Robot manufacturers emphasize that their technology supersedes antiquated technologies like the telephone.

Finally, telemedicine robots diagnose patients exactly as doctors normally would. A video depicts a robot moving to talk to a patient in a hospital: "*She [remote doctor] had me stick out my tongue. Open my mouth real wide and do some hand things, like my fingers to my nose. She says to me there, she said it was a stroke.* {he11}" Our videos show testimonials of patients who are surprised and skeptical of robots at first but "*after a few minutes, the television monitor seemed to melt away, and they [patients] believe they're right there with you.* {c15}"

Leveling the Playing Field

Not only do robots bring expertise anywhere and anytime, they level the playing field in the arena of hospitals. For rural residents, "communities in need {c8}," or patients not near a "major city {he4}," telemedicine robots play a morally laudable goal in democratizing healthcare.

Depicting a snowy, isolated landscape, a video by the Government of Canada purports the benefits of telemedicine for Nain, a remote Inuit community:

> Nain is a small, remote, isolated community in Northern Labrador. Their health clinic does have a nursing staff but only one visiting physician for the entire community of 1,500. Patients must depend on air travel nine months

of the year to see a specialist. The bad weather often delays access to needed medical services.

There's only one way in and one way out of communities like Nain. And those flights are often unreliable and they're always expensive. So, when a plane doesn't land, patient care can be compromised and it leaves patients, their families, nurses, and doctors frustrated because of the inability to provide access to the care that patients need in these Northern rural communities.

Individuals that live in the smaller communities, individuals that live in communities that are far away from urban centers, do not have the same access to healthcare of our citizens that live in Halifax or in Toronto. {c4}

These *disadvantaged* communities lack the specialists that big hospitals and cities have. Some of these communities are isolated, making travel difficult. Yet, "*patients expect even rural communities to get good patient care. They don't think they should be in a rural community and not have access to the same technology and resources that they have in the major centers.* {he11}" Robots "*makes us not a small hospital anymore. It makes us a hospital that has...in-depth consultative abilities, so it makes a little hospital powerful.* {c10}"

Similar narratives are weaved in videos for STAR (Stroke Telemedicine for Arizona Rural Residents), the Mayo Clinic, Palm Drive, and the St Joseph Health System. An important component of these narratives is that robots create a hospital *conglomerate*. That is, robots support either a "hub and spoke model" or "flat hospital": a hospital that combines the abilities of several hospitals, strengthening hospitals that have fewer resources, and creating a new, lean hospital system. The size of such centers are impressive: "*The Mayo Clinic Telestroke Program...has grown from the original 2 participating centers...to a total of 10 centers...we're also excited about new participation out of state.* {c11}" In one video, the inventor of RP-7 notes, "*There's really one big healthcare system for the whole world, and the resources are mobilized through that network.* {he13}"

Symbol of Hospital Innovation
Robots are a symbol [12] for hospital innovation. By having robots roaming in their hallways, hospitals label themselves as leaders in healthcare. By being leaders, institutions demonstrate their commitment to patients: "*St. Mary's Medical Center has always been a leader in technology. And these new remote presence robots are the latest example of how we're helping patients across West Virginia and the tristate.* {c14}" Certainly for the hospitals *providing* experts via robots, ownership gives prestige: "*Our award winning healthcare providers can provide outstanding patient care to a growing number of people through the St Joseph Health System.* {he7}" Major centers are able to gift their superior medical practices: "*Telemedicine, an innovative personalized way to provide added value to your patients by partnering with Mayo clinic.* {c15}" Innovation places the patient as #1.

Robots are presented as increasing the capabilities of organizations, facilitating better care to more patients at lower costs. By flaunting their ownership of various robots, organizations can provide evidence of increased use of limited resources such as doctors and more agile work activities. One video starts with a catch phrase: "*Service to our patients starts here and the AGVs [Automated Guidance Vehicles] assist us in providing the best service that we can so that our customers, the doctors and nurses, can provide the best care for the patients.* {c2}" A robot that delivers samples allows a hospital to become efficient: "*The way he [Robbie the transport robot] benefits the patient is by delivering the samples faster to the department. The department can process the sample in a single piece flow, and that expedites the process instead of having someone sitting there for 20 minutes, trying to process different patients, and then taking the samples to the department.* {ho2}" For a nurse, robots provide an unequivocally beneficial role with patient visits: "*We can be more effective by using the Giraff with just one nursing assistant instead of using four nursing assistants, making four visits to four people. We can use one nursing assistant, and that's more cost effective.* {he3}" Yet, this is not just a way to save money: "*But is it simply a cost-cutting exercise? Officials at the Department of Health in Northern Ireland say no. They claim it's [robots] a way to make the most of a doctor's time, and even some of the medical skeptics have been won over.* {ho13}"

Lastly, health institutions view robots as a stake to claim they are unique or ahead of the curve. Their hospital is the first "*in the UK to use a robot for ICU doctors* {ho13}" or "*in Missouri* {c11}" to deploy robots. One video proudly mentions they are "*one of the only hospices that uses Paro.* {nur9}" In these vast conglomerates, these unique technologies require new *professions* to manage; for example, the Mayo Clinic has a new class of employees, the "telestroke-ologists."

The Mundane Robot
As robots become more pervasive in society, for them to actually accomplish their jobs, they cannot be seen as astonishing or special. To be constantly in awe or fear of robots would hinder work in healthcare environments. Thus, the miraculous robot becomes mundane. In this section, we detail how the discourse of robots argues that the miraculous robot will blend into its surroundings, and hence become the mundane robot we can all accept.

Robots will Work with Us
Several videos allude, sometimes jokingly, to the fear that robots will replace humans. However, the response from organizations and roboticists assuage that fear:

> We face a lot of fears when it comes to robots in welfare and elderly care, but it's quite easy to overcome that because we're not trying to replace people with something bad or evil...nobody's job was eliminated...It was really to try and help people so that they could focus on the duties that were more important. {ho10}

Robots will never "*replace our employees and their compassionate bedside manner that only humans can provide.* {he7}"; they merely enhance our health care.

In fact, robots will become our coworkers, assisting physicians, nurses, and other clinicians. Testimonials from doctors and staff emphasize this point. A employee at Parkheim Berg

Figure 2. Working with Robots: A. Nurse with Transport Robot, B. Telemedicine Robot Dressed in US Army Fatigues, C. Nurse as Physical Proxy for Telemedicine Robot, D. Care Assistant with RIBA-II
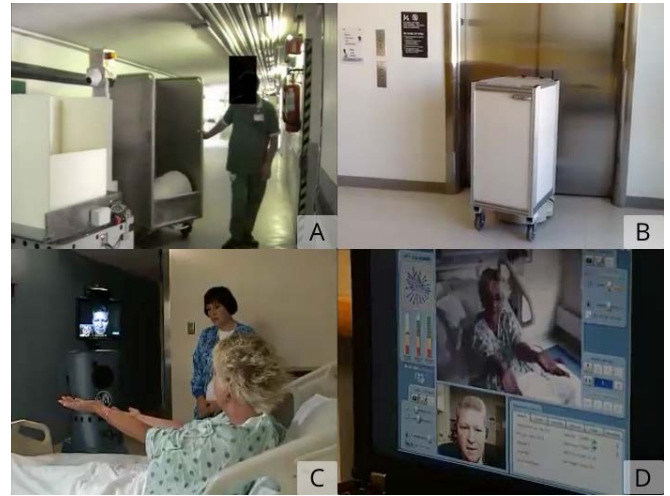

Figure 3. Robots being Safe: A. Transport robot avoiding nurse with cart [redacted in original] and B. waiting for elevator. C. Scenes showing Patient's POV and D. Doctors's POV

in Stuttgart says, "*He's [robot] a big help, especially to me, because I also do nightwatch in Parkheim Berg. He enables me to see...in the corridors, [that] everything is okay, which is really useful. He also brings me the first-aid case. He's a big help.* {nur1}" Staff also act as *physical proxies* with telemedicine robots:

> One of the nursing staff will be present...and help complement what we do—meaning, help me place the stethoscope on the patient and the chest and the lungs, on the heart, and also they help me feel the abdomen and I'm witnessing what they are trying to do and direct them where to push and ask the patient how they're feeling. So...they [nurses] become my hands on the scene. {c13}

Doctors also start to feel like they are part of the hospitals in which they control robots: "*With this technology, I feel like they're my colleague[s]. I have credentials in their hospitals. We are partners in caring for those patients now.* {he11}" These robots are dressed as doctors (Figure 2B), have nicknames, and have their own hospital badges.

A more compelling response to fears of robots replacing workers, however, is in how videos visually depict robots as working alongside us. Robots will be a part of hospital routines. Numerous videos show robots walking alongside clinicians in hospital hallways and surrounded by doctors. Figure 2 illustrates how videos visually frame scenes of robots mundanely working with employees in healthcare. Figure 2B shows the robot dressed as a doctor in the US Army Medical Center. Figure 2C has the following conversation showing the nurse working with the remote doctor and its stethoscope:

> Remote doctor [to nurse]: Excellent. Can you...have her sit up and listen to her back?
>
> Nurse [to patient]: You want to sit up? Let's listen to your back.

> Nurse [to remote doctor]: Let me know when you want me to move.
>
> Remote doctor [to patient]: Please take big, deep breaths. {he2}

Figure 2D shows a robot designed to assist employees in lifting and transporting the elderly. In all our videos, the employee always works together with such robots when moving patients.

Robots are Safe

With the T-1000 from *The Terminator* and HAL from *2001: A Space Odyssey* still a powerful stereotype of aggressive robots, our videos provide a rebuttal to establish the safety of robots in both subtle and overt ways. While working with robots (see previous section) does establish robots as already safe for employees in healthcare, the discourse of robots puts forth their safety for patients and visitors.

With telemedicine robots, scenes are often shot from multiple *points of view* to establish that there is, in fact, a doctor "driving" the robot. Video {c9} (Figures 3C and D) shows the perspective of the real-life doctor operating a telemedicine robot and then switches to the perspective of the robot itself as perceived by the patient. These scenes establish that the robot's "agency" is real; the robot is a proxy for the expert doctor. The narratives of such videos also "disassemble" telemedicine robots, explaining that the robot in fact is made up of familiar technologies: "*From miles away physicians can navigate the robots to provide bedside exams and evaluations using the robot's computer* **screens** *with realtime video* **cameras** *eyes and built in* **microphones** *for ears.* [emphasis added] {he7}" By understanding robots, we can assuage public fear of them.

Videos also demonstrate how robots make their *intentions public* by audibly announcing their "thoughts." This is especially needed for service/transport robots who appear alien and inscrutable. In Figure 3B, the robot (in a flat voice) declares:

Robot: Approaching elevator, please stand aside. [Robot waits in front of elevator] Waiting for doors to open. {ho8}

While the robot is in motion, however, its intentions are not necessarily known. Videos take pains to explain the *underlying algorithms* of the robot's locomotion:

> We have a series of sensors from laser to sonar and 3D imagers that allow the robot to know where it is and see the space around it: moving objects, static objects, or features of the building. It moves accordingly. And of course, in a hospital situation, there may be patients that may be walking by, so it's extremely careful. {he5}

The scene in Figure 3A is remarkable for juxtaposing a transport robot with a human moving a cart—whom the robot may precisely replace. Here, the robot has stopped after detecting the nurse; the nurse then moves his cart around the robot. Just like humans, both parties act safely when they "bump" into each other. Some robots have been customized for particular environments: "*The hallways have been pre-measured, and they're pre-programmed, so he's [robot] able to see what's in the hallway, what's in the way, and he will deviate from his step in order to make it to the department*. {ho2}"

Lastly, for nursing homes, robots have been designed to protect the elderly (in addition to requiring that they work collaboratively with staff). For example, the video narrator explains the RIBA-II's (Figure 2D) safety features, "*As this robot comes into direct contact with people, we've made its entire covering soft, so as not to injure people. {he1}*"

Robots will Work for Us

In contrast, to make robots mundane will also create a new population of service robots that replace more "menial" jobs. One reporter asks, "*What we're talking about today are a new breed of robots that are sort of more blue collar...They do grunt work...[A]re the only people left in the hospital going to be the nurses, the emergency technicians, and the doctors? Is that what it's going to be in the future?* {ho3}" The rhetoric around service robots is markedly different than that of therapy or telemedicine robots. These robots will become our slaves. After all, "*it does all the work we don't really like to do...The robot's job is a bit like a butler's, who would get you drinks from the kitchen or help serving snacks at a reception. Basically, it's here to look after you.* {nur4}"

These robots are not controlled by human beings and do not demonstrate an intelligence/learning ability that would make us sympathize with their plight. We can use them at will, "*24 hours a day, 7 days a week* {ho2}": "*The robots don't complain, get tired, or need a break no matter how many hours they work.* {ho1}" In such discourse, robots are not seen at all as humans: "*He doesn't take a break, doesn't go to the bathroom, he doesn't eat.* {ho2}" Many of the videos show transport robots as what we call *busy bees*: robot employees who are happily working away invisibly in the background/infrastructure of the hospital. Such robots take the form of transport robots and the service robots for the elderly care industry (particularly important for Japan's "ageing society {nur11}").

Figure 4. The Preternatural Robot: A. Paro fed water by person with dementia, B. Cognitive games by a robot in a Melbourne nursing home, C1-2. Scenes showing a robot interacting with a child with autism.

Videos sometime show such robots being teased. In one video, as a transport robot moves by, a man sticks his foot in front of the robot and another person steps in front of the robot. The latter jokes, "*Is it mad at me? I didn't do anything. {ho14}*" One newsperson reports on how children bully robots, "*In the hospitals where they are used, sometimes kids can't resist but jump in front of one to see what's going to happen. Or, messing with the robots.* {ho3}"

The Preternatural Robot

While robots in hospitals and clinics are both mundane and miraculous, the discourse of therapy and companion robots is that of a being to be taken on its own terms. It establishes what the post-phenomenologist Don Ihde [18] calls an *alterity relation* with the world. The robot exhibits a "technological otherness" by being more than just a humanoid copy. These preternatural robots do not reside in the background, becoming mundane; rather, they call our attention. The preternatural robot "*may look like a toy, but it's actually a whole lot more*. {nur11}"

First, the relationships we establish with service and telemedicine robots are different than our relationships with preternatural robots. Service robots are subservient servants. Telemedicine robots are proxies towards a relationship with a real-life doctor. In contrast, we build meaningful relationships with the preternatural robot itself. These robots assist people with cognitive impairments. Paro, perhaps the only robot as of writing that is used in nursing homes, "*can build a relationship with elderly people, liven up the therapy and make it less boring. {nur3}*" Videos of Paro are powerful. Scenes show smiling and laughing elderly patients hugging or petting Paro. Figure 4A shows an elderly man with Paro on his lap trying to give Paro a drink from his cup.

Several features allow these robots to have meaningful interactions. These robots can not only detect obstacles, but they can "*detect their [patients'] moods, for example, if they are in a low mood, it can send emails to their relatives to come*

and visit them. {nur11}" Robots like Paro can actively learn: "*it's equipped with tactile sensors and artificial intelligence software, enabling it to interact with its owner. It can also remember its own name and learn to respond to words that the owner articulates regularly.* {nur14}" Robots allow the elderly to "develop a sense of independence" (Figure 4B) by keeping them "mentally active. {nur11}" Robots also play songs and flash lights to encourage residents to dance, thereby increasing community spirit and morale.

The robots, by virtue of being robots, also provide a kind of treatment not attainable through human interactions or typical medication. For children with autism, a researcher explains (Figure 4C) that "*what we've demonstrated that if the children were really more interested towards robot than human therapists, then the robot might be able to use this engagement to some beneficial activities.* {he8}" Similarly, animal therapy has been proven that by "*using dogs...[it can] improve patients' social, emotional, or cognitive functioning.* {nur3}" Without the hassle of training and maintaining dogs, we are able to leverage robotic pets. However, we cannot take Paro as merely an approximation of a pet. Paro is a robotic seal, and seals are not pets. Paro's fictitious form perpetuates its miraculous state; Paro will never be mundane.

STUDYING UP INSTITUTIONS OF ROBOTICS

We have presented a discourse analysis of YouTube videos featuring robots in healthcare. Our intent is not to create a set of design recommendations for robots from these findings but rather to tease out the dominant discourse promulgated by institutions of robotics. Just as fields like ubiquitous computing can learn from dominant visions [3], we can learn from the dominant visions of robots in healthcare. Dominant visions are not only useful for understanding how institutions frame, package, and legitimize technologies as indispensable, they also elucidate how particular discourses may in fact marginalize actors in regimes of truth [15] established by technologies (i.e., robots).

The discursive strategies utilized by the videos are an effective method to legitimize robots for the *long term*. The miraculous provides insight to their immediate (and long-term) benefits; the mundane provides insight into how robots will be part and parcel of everyday health practices. Robots are here already, doing great things; we might as well embrace them and prepare ourselves for their integration. Testimonials by patients, doctors, and researchers provide "real" evidence that robots are and will be successful. The preternatural robot rescues those who cannot be helped by mere mortals (e.g., older adults with dementia or children with autism) and establishes itself as a new member of society.

Ljungblad et al. [22] insightfully examined how staff members and patients of hospitals were integrating robots into their medical practices. Though limited to the hospital environment, their study showed how robots were conceptualized by staff as alien, machine, worker at hospital, and work colleague. Certainly, our discourse analysis revealed some analogous qualities of robots as presented by institutions. As a grand vision of the future and present, our videos, however, present robots in a positive and relatively unproblematic light.

While a hospital staff member may see transport robots as embodying, to varying degrees, all the qualities mentioned in Ljungblad et al.'s study, the dominant discourse of our videos established transport robots as "busy bees" who do the dirty work of hospitals alongside their more esteemed human counterparts. These conflicting realities should be probed.

By constructing our own narrative of mundane, miraculous, and preternatural discourses of robots in healthcare, we issue a call to study the *institutions of robotics* that we take for granted when we encounter them. We lack in-depth studies looking at the role of robots within a network of robotic manufacturers, hospitals (and their systems), patients, nursing homes, researchers, staff, and doctors. The sheer number of videos featuring not only manufacturers such as iRobot and InTouch Health but hospitals, health news agencies, governments, and researchers speaks to the importance institutions place on constructing a particular reality of robots. Many of these videos seem to have been jointly produced by hospitals and researchers/robot manufacturers. This leads us to ask, **how are these networks mobilized? How are these visions of future robots jointly designed?**

Perhaps most valuable is to not only ask about the origins of these dominant discourses but what other interpretations of robots are marginalized or *oppose* the dominant discourse. Hence, our findings are a framing device to critique the dominant discourse from various actors' points of views. Below, we present the dominant, utopian, viewpoint drawn from our narrative, and then we problematize this vision with a dystopian version:

- **Utopian: A New Breed of Doctors.** Doctors regularly work both locally and remotely via telemedicine robots. Time-sensitive conditions are immediately diagnosed by specialist doctors controlling telemedicine robots.

  Dystopian: The Commodification of Doctors. Doctors are turning from a limited resource into a resource that is efficiently doled out to a hospital conglomerate. Doctors in rural areas are "upgraded" with expert doctors. Local doctors have been labeled as a "second best" option. This new breed of doctors is challenged with prioritizing between local and remote patients.

- **Utopian: Democratic Healthcare.** Patients now expect experts at their fingertips to properly and efficiently diagnose their ailments. Telemedicine robots allow doctors, regardless of their location, to establish close and consistent connections with their patients.

  Dystopian: A Taxed Healthcare System. Care is redefined to unreasonable standards that undermine staff and doctors in the healthcare industry. Patients no longer will settle for anything less than the best doctors, locally or remotely. Yet some doctors and patients still feel that remote care via robots pale in comparison with traditional face-to-face care.

- **Utopian: The Empowered Staff.** Employees in a hospital now count service and telemedicine robots as their coworkers. These robots are an integral part of keeping the hospital running.

Dystopian: The Enslaved Staff. In addition to their usual responsibilities, staff are now burdened with the maintenance of healthcare robots. Clinicians now fulfill the role of a "physical proxy" for telemedicine robots. These robots reinforce hierarchical levels of employment in hospitals (e.g., nurses vs. doctors).

- **Utopian: Hospital Conglomerates.** To achieve better healthcare for their patients, all hospitals now leverage other hospitals' capabilities to form conglomerates. Robots play a key role in forming these conglomerates, democratizing access and quality of healthcare.

  Dystopian: Marginalized Hospitals. Hospital prestige is attached to being the "hub" of a hub and spoke model in a telemedicine robot network. Healthcare institutions face pressure to incorporate robots into their infrastructure to remain competitive. Robot manufacturers and researchers design services to ensure constant revenue (one video states that InTouch Health rents units to hospitals for $4,000 a month and a control station for $5,000 each).

- **Utopian: Better Care Assistants.** In nursing homes, care assistants utilize therapy and companion robots to provide a level of care unattainable by humans alone.

  Dystopian: Obsolete Care Assistants. Care assistants have been made mostly obsolete by healthcare robots. Humans now mostly handle menial tasks, while robots provide therapy and companionship for nursing home residents. Nursing homes without preternatural robots have a severe competitive disadvantage compared with homes having robots such as Paro.

Our dyspotian rejoinders challenge the dominant discourse. These contrary narratives suggest future fieldwork "studying up" [24] the institutions, bureaucracies, and markets of robotics and "studying down" the doctors, patients, and staff who must live/work with and be treated by robots.

CONCLUSION

We issue a disclaimer that our own construction of a narrative to explain the discourse of healthcare robots in video is itself subject to the same critical methods we have utilized. While our analysis is rigorous, we do not claim to have the definitive or single "true" account of the discourse of robots in healthcare. Indeed, such a claim would be an anathema to the tenets of discourse analysis. Another reading of our texts or a different type of text (e.g., newspapers or magazines versus videos) may lead to a different interpretation.

What we have argued is that the discourse of robots in healthcare seeks to legitimize robots for a variety of actors with a multiplicity of arguments. Robots are both mundane and miraculous. Transport, telemedicine, and service robots in healthcare promise to create a new level of quality healthcare by providing experts to patients. Robots also bridge multiple hospitals together, democratizing them as well as empowering smaller hospitals. Robots are a strong sign for a hospital's innovation and commitment to efficient and timely use of resources. Yet, robots will become part of the daily rhythm of the hospital—working alongside with clinicians and staff

as well as handling tedious work. Finally, there is an altogether different class of robots that are able to connect with patients with cognitive difficulties in an emotional and meaningful way that is unobtainable with humans.

There is no single, coherent discourse for robots in healthcare. As a case in point, therapy and companion robots are distinctly unique from other robots. Yet, we suspect that these discourses get mixed up and appropriated from one robot form to another. Just as staff may feel that transport robots have a technological otherness (aliens [22]), staff may also believe Paro should be treated as a "blue collar" worker. It remains open whether robotic institutions have succeeded in cultivating (perhaps through design, propaganda, deployment, training, etc.) their "correct" reality of how we ought to perceive each type of robot in its environment.

All these arguments constitute a rich interpretive repertoire that gives the discourse of healthcare robots a remarkable adaptability. Depending on the environment and granularity of the actors (e.g., we see here that organizational issues dominate the miraculous discourse, while individual issues dominate the mundane discourse), this discourse constructs the appropriate reality. We have suggested using our analyses to scaffold a set of critical studies on the *institutions* of robotics. For, while there is a coherent reality constructed by these YouTube videos—robots in healthcare are here to stay, and we must readily embrace them—we ought to study whether this is and should be our reality for the sick, disabled, and disadvantaged and the people and organizations who work with them.

ACKNOWLEDGMENTS

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