Love and Sex with Robots

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R. Nakatsu et al. (eds.), *Handbook of Digital Games and Entertainment Technologies*,
DOI 10.1007/978-981-4560-50-4_15

Abstract

The publication of the book *Love and Sex with Robots*, late in 2007 by David Levy, heralded a new era in this somewhat controversial field. Human-robot intimate relationships were no longer pure science fiction but had entered the hallowed halls of serious academic research. Since then, researchers have come up with many implementations of robot companions like sex robots, emotional robots, humanoid robots, and artificial intelligent systems that can simulate human emotions. This book chapter presents a summary of significant activity in this field during the seven years since that publication and predicts how the field is likely to develop.

Keywords

Love and Sex with Robots • Kissenger • Haptics • Humanoid robots • Human-robot intimate relationships • Lovotics

Introduction

Intimate relationships, such as love and sex, between human and machines, especially robots, has been one of the main topics in science fiction. However, this topic has never been treated in academic areas until recently. The topic was raised and discussed by David Levy in his book titled *Love and Sex with Robots* published in 2007 (Levy 2007b). The book found an eager public in North America who wanted to know more. During the period immediately prior to publication of the book and for a few months afterward, the topic caught the imagination of the media, not just in the USA and Canada but on a worldwide scale. During those months David Levy gave around 120 interviews, by telephone, email, and in person; to newspapers, magazines, radio, and TV stations; and to electronic media. Television interviews included an appearance on The Colbert Report (2008), as well as visits to his home by TV crews from Russia, Canada, Austria, France, Germany, Switzerland, and other countries. There was also, not surprisingly, a flurry of interest from women's magazines, including Elle and Marie Claire. And the coverage in general science publications included articles in *IEEE Technology and Society Magazine*, *MIT Technology Review*, *Scientific American*, and *Wired*.

In the academic world there has already been sufficient coverage of the topic to demonstrate rather convincingly that it is of interest not only for mainstream media.

An academically rewritten version of the book titled *Intimate Relationships with Artificial Partners* (Levy 2007a) also attracted a lot of media publicity. Conferences on robotics, AI, and other computer science-related subjects began to accept and even invite papers on the subject, and there have thus far been two conferences devoted specifically to Human-Robot Personal Relationships. In 2014 the First International Congress of Love and Sex with Robots was held in Madeira. The academic journals that have since chosen to publish papers on the topic have included *Accountability in Research*, *AI & Society*, *Artificial Intelligence*, *Current Sociology*, *Ethics and Information Technology*, *Futures*, *Industrial Robots*, *International Journal of Advanced Robotic Systems*, *International Journal of Social Development*, *International Journal of Social Robotics*, *International Journal of Technoethics*, *New Media and Society*, *Phenomenology and the Cognitive Sciences*, *Philosophy Technology*, *Social Robotics*, *Technological Forecasting and Social Change*, and various publications from the IEEE, Springer, and other highly respected technology stables. One paper, from Victoria University of Wellington, New Zealand, achieved a high profile in the general media when it appeared in 2012 for its entertaining depiction of a future scenario in the red light district of Amsterdam – a life, in 2050, revolving around android prostitutes "who are clean of sexually transmitted infections (STIs), not smuggled in from Eastern Europe and forced into slavery, the city council will have direct control over android sex workers controlling prices, hours of operations and sexual services." (Yeoman and Mars 2011).

Since the initial burst of media interest late in 2007, there have also been TV documentaries and feature movies in which sex with robots, with virtual characters, or with life-sized sex dolls was the dominant theme: Lars and the Real Girl, Meaning of Robots (which had its premiere at the 2012 Sundance Festival), My Sex Robot, Her (2013), and the BBC TV documentary Guys and Dolls as well as the 2004 remake of The Stepford Wives. This points out that it is the sexual nature of the subject matter which is responsible. Sex Sells.

Following the storm of publicity by the launch of the David Levy's book in 2007 (Levy 2007b), the subject of human-robot romantic and intimate relationships rapidly developed into an academic research discipline in its own right. The subject was named "Lovotics," and first mentioned in the literature in 2009 (Nomura et al. 2009). In his PhD thesis in 2011, Adrian David Cheok's student Hooman Samani explored certain aspects of Lovotics and describes the design and development of a hardware platform – a robot – which was capable of experiencing complex and humanlike biological and emotional states that were governed by artificial hormones within its system (Samani 2011). Samani's robot was a novel advanced artificial intelligence system and is described in a little more detail in sections below.

The interest in this field from the academic community resulted, in 2013, in the founding of a journal and e-journal devoted entirely to the subject, whose editor-in-chief is Adrian David Cheok. Lovotics (*Lovotics Journal*) defines its own domain as "Academic Studies of Love and Friendship with Robots" (Fig. 1).

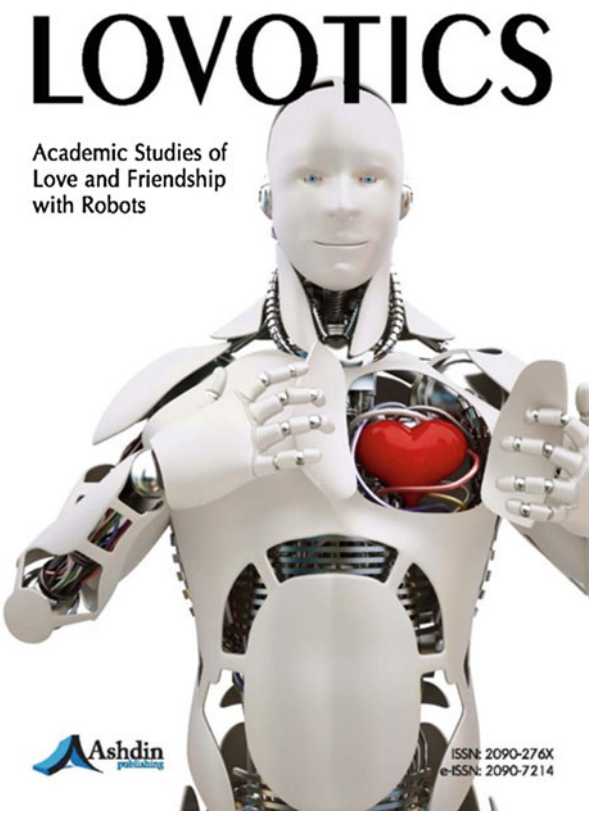

Fig. 1 Journal *Lovotics, Academic Studies of Love and Friendship with Robots*

The First Crude Sex Robot

One of the most often asked questions in media interviews with the David Levy in 2007–2008 was this: "How soon do you think the first sex robots will be on the market?" His consistent response was that the technologies necessary to create a crude sex robot were already available, and therefore it would probably not be more than 2–3 years before some enterprising entrepreneur(s) put these technologies together. For example, a sex doll with certain parts vibrating and some sexy synthetic speech would be a significant step up for those customers who have hitherto purchased just a static sex doll. This applies equally to a malebot as to a fembot – the worldwide commercial success of female vibrators indicates that a male sex doll endowed with a well-designed vibrating penis would be a good start in that direction.

Late in 2009 publicity began to appear in the media about a "sex robot" developed by a New Jersey entrepreneur, Douglas Hines. His Web site www.truecompanion.com proudly proclaimed that:

> We have been designing "Roxxxy TrueCompanion", your TrueCompanion.com sex robot, for many years, making sure that she: knows your name, your likes and dislikes, can carry on a discussion and expresses her love to you and be your loving friend. She can talk to you, listen to you and feel your touch. She can even have an orgasm!

Other amazing claims on the truecompanion.com site included:

> She also has a personality which is matched exactly as much as possible to your personality. So she likes what you like, dislikes what you dislike, etc. She also has moods during the day just like real people! She can be sleepy, conversational or she can "be in the mood!"

and

> Roxxxy also has a heartbeat and a circulatory system! The circulatory system helps heat the inside of her body.

and

> She can talk to you about soccer, about your stocks in the stock market, etc.

For millions of men eagerly awaiting the next major technological development that would enhance their sex lives, the announcements about Roxxxy probably seemed too good to be true. And they were! The press launch of Roxxxy took place at the Adult Entertainment Expo in Las Vegas on January 9th 2010, but it posed more questions than it answered. It appeared, for example, that touching Roxxxy's hand caused it to exclaim that "I like holding hands with you," but what does that prove? Only that an electronic sensor was linked to some sort of recorded sound output. It was not a demonstration of the speech technology that would be needed in a talking conversational robot. And furthermore, Hines's behavior during the demonstration prompted the question – how much of the technology was inside Roxxxy and how much in the computer or whatever electronics were located behind the prototype?

The media hype surrounding Hines's launch in Las Vegas seems to have attracted the attention of many prospective customers for Roxxxy's supposedly seductive charms. At the beginning of February 2010, Hines's Web site started to take orders for Roxxxy, advertising the product at a "sale price" of $6,495, which it claimed represented a reduction of $500. Accompanying the invitation to place an order, the site also presented a "master agreement" that extended to 15 clauses of legalese, covering the purchase of Roxxxy and subscriptions to associated services, but the "returns, refunds and cancellation policy" of that agreement (clause 12.1) made it clear that once production of a customer's Roxxxy commenced, the purchaser could not get any of their money refunded. This begs the question why would any prospective customer be willing to part with their money without any possibility of recovery, when there had been no public demonstration or independent product review of a fully working Roxxxy that could perform as advertised?

Shortly after truecompanion.com started taking orders for Roxxxy, various news sites posted comments such as:

> Roxxxy won't be available for delivery for several months, but Hines is taking pre-orders through his Web site, TrueCompanion.com, where thousands of men have signed up.

Doubts about Roxxxy persist to this day (July 2015). David Levy wrote an exposé entitled "Roxxxy the "Sex Robot" – Real or Fake?" and posted it on www.fembotcentral.com. And the Wikipedia entry for Roxxxy (2012) includes the following:

> According to Douglas Hines, Roxxxy garnered about 4,000 pre-orders shortly after its AEE (*A*dult *E*ntertainment *E*xpo) reveal in 2010. However, to date, no actual customers have ever surfaced with a Roxxxy doll, and the public has remained skeptical that any commercial Roxxxy dolls have ever been produced.

If it is true that Hines received 4,000 preorders, then he would have raked in something over $20 million for those orders, since his Web site demands payment in advance. But as the above extract from the Wikipedia entry indicates, neither Hines himself or any of his customers has demonstrated, in public or to reputable media, the advertised features of Roxxxy actually working. Three years after its "launch," there still appears to be absolutely no sign of a demonstrable product that can talk about Manchester United (as Hines claimed Roxxxy could do) or perform in the other ways that Hines's advertising blurb claimed for Roxxxy.

Despite all the negative aspects of Hines's operation and of the product itself, the launch of Roxxxy at the January 2010 Adult Entertainment Expo can be viewed as some sort of milestone – a vindication of the forecast for a 2–3 year time span from late 2007 to the launch of the world's first commercially available sex robot. Hines has proved that there is indeed a significant level of interest in sex robots from the buying public.

Lovotics

Samani describes the design and development of a robot aimed at imitating the human affection process so as to engender attraction, affection, and attachment from human users toward the robot (Samani 2011). Then Samani summarizes the design of the robot thus:

> The artificial intelligence of the robot employs probabilistic mathematical models for the formulation of love. An artificial endocrine system is implemented in the robot by imitating human endocrine functionalities. Thus, the robot has the capability of experiencing complex and human-like biological and emotional states as governed by the artificial hormones within its system. The robot goes through various affective states during the interaction with the user. It also builds a database of interacting users and keeps the record of the previous interactions and degree of love.

The artificial intelligence of the Lovotics robot includes three modules: the artificial endocrine system, which is based on the physiology of love; the

probabilistic love assembly, which is based on the psychology of falling in love; and the affective state transition, which is based on human emotions. These three modules collaborate to generate realistic emotion-driven behaviors by the robot.

The next four subsections summarize the formulation of love that underpins much of Samani's work, as well as the three software modules of the system mentioned above. The combined effect of these modules is to provide an artificially intelligent model that can display a range of emotions, adjusting its affective state according to the nature and intensity of its interactions with humans. The goal is to develop a robotic system that can exude affection for the user and react appropriately to affection from the user.

The Formulation of Love

The robot's intimacy software employs parameters derived and quantified from five of the most important reasons for falling in love (Levy 2007b): proximity, repeated exposure, attachment, similarity, and attraction. Intimacy in the robot is thereby related to those same factors that cause humans to fall in love. The robot utilizes audio and haptic channels in order to provide these different types of input which communicate the user's emotional state to the robot (Samani et al. 2010). The audio channel carries data for five audio parameters that characterize emotional cues within a human voice. The haptic channel carries data relating to the user touching the robot – the area of contact between robot and human and the force of that touch.

The Lovotics robot includes mathematical models for those five causal factors of love, creating a mathematical formula to represent each factor as well as a single "overall intimacy" formula which combines these five individual formulae into one. As an example of the five models, the proximity formula incorporates various distances between robot and human that indicate, inter alia, how closely the robot and human are to touching each other and how close they are emotionally.

The Probability of Love

The robot algorithm has taken account of the various factors that can engender human love, in order to develop a systematic method for assessing the level of love between a robot and a human. This is achieved by formulating probabilistic mathematical models for these factors, which in turn enable the robot to determine the level of intimacy between humans and robots. These models can be represented in a Bayesian network that depicts the relationship between love and its causal factors. The factors involved in this model include proximity (the physical distance between human and robot), propinquity (spending time with each other), repeated exposure (this can increase familiarity and liking in the other individual), similarity (this is directly related to the feeling of love), etc.

The probabilistic nature of these parameters allows a Bayesian network to be employed to link the parameters to relevant audio, haptic, and location data, leading

to an estimate of the probability of love existing between robot and human. For example, audio proximity is employed in the calculations to emulate the effects of physical distance.

From the various causal parameters, the system calculates the probabilistic parameters of love, resulting in an appraisal of the level of love between human and robot (Samani and Cheok 2010).

The Artificial Endocrine System

The human endocrine system is a system of glands that secretes different types of hormones into the bloodstream. The purpose of those hormones is to maintain homeostasis, i.e., to regulate the internal environment of the body in order to keep certain functions stable, such as body temperature, metabolism, and reproductive functions.

The Lovotics artificial endocrine system is based on the human endocrine system, employing artificial hormones to create a simulation of the human system. The artificial hormones are software simulations of those human hormones which are related to the emotions – dopamine, serotonin, endorphin, and oxytocin, inter alia. The levels of these artificial hormones change dynamically due to the robot's interactions with users and according to its awareness of its emotional and physical circumstances.

The Affective State Transmission System

The affective state of the Lovotics robot depends largely on the various inputs it receives that are caused by its interactions with humans. Every interaction provides input data that is mapped onto a combination of six basic emotional parameters: happiness, sadness, disgust, surprise, anger, and fear. These six emotions are widely employed and described in the emotion literature.

The manner in which the robot's emotional state changes with the various inputs it receives is controlled by a model of emotion referred to as affective state transition (Samani and Cheok 2010). The Lovotics robot has a novel transition system which governs the immediate emotional changes in the robot. Their transition system functions in collaboration with the "probabilistic love assembly" module in order to control the overall emotional state of the robot. The short-term affective state of the robot is thereby transformed repeatedly into other affective states which are determined by the robot's previous affective states, its current mood, and the influences of the various input data it received during its interactions with humans, including audio and touch, and with its environment. For example, temperature could be one environmental input that might be programmed to influence the robot's affective state, if it "dislikes" being cold.

The Kissenger

In order for robots, such as the Lovotics robot, to have realistic physical interactions with humans, technology needs to be developed for human – machine kissing. In order to address this issue, Adrian David Cheok and his research team in Mixed Reality Lab has developed a kissing robot messenger called "Kissenger" (Fig. 2) (Samani et al. 2012).

We live in a global era, and more and more couples and families are apart due to work and business. New technologies are often employed to help us feel connected with those who we care about, through an increasing interest in touch and feeling communication between humans in the human-computer interaction community. Research like "Hugvie" (Kuwamura et al. 2013) and the "Hug over a Distance" project (Mueller et al. 2005) tested the feasibilities of telepresence and intimacy technology. However, these are big, bulky, and impractical.

There is some commercial work like "The HugShirt" (2002) and "Huggy Pajama" (Teh et al. 2008), which explore hugging in remote with love ones using wearable fashion technology. But these still lack a proper interface for "abstracted presence." Thus, Kissenger propose a new system to feel real presence using communication over internet for humans or robots.

Kissing is one of the most important modes of human communication as it conveys intimacy and many deeply feel positive emotions such as respect, greeting, farewell, good luck, romantic affection, and/or sexual desire through the physical joining or touching of lips by one individual on another individual's cheek, forehead, etc. (Millstein et al. 1993).

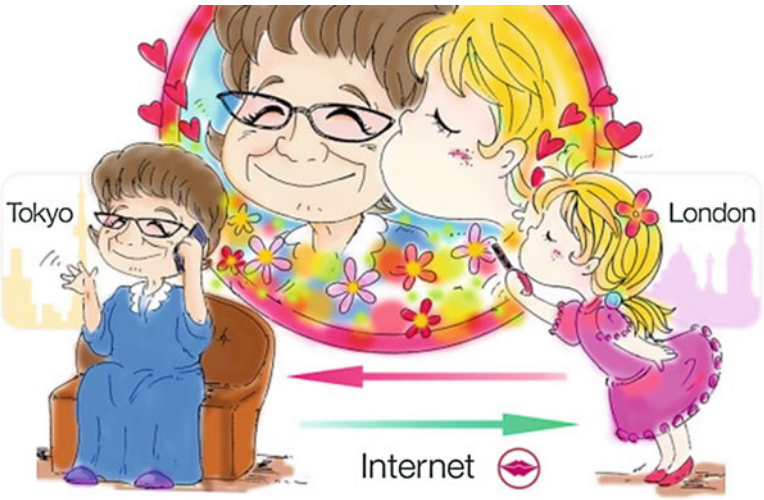

Fig. 2 The concept of kiss communication

The first Kissenger device to be developed by the Lovotics community was unveiled at the Designing Interactive Systems Conference in Newcastle in June 2012 (Samani et al. 2012). Then its development was started in the Mixed Reality Lab under the supervision of Adrian David Cheok. It would be possible to integrate the Kissenger technology into a sex robot but initially its use will be in teledildonic products for enabling lovers to kiss each other via the Internet.

The Kissenger employed soft, pressure-sensitive, vibrating silicone lips which, in the early prototypes, stood out from the surface of a smooth plastic casing shaped somewhat like a human head. Those early prototypes have since been replaced by a version for mobile phones.

When a user kisses the device on its lips, the changes in shape of the lips are detected by sensors and the resulting data is transmitted over the Internet to a receiving Kissenger, which converts the data back to lip shapes. This reproduces the changes in the kisser's lip shape, changes which are felt by the kisser's partner.

The Kissenger technology could perhaps be enhanced with an idea from a rather more ambitious haptic device of the same ilk which has been developed in Tokyo at the Kajimoto Laboratory in the University of Electro-Technology. Their invention is a French-kissing device (Takahashi et al. 2011), whose prototypes are not yet at a stage where they are likely to inspire erotic thoughts, being based on a straw-like tube that moves when in contact with a user's tongue. But we can expect to see an enhanced form of this idea in a future version of the Kissenger and similar inventions – enhancements under consideration at the Kajimoto Laboratory include adding taste, breath, and moistness to the experience.

During a kiss, along with its strong emotional and affectionate connections, a series of physical interactions takes place. The touch of the lips exchanges the pressure, softness, and warmth of each lip in a convincing way. The inventers of Kissenger approached this design problem carefully, given the intimate nature of the interaction and iteratively designed Kissenger which consists of two paired devices that can send and receive kisses simultaneously as shown in concept images of Figs. 3 and 4.

After studying the biological and psychological parameters of a kiss, a series of exploratory form factors were drawn to help visualize the possible interfaces. Figure 5 shows some of our initial concept designs.

At this stage, they looked for designing a system that effectively transmits the same sensation of kiss to one another. The one key issue was that the use of the device should be comfortable and not distract or obstruct the natural interaction of the kiss. Hence, they decided to integrate the initial concept design for a lip-like portable device with a minimalistic shape. However, one of the main concerns was the lip needed to be equipped with sensors and actuators. Hence, they looked into the possible technologies and sizes which could be fit into the form factor of our device. Figure 6 shows the 3D depiction of the proposed device with the new shape which can be attached to a smartphone, allowing a video call and virtual kiss simultaneously.

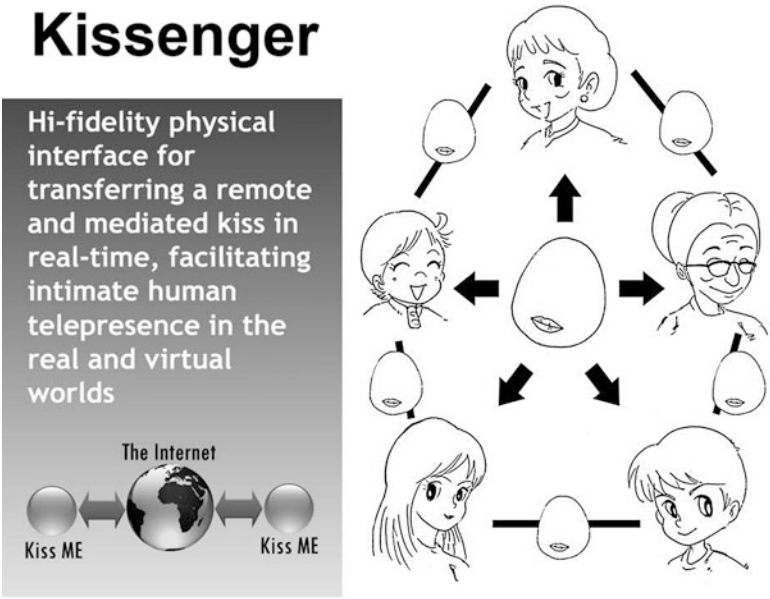

Fig. 3 Kissenger usage scenario A

Design Features

The interaction mechanism for Kissenger was devised with a number of features that make kiss communication between two users more meaningful. The system consists of following key features:

- Lip sensor push and pull reverse feedback for kiss behavior
- Lip rotation force feedback
- Sending scents
- Feeling LED light color communication (red, orange, green, and blue)
- Apps for kiss communication with video chat (Facetime, Google + Hangout, Skype, Facebook, Zoom, etc.)
- Changing the user characters and voices (face images)
- One-to-one pair and one-to-many user connections
- Recording the behavior of the partner's lips
- Scent tank that changes the scent to suit the partners
- Soft silicon cover made with gel for kiss communication

Design Flow

The hardware design of Kissenger with all the features listed above specifies the use of a light feeling sensor, pressure sensors, actuators, a vibration motor, a scent tank, and a smartphone connector in the Kissenger design flow. Their design role is as follows:

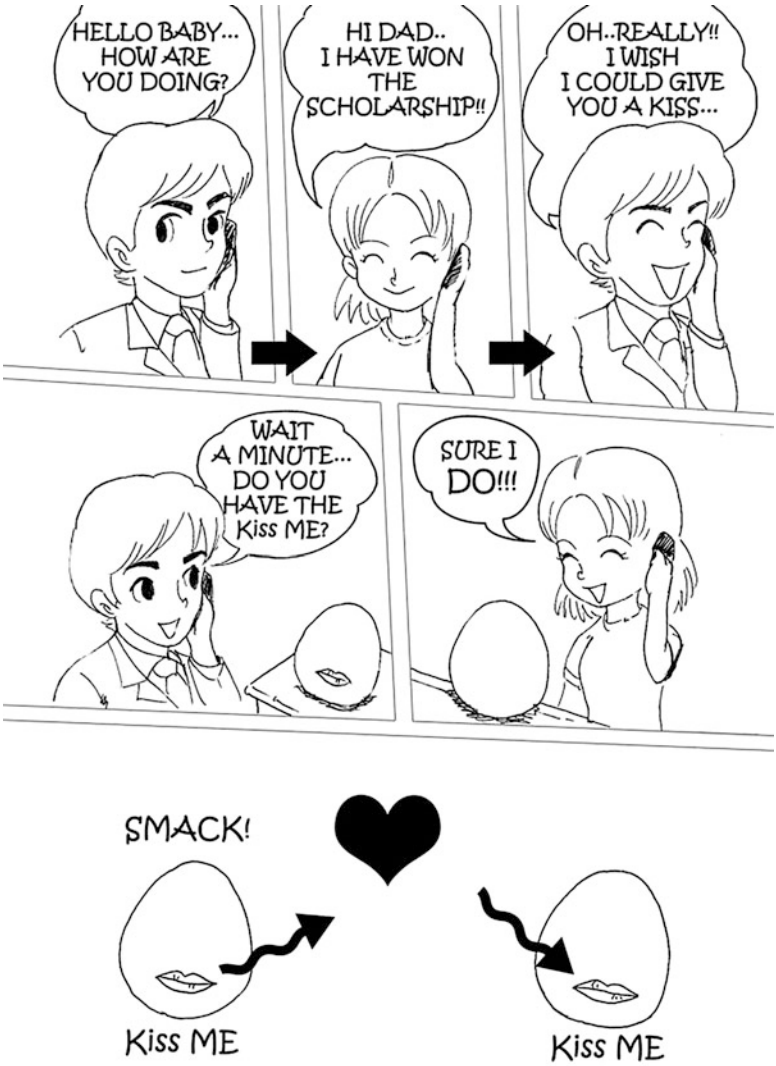

Fig. 4 Kissenger usage scenario B

Input Kiss Sensing

The front of the lip has pressure sensors placed just below the outer surface to initiate the Kissenger for the transmitter (the kissing person) and the receiver (the kissed person) and also to sense varying levels of soft touches. The features for the lip sensor push and pull reverse feedback for kiss behavior as shown in Fig 7.

Upon initialization, the front end of Kissenger can be tilted to a maximum of 18 degrees to replicate different styles of kissing. Thus, this design simplifies the

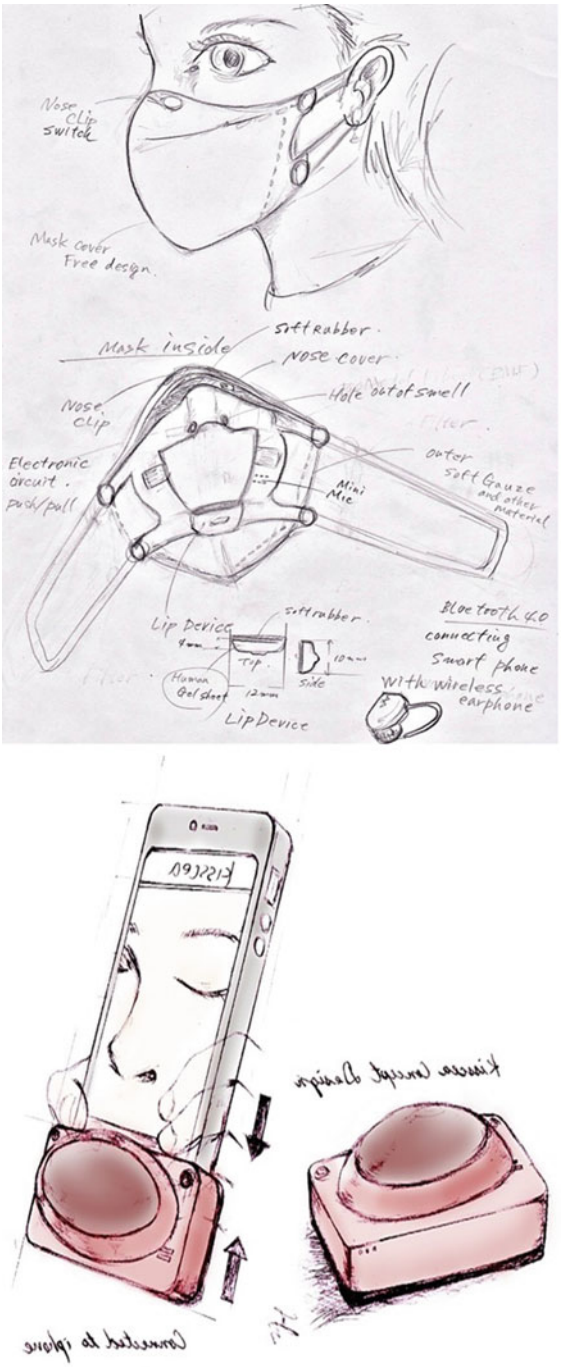

Fig. 5 Preliminary concept designs of Kissenger

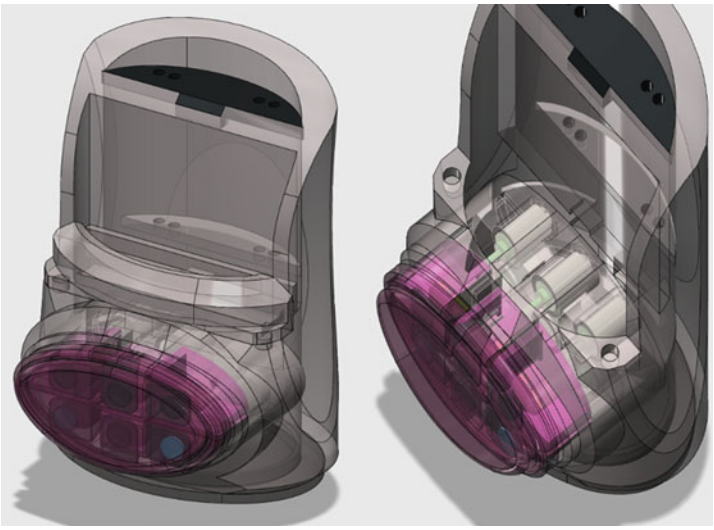

Fig. 6 The new design of Kissenger which can be attached to a mobile phone

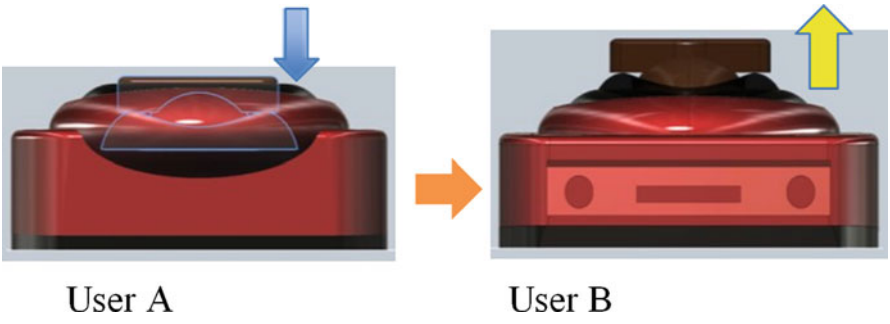

Fig. 7 Lip sensor push and pull reverse feedback for kiss behavior

interface and enables users to form a correct and semantically meaningful mental representation of the system with great feasibility for real kissing. The system also can be used for kissing a robot or a virtual 3D character.

Control and Wireless

Each Kissenger device is equipped with lip sensors (pressure sensor + heat sensor), a scent tank, a smartphone connector, and voice speaker (Fig. 8) connected to an embedded circuit that controls the sensors and actuators with your phone and

Fig. 8 Key design features of Kissenger

thereon with other Kissenger devices through the Internet. Data from the pressure sensors is read continuously until a change is detected. If there is a substantial change, the resulting increase is transmitted wirelessly to a receiver circuit that then actuates a servomotor array to produce similar motion of the lips.

Output Kiss Actuation

The kiss sensation on receiver (the kissed person) is produced through movement of servomotors that distend the surface of the lip. Simultaneously, the scent, LED light feeling sensor, and voice speaker are actuated for pheromone scents, colors to depict different moods, and sounds, respectively (Fig. 9). Pheromones are the scents

LED Color	User's Feeling Image
	Blue: (Chat start) Feeling: Normal Chat Time: 0s~120s Number of Kiss 0 Number of Sent 0
	Green: Feeling: Peace Chat Time: 120s~240s Number of Kiss 1~3 Number of scent 1
	Orange: Feeling: Empathy Chat Time: 240s~300s Number of Kiss 3~5 Number of scent 2
	Red: Feeling: Love (sincerely) Chat Time: 300s~ Number of Kiss 5~ Number of scent 3 more (1/s)

Fig. 9 LED light feeling sensor color depiction

used in Kissenger that are capable of acting outside the body of the secreting individual to impact the behavior of the receiving individual giving the feel of real presence of the partner. The shape and size of the lip covers hide the inner electronics that go into the sensing, control, and actuation of the device. Thus all these features make the user more amicable to this device and help evoke emotional responses and feelings for kiss communication.

Communication

Two or more Kissenger devices are wirelessly connected to each other via the smartphone Kissenger app, which are internally connected to their respective

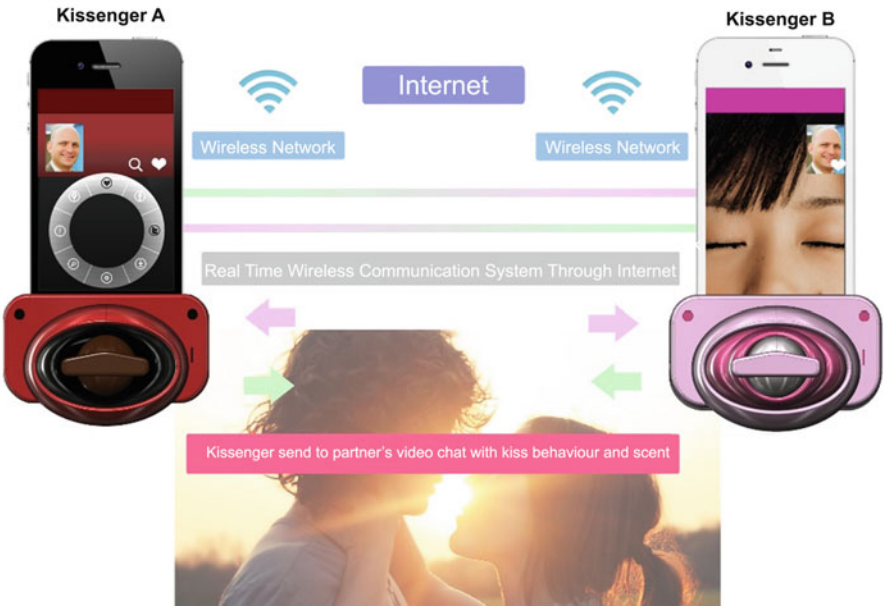

Fig. 10 Kissenger system diagram

smartphones as shown in Fig. 10. One of the unique added features of the app is that it allows one-to-many user communication along with one-to-one user communication as shown in Fig. 11. With the Kissenger app, the user can also actuate and transmit different colors to their partners to depict different moods with different scents, thus giving a real sense of kissing.

An assessment of the new proposed shape and its implementation was conducted with a wide variety of people including researchers not involved in our project, mall shoppers, and friends over a period of time with around fifty people from different cultural backgrounds, age, and sexes who participated in the evaluation process and provided feedback for the proposed shape and features. The major feedback is to integrate the size to make it more portable and user-friendly and provide the room for asynchronous kissing. There is the ability for the device to store a kiss that can be read at a later time on which the researchers will be working in the future for the social impact of this project.

The Ethical and Legal Debate

The ethics of robot sex were first aired in an academic forum at the EURON Workshop on Roboethics in 2006 (Levy 2006a, b, c). The following year this David Levy has discussed five aspects of the ethics of robot prostitution at an IEEE conference in Rome (Levy 2007c): the ethics of making robot prostitutes

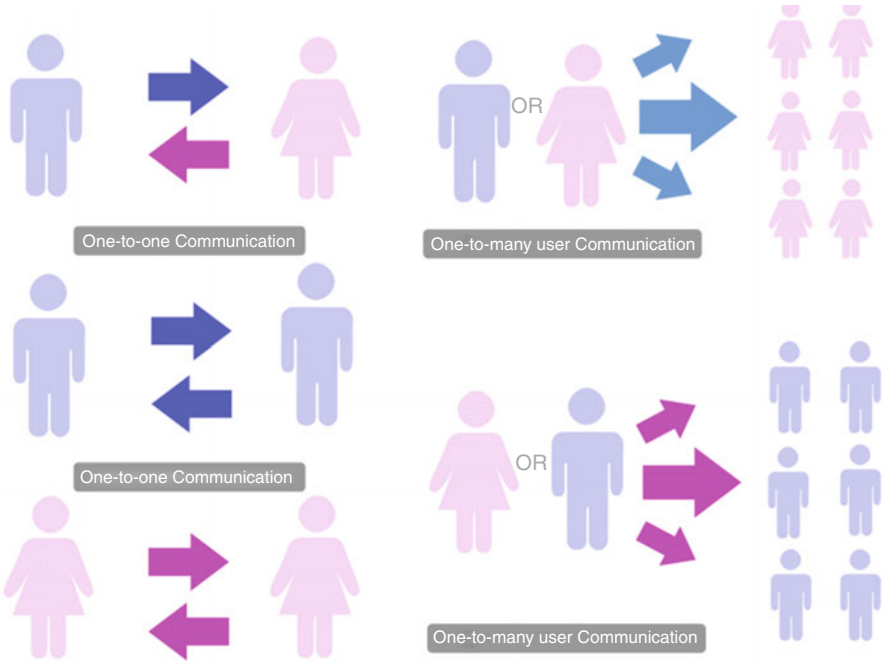

Fig. 11 User communication via Kissenger app

available for general use; the ethics vis à vis oneself and society in general, of using robot prostitutes; the ethics vis à vis one's partner or spouse, of using robot prostitutes; the ethics vis à vis human sex workers, of using robot prostitutes; and the ethics vis à vis the sexbots themselves, of using robot prostitutes. Since the last of these issues is only of significance if robots are eventually developed with (artificial) consciousness, it is also relevant when considering this particular issue to contemplate the ethical treatment in general of artificially conscious robots (Levy 2012).

A somewhat broader airing of the ethical impacts of love and sex machines was presented by John Sullins (2012). Sullins explores the subject partly on the basis that such entities are programmed to manipulate human emotions "in order to evoke loving or amorous reactions from their human users." He submits that there should be "certain ethical limits on the manipulation of human psychology when it comes to building sex robots," and accordingly he identifies three design considerations which he proposes should be applied to the development of robots designed for love: (i) robots should not fool people into ascribing more feelings to the machine than they should; (ii) robot designers should be circumspect in how their inventions exploit human psychology; and (iii) robots should not be designed to intentionally lie to their users in order to manipulate their user's behavior.

A considerably more strident attitude to the ethics of robot sex pervades a 2012 paper by Yusuff Amuda and Ismaila Tijani (Amuda and Tijani 2012), which views

the subject from an Islamic perspective. These authors appear to have no doubts that "having intercourse with robot is unethical, immoral, uncultured, slap to the marriage institution and respect for human being." While many might not concur with the robustness of their position on the subject, it cannot be denied that the question of robot sex within the confines of marriage, or indeed within any existing human sexual relationship, is a serious issue. The question most often asked of the present author in media interviews has been: "Is it cheating for someone who is married or in a committed relationship to have sex with a robot?"

In this author's opinion, the answer is a resounding "no." A partner or spouse who has sex with a robot is no more guilty of cheating on their other half than are any of the tens of millions of women who use a vibrator. But not everyone agrees with this position, and in parallel with the possibility that sex with a robot should be regarded as cheating on one's spouse, there comes an interesting legal question which has been flagged by the California lawyer Sonja Ziaja (2011). Could a sex robot be legally regarded as the enticing protagonist in a law suit brought for the enticement of one's spouse? In the eight states of the USA where this type of law is still on the statute books, where they are called amatory or "heart balm" laws, Ziaja questions whether a sex robot could be held to be the cause, or a contributing cause, to the breakdown and dissolution of a marriage, and if so, who should be held legally liable to pay whatever damages a court might assess? Ziaja suggests a few obvious possible culprits for cases of enticement by a robot: the robot's inventor, its manufacturer, its owner, or even the robot itself. But the attribution of liability for a wrong wrought by a robot is an extremely complex issue, one which this author believes will not be adequately solved in the foreseeable future. Instead it has been suggested (Levy 2012) that robot wrongs could be compensated by an insurance scheme, much akin to that which works well for automobiles and other vehicles.

The only form of punishment considered by Ziaja for transgressing the American heart balm laws is to compensate the plaintiff, which is a notion that pales into insignificance when compared to the punishments discussed by Amuda and Tijani. They point out that, under Sharia law, judges are permitted to invoke lashes or even capital punishment for having sex with a robot, provided there is sufficient credible evidence of the crime (Ziaja 2011). "To this study, death penalty by hanging may not be applicable and implemented unless there are enough and credible evidences to justify the death by hanging of robot fornicator or adulterer."

Ziaja's paper largely avoids discussing punishment in relation to enticement cases in which a robot is the protagonist, preferring to prevent the problem from occurring by having robots designed in such a way as to incorporate feelings of heartbreak together with the goal of caring for those in its owner's circle of friends and relatives. "In order for robots to enter into human romantic relationships in a way that is consistent with the values underlying the heart balm torts, it may also need to experience heartache and empathy as we do." Ziaja's position thus supports that of John Sullins.

An in-depth consideration of whether or not human-humanoid sexual interactions should be legally regulated was discussed by Anna Russell in *Computer Law & Security Review* (Russell 2009). The very fact that such a discussion should appear in the pages of a respected legal journal points to the seriousness with which

the legal profession is viewing the legal implications of the human-robot relationships of the future. Russell suggests that:

> Regulation of human-humanoid sexual interaction either by the state or federal government (In the USA.) will be sought when the level of interaction either (1) mimics human sexual interactions currently regulated or (2) will create a social harm if the interaction is not regulated. . . currently, in places where humans are using robots for pleasure in a sexual way that pleasure is either not regulated or is regulated in the way the use of any sexual device may be regulated" but that when more advanced robots – humanoids – are used for sexual pleasure, "then in many places, traditional norms and social mores will be challenged, prompting the development of state regulation. Will such regulation, then, be at odds with accepted notions of rights and freedoms?

Russell then delves further into the question of how regulation of human-humanoid sexual encounters would work and highlights some of the questions that will arise, including:

> How many rights will humans allow if humanoids clamor for sexual freedoms? How will humanoids be punished for sexual transgressions? Will humanoids need legal protection from the abuse of human sexual proclivities?

Russell's conclusion is a call for the:

> . . .early discussion of the ramifications of a future species' demand for legal rights. . . the legal profession should develop legal arguments before attest case occurs in order to avoid the illogic and danger of arguments that stem from species bias.

In 2011 the *MIT Technology Review* conducted a poll on people's attitudes to the idea of loving a robot. 19 % of those questioned indicated that they believed they could love a robot, 45 % said "no," and 36 % responded "maybe." When it came to a question of whether or not people believed that robots could love humans, 36 % said "yes," only 23 % responded "no," and 41 % said "maybe." So already the idea of human-robot love was taking root as a serious proposition.

In a later poll about robot sex rather than robot love, which was conducted in February 2013 by The Huffington Post and YouGov among 1,000 American adults, 9 % of respondents indicated that they would have sex with a robot and 42 % opined that robot sex would constitute cheating on one's human partner (31 % said "no" to the cheating question, while 26 % said they were uncertain). This can be taken as further evidence that a significant portion of the population already regards robot sex as a serious subject. Just how serious can perhaps be judged by a news story that hit the media in March 2013 about an online auction for the virginity of a Brazilian sex doll called Valentina (Gates, 26) which was inspired by a 20-year-old Brazilian woman, Catarina Migliorini, who had auctioned her own virginity for $780,000 (sold to a Japanese buyer). True, a sex doll is only an inanimate product, lacking all the interactive capabilities of the sex robots of the future. But the level of interest demonstrated by this news story bodes well for the commercial possibilities of sex robots.

For the Brazilian sex doll auction, the online retailer Sexônico offered a complete "romantic" package for the successful bidder, which included a one-night stay with Valentina in the Presidential Suite at the Swing Motel in Sao Paulo, a candlelit champagne dinner, an aromatic bath with rose petals, and a digital camera to capture the action. If the successful bidder lived outside Sao Paulo, Sexônico also offered to provide a round-trip air ticket. Valentina's charms were not able to match the great commercial success of Ms Migliorini, but considering that most sex dolls retail at prices in the range $5,000–$10,000, the final bid of $105,000 was still a good result for Sexônico, not to mention the value of all the media exposure they attracted.

Robot Love

In parallel with the developments we have discussed in the field of robot sex and teledildonics, there is a continuing and burgeoning research interest in robot love. Among the fundamental conditions for engendering human love, physical appearance and attractiveness rank highly. The translation of these conditions to the field of robotics has a champion in Professor Hiroshi Ishiguro, whose research teams are based at the Graduate School of Engineering Science at Osaka University and at the Hiroshi Ishiguro Laboratory in the Advanced Telecommunications Research Institute International in Kyoto.

Ishiguro is famous for, inter alia, the amazingly lifelike robots he has developed in various human images (Hofilena 2013). These include one in his own image which is sometimes sent to deliver his lectures when he is too busy to do so himself. Another of his robots, called "Geminoid F" (Fig. 12), is made in the image of an attractive young woman who can blink, respond to eye contact, and recognize and respond to body language (Torres 2013). Ishiguro is encouraged in this aspect of his work by his conviction that Japanese men are more prone than are western men to develop amorous feelings toward such robots because, in Japan, with the influence of the Shinto religion, "we believe that everything has a soul and therefore we don't hesitate to create human-like robots."

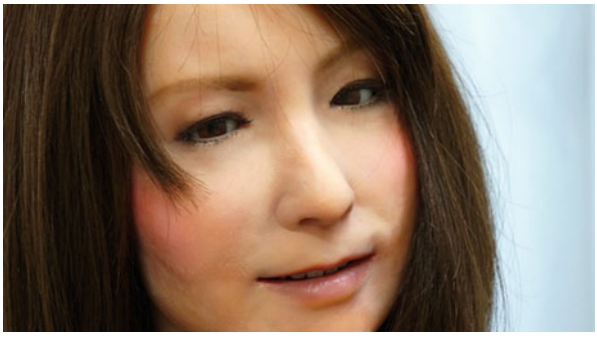

Fig. 12 "Geminoid F" robot (Countdown.org, 2015)

Another strand of Ishiguro's research into artificially engendering feelings of love in humans is concerned with promoting romantic forms of communication. The "Hugvie" (2011) is a huggable pillow, shaped in a somewhat human form, that is held by a user close to their body while they speak to their human partners via their mobile phone, located in a pocket in the Hugvie's head. (The Hugvie project grew out of an earlier Ishiguro project called "Telenoid.") The Hugvie incorporates a vibrator to simulate a heartbeat, and the vibrations emanating from it are synchronized with the sounds of the partner's voice. This allows the simulated heartbeat to be changed according to the volume of the partner's voice, with the result that the listening user feels as though they are close to their partner. The comfort felt by holding the cushion, the sense of hugging one's partner, hearing one's partner's voice close to one's ear, and the simulated heartbeat aligned with that voice, all these combine to create a sense that the partner is in some way present, which in turn intensifies the listener's feelings of emotional attraction for their partner. Ishiguro expects this intensified affinity to increase the sense of intimacy between couples who are communicating through their respective Hugvies. Ishiguro shared in a breakthrough study that the Hugvie could decrease blood cortisol levels, therefore reducing stress (Sumioka et al. 2013). Integrating the Hugvie technology into the design of an amorous robot might therefore enable a human user of such a robot to experience an enhanced feeling of a humanlike presence and a greater sense of intimacy from and for the robot.

Yet another direction of Ishiguro's research into having a robot engender emotions in humans is his investigation of the emotional effects, on a human user, of different facial expressions exhibited by a robot (Nishio et al. 2012). That research is currently in its early stages, but there is already some indication that it will be possible for robots, by their own facial expressions, to affect a user's emotional state. Emotional facial expression is also a hot topic at the MIT Media Lab, where the Nexi robot was developed (Allman 2009).

Predictions

Robot Sex

Clearly a significant sector of the public is now ready for the advent of commercially available sex robots, and the public's interest in and appetite for such products seems to be growing steadily. We have noticed a steady increase in the number of requests for media interviews on the subject during the past two years. Also growing steadily is the interest within the academic research community.

In our opinion nothing has occurred since the publication of *Love and Sex with Robots* to cast doubt on his 2007 prediction that sophisticated sex robots would be commercially available by the middle of this century. On the contrary, the increase in academic interest in this field has reinforced David Levy's conviction regarding that time frame.

What will be the next significant steps in this field? Intelligent electronic sex toys are gaining in popularity, for example, the SaSi Vibrator, which "comes pre-loaded with

sensual intelligence which learns movements you like, specifically tailoring a unique experience by remembering movements that suit you," and the "Love Glider Penetration Machine" which can be purchased from Amazon.com at around $700 and which is claimed to "give you the most comfortable stimulating ride you will ever have!" The Amazon Web site also offers a very much more primitive looking sex machine at around $800, a machine of the type seen in many variations on the specialist site www.fuckingmachines.com, which "supports multiple positions and has adjustable speeds, strong power, and remote control." (The sole review on Amazon.com as of May 2013 suggests that this product is poorly made and describes it as "a piece of junk.")

Another research direction that perhaps offers even greater commercial potential comes from a combination of augmented reality with digital surrogates ("dirrogates") of porn stars. A recent (June 2013) posting by Clyde DeSouza (2013) posits that the 3D printing of human body parts will enable the downloading, from "hard-drives in Hollywood studios" of "full body digital model and "performance capture" files of actors and actresses." DeSouza continues:

> With 3D printing of human body parts now possible and blue prints coming online with full mechanical assembly instructions, the other kind of sexbot is possible. It won't be long before the 3D laser-scanned blueprint of a porn star sexbot will be available for licensing and home printing, at which point, the average person will willingly transition to transhuman status once the 'buy now' button has been clicked.
>
> If we look at Digital Surrogate Sexbot technology, which is a progression of interactive porn, we can see the technology to create such Dirrogate sexbots exists today, and better iterations will come about in the next couple of years. Augmented Reality hardware when married to wearable technology such as 'fundawear' (2013) and a photo-realistic Dirrogate driven by perf-captured libraries of porn stars under software (AI) control, can bring endless sessions of sexual pleasure to males and females.

Fundawear is a prime example of the increase in popularity of intelligent electronic sex toys and teledildonic devices. It is a wearable technology project currently under development by the condom manufacturer Durex, which allows lovers to stimulate their partner's underwear via their respective mobile phones. Such products seem likely to benefit from the increased academic interest in Lovotics, which will surely lead to at least some of the academic research in this field being spun off into commercial development and manufacturing ventures. And the more prolific such products become in the market place, the more the interest in them and in fully fledged sex robots will grow. How long will it be before we see a commercially available sexbot much more sophisticated than Roxxxy? Almost certainly within the next five years.

Robot Love

The past five years has seen a surge of interest in research projects aimed at different aspects of love with robots. One aspect is concerned with enabling humans to convey amorous feelings to artificial partners or to remotely located human partners with whom they communicate by artificial means (i.e., technology). Another aspect works

in the opposite direction, enabling artificial partners to exhibit their artificial feelings, including love, to human partners. Some of this research has already demonstrated promising results, for example, the experiments conducted with Hugvie by Ishiguro and his team in Japan. They plan further research with the Hugvie to investigate how vibration can further enhance the feeling of presence experienced by a user. Additionally they plan to employ tactile sensors to monitor the emotional state of a user, which will provide feedback for the Hugvie and thereby enhance its ability to influence a user's emotions. Ishiguro's team has already found that hugging and holding such robots "is an effective way for strongly feeling the existence of a partner."

Another domain to become an important catalyst for the development of human-robot emotional relationships is what might be called girlfriend/boyfriend games. An example of this type of game is "Love Plus," which was first released in 2009 for the Nintendo DS games console and subsequently upgraded for re-release. A recent (February 2013) article describes the relationship between a 35-year-old Tokyo engineer, Osamu Kozaki, and his girlfriend Rinko Kobayakawa (Belford 2013). When she sends him a message:

> . . .his day brightens up. The relationship started more than three years ago, when Kobayakawa was a prickly 16-year-old working in her school library, a quiet girl who shut out the world with a pair of earphones that blasted punk music.

Kozaki describes his girlfriend's personality as being:

> . . .the kind of girl who starts out hostile but whose heart gradually grows warmer. And that's what has happened; over time, Kobayakawa has changed. These days, she spends much of her day sending affectionate missives to her boyfriend, inviting him on dates, or seeking his opinion when she wants to buy a new dress or try a new hairstyle.

But while Kozaki has aged, Kobayakawa has not. After three years, she's still 16. She always will be. That's because she is a simulation; Kobayakawa only exists inside a computer.

Kozaki's girlfriend has never been born. She will never die. Technically, she has never lived. She may be deleted, but Kozaki would never let that happen.

Because he's "in love."

Conclusion

In this chapter, we discussed about the possibility of human-robot intimate relationships and humanoid robot sex. We detailed Lovotics, which is a new research field that study emotions of robots with an artificial endocrine system capable of simulating love. We also presented the design and principle of Kissenger, an interactive device that provides a physical interface for transmitting a kiss between two remotely connected people. Finally we have discussed ethical and legal background and future predictions of love and sex with robots.

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