A survey on the latest types of Humanoids and its Applications

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***Abstract*— In the past, we only know robots that looked like a machine. Well nowadays, with the contribution of robots in our life and technological development, we can find many robots that look like human. Humanoid robotics can be said as the most complex robot types because the robots are completed with various components and programs so it can imitate human perfectly. Currently humanoid robots are being implemented in a wide range of industries. The most common place to find humanoid robots is in the entertainment industry. In present time robots has go into a wide development and innovation for real life needs. Depending on the applications a wide variety of humanoids have being developed in the field of space exploration, military, agriculture, construction and manufacture, education, sports, medical, research, entertainment etc. The new applications will require social interaction between humans and robots. If a robot is able to analyze and synthesize speech, eye movements, mimics, gestures, and body language, it will be capable of intuitive communication with humans. Last, but not least, humanoid robots are used as a tool to understand human intelligence. A detailed survey on the current types of humanoid based on its application is dealt in this paper. This is a complete paper on humanoid robotics.**

IndexTerms*—Humanoids, Gestures.(keywords)*

I. INTRODUCTION

Humanoid robots, robots with an anthropomorphic body plan and human-like senses, are enjoying increasing popularity as research tool. More and more group worldwide work on issues like bipedal locomotion, dexterous manipulation, audio-visual perception, human-robot interaction, adaptive control, and learning, targeted for the application in humanoid robots. These efforts are motivated by the vision to create a new kind of tool: robots that work in close cooperation with humans in the same environment that we designed to suit our needs. While highly specialized industrial robots are successfully employed in industrial mass production, these new applications require a different approach: general purpose humanoid robots.

The human body is well suited for acting in our everyday environments. Stairs, door handles, tools, and so on are designed to be used by humans. A robot with a human-like body can take advantage of these human-centered designs. The new applications will require social interaction between humans and robots. If a robot is able to analyze and synthesize speech, eye movements, mimics, gestures, and body language, it will be capable of intuitive communication with humans. Most of these modalities require a human-like body plan. A human-like action repertoire also facilitates the programming of the robots by demonstration and the learning of new skills by imitation of humans, because there is a one-to-one mapping of human actions to robot actions. Last, but not least, humanoid robots are used as a tool to understand human intelligence. In the same way biomimetic robots have been built to understand certain aspects of animal intelligence, humanoid robots can be used to test models of aspects of human intelligence.

Today's humanoid robots display their capabilities in tasks requiring a limited subset of skills. After some brief historical notes, this article will review the state of art, the various applications and discuss possible future developments..

II. HISTORY

The concept of human-like automatons is nothing new. Already in the second century B.C., Hero of Alexander constructed statues that could be animated by water, air and steam pressure. In 1495 Leonardo da Vinci designed and possibly built a mechanical device that looked like an armoured knight. It was designed to sit up, wave its arms, and move its head via a flexible neck while opening and closing its jaw. By the eighteenth century, elaborate mechanical dolls were able to write short phrases, play musical instruments, and perform other simple, life-like acts. In 1921 the word robot was coined by Karel Capek in its theatre play: R.U.R. (Rossum's Universal Robots). The mechanical servant in the play had a humanoid appearance. The first humanoid robot to appear in the movies was Maria in the film Metropolis (Fritz Lang, 1926). Westinghouse Electric Corporation exhibited at the 1939 and 1940 World's Fairs the tall motor man Elektro. Humanoid in appearance, it could drive on wheels in the feet, play recorded speech, smoke cigarettes, blow up balloons, and move its head and arms. Elektro was controlled by 48 electrical relays and could respond to voice commands.

Humanoid robots were not only part of the western culture. In 1952, Ozamu Tezuka created Astroboy, the first and one of the world's most popular Japanese sci-fi robots. In 1973 the construction of a human-like robot was started at the Waseda University in Tokyo. Wabot-1 was the first full-scale anthropomorphic robot able to walk on two legs. It could also communicate with a person in Japanese and was able to grip and transport objects with touch-sensitive hands. The group of Ichiro Kato also developed Wabot-2, which could read music and play an electronic organ. It was demonstrated at the Expo

1985 in Tsukuba, Japan. Wabot-2 was equipped with a hierarchical system of 80 microprocessors. Its wire-driven arms and legs had 50 degrees of freedom.

Many researchers have also been inspired by the movie Star Wars (George Lucas, 1977) which featured the humanoid robot C3-PO and by the TV series Star Trek - The Next Generation (Gene Roddenberry, 1987) which featured the humanoid Data. In 1986 Honda began a robot research program with the goal that a robot "should coexist and cooperate with human beings, by doing what a person cannot do and by cultivating a new dimension in mobility to ultimately benefit society. After ten years of research, Honda introduced in 1996 P2 to the public, the first self-contained full-body humanoid. It was able to walk not only on flat floors, but could also climb stairs. It was followed in 1997 by P3 and in 2002 by Asimo. In the U.S. Manny, a full-scale android body was completed by the Pacific Northwest National Laboratory in 1989. Many had 42 degrees of freedom, but no intelligence or autonomous mobility. Rodney Brooks and his team at MIT started in 1993 to construct the humanoid upper-body Cog. It was designed and built to emulate human thought processes and experience the world as a human. Another milestone was the Sony Dream Robot, unveiled by Sony in the year 2000. The small humanoid robot, which was later called Qrio, was able to recognize faces, could express emotion through speech and body language, and could walk on at as well as on irregular surfaces. More recent examples of humanoid robot appearances in the movies include David from A.I. (Steven Spielberg, 2001), and NS-5 from I, robot (Alex Proyas, 2004).

III. State Of Art

Although, from the above, it may seem that the most important issues for construction and control of humanoid robots have been solved; this is not at all the case. The capabilities of current humanoid robots are rather limited, when compared to humans.

A. *Bipedal Locomotion*

The distinctive feature of full-body humanoids is bipedal locomotion. Walking and running on two legs may seem simple, but humanoid robots still have serious difficulties with it. There two opposing approaches to bipedal walking. The first-one is based on the zero-moment-point theory (ZMP), introduced by Vukobratovic [1]. The ZMP is defined as the point on the ground about which the sum of the moments of all the active forces equals zero. If the ZMP is within the convex hull (support polygon) of all contact points between the feet and the ground, a bipedal robot is dynamically stable. The use of the ZMP to judge stability was a major advance over the center-of-mass projection criterion, which describes static stability. Prominent robots, which rely on ZMP-based control, include Honda Asimo and Sony Qrio. Asimo was shown in 2006 to be capable of 6km/h running. However, its gait with bent knees does not look human-like. It does not recycle energy stored in elastic elements, the way humans do it and, hence, it is not energy efficient. Furthermore, Asimo requires flat, stable ground for walking and running and can only climb certain stairs.

B. *Perception*

Humanoid robots must perceive their own state and the state of their environment in order to act successfully. For proper perception, the robots measure the state of their joints using encoders, force sensors, or potentiometers. Important for balance is the estimation of the robot attitude. This is done using accelerometers and gyroscopes. Many humanoid robots also measure ground reaction forces or forces at the hands and fingers. Some humanoid robots are covered with force-sensitive skin. One example for such a robot is CB2 [7], developed at Osaka University.

C. *Human-Robot Interaction*

Many humanoid research projects focus on human-robot interaction. The general idea here is that the efficient techniques which evolved in our culture for human-human communication allow also for intuitive human-machine communication. This includes multiple modalities like speech, eye gaze, facial expressions, gestures with arms and hands, body language, etc. These modalities are easy to interpret by the human sensory system. Because we practice them since early childhood, face recognition, gesture interpretation, etc. seem to be hard wired in our brains. A smile from a robot does not need much explanation. In order to address these modalities, communication robots are equipped with expressive animated heads. Examples include Kismet and Leonardo, developed at MIT [11, 12], and WE-4RII developed at Waseda [13]. Movable eyes, head, and chests communicate where the robot focuses its attention. When the robot looks at the interaction partner, the partner feels addressed. Some robots animate their mouth while generating speech. This helps the listener to detect voice activity. Some robots have an emotional display. By moving eyebrows, eyelids, the mouth, and possibly other parts of the face, a number of basic emotions can be expressed. The expression of the emotional state can be supported by adapting pitch, loudness, and speed of the synthesized speech.

D. *Dexterous Manipulation*

Another key human capability is dexterous manipulation. The human hand has about thirty degrees of freedom. It is not easy to reproduce its strength, flexibility, and sensitivity. Among the most advanced robotic hands are the Shadow hand, which is driven by 40 air muscles [21] and the four finger hand developed by DLR and HIT [22]. Dexterous manipulation not only requires capable hands, but also hand-arm coordination and the coordination of two hands and the vision system. Due to the high number of joints involved, controlling grasping and manipulation is challenging.

E. *Learning And Adaptive Behaviour*

To be useful in everyday environments, humanoid robots must be able to adapt existing capabilities and need to cope with changes. They are also required to quickly learn new skills. Fortunately, humanoid robots have the unique possibility to learn from capable teachers, the humans in their environment. This is called imitation learning [25] or programming by demonstration [26]. Imitation learning has been applied, for example, to complex motions like swinging a tennis racket or generating gestures [27] and to manipulation tasks. One difficulty of imitation learning is the perception of the teacher. Frequently, external motion capture systems relying on special markers or attached motion sensors are used to sense the motion of the teacher.

IV. Types Of Humanoids Based On Specific Applications

Because the capabilities of humanoid robots are rather limited, there are few real-world applications for them so far. The most visible use of humanoid robots is technology demonstration.

A. Technology Demonstration

Famous humanoid robots like the Honda Asimo [32] or the Toyota Partner Robots [33] do not accomplish any useful work. They are, however, presented to the media and demonstrate their capabilities like walking, running, climbing stairs, playing musical instruments or conducting orchestras on stage and during exhibitions. Such a showcase of corporate technology attracts public attention and strengthens the brand of the car manufacturers. Hence, the huge development costs of these advanced humanoids might be covered from the marketing budgets.

B. Space Missions

Another area where money is not much of an issue is missions to space. Since human life support in space is costly and space missions are dangerous, there is a need to complement or replace humans in space by human-like robots. The two prominent projects in this area are the NASA Robonaut [9] and DLR's Justin [23]. Both use a humanoid torso mounted on a wheeled base. The humanoid appearance of the robots is justified, because they can keep using space-certified tools which have been designed for humans and because the humanoid body makes teleoperation by humans easier.

C. Manufacturing

While in industrial mass production robot arms are used which are not anthropomorphic at all, the Japanese company Yaskawa sees a market for human-like dual-arm robots in manufacturing. It recently announced the Motoman-SDA10 robot [34] which consists of two 7DOF arms on a torso that has an additional rotational joint. Each arm has a payload of 10kg. Yaskawa aims to directly replace humans on production lines. The robot is able to hold a part with one arm while using a tool with the other arm. It can also pass a part from one arm to the other without setting it down. Sales target for the SDA10 is 3000 units/year.

D. General-Purpose

General-purpose humanoid robots can perform a variety of tasks autonomously. They are useful because they typically can navigate independently in known spaces, handle their own re-charging needs, and interface with electronics, networks, software and accessories. They may recognize people or objects, talk, translate, provide companionship, monitor environmental quality, respond to alarms, pick up supplies and perform other useful tasks. Because these robots mimic human beings and even resemble people in appearance, humanoid robots and androids are able to interact socially, intellectually and emotional with people. This can be useful to the young and old alike, in such roles as elderly care, babysitters, tutors, entertainers and companions. And for the disabled and blind, an intelligent robot companion will be indispensable. Domestic androids are perhaps also not too far in the future.

E. Household

An obvious domain for the use of humanoid robots is the household. Some humanoid projects explicitly address this domain. They include the Armar [35] series of robots developed in Karlsruhe, Twendy-One developed at Waseda University, and the personal robot PR1 [10] developed in Stanford. While these robots demonstrate impressive isolated skills needed in a household environment, they are far from autonomous operation in an unmodified household.

F. Hazardous Jobs

Humanoid robots will perform tasks where no human can safely go, such as dangerous explorations, both here on earth and in space. NASA has already sent the first humanoid robot into space. It’s a 330-pound humanoid robot called Robonaut 2 (“R2″) that may eventually go to the moon. R2 is designed to help astronauts perform tedious and dangerous missions, including vacuum outside air filters, do space walks, flip switches, and go into dangerous toxic environments. The day may perhaps also come where they will take over hazardous jobs such as in nuclear power plants.

G. Military And Law Enforcement

Military, security and law enforcement applications for robots that look and act like humans are plentiful and research and development in this are continues. If we can remove human soldiers, fireman and police officers completely from harm’s way it would be a great achievement. Smash Super-Tough Robot Arm, the most advanced and tough robotic arm ever. It's called the DLR Hand Arm System. It has an anthropomorphic design and packs 52 motors, ultra-miniaturized control electronics, a super capacitor-based power supply, and a web of synthetic tendons stronger than Kevlar. What makes it stand out compared to conventional systems is its ability to withstand collisions, due to ingeniously designed joints and actuators that can absorb and dissipate energy, much like our own arms and hands do. Markus Grebenstein, the Hand Arm System's lead designer, tells me that robustness is essential if we want to deploy service robots in the real world, where collisions are likely to happen. Even small shocks, he says, can damage conventional robots, which rely on motors coupled to joins in mechanically stiff configurations.

H. Agriculture

Imagine old McDonald replacing his hired help and many of his equipment with a humanoid robot that will work tirelessly 365 days a year! Production will increase dramatically.

I. Construction And Manufacture

Humanoid robots will take over many of the most hazardous and mundane jobs in manufacturing and construction. Anthropomorphic robots with hands like humans will be used for factory jobs.

J. Education

Ever get that feeling your kids aren't paying attention to what you're trying to teach them? Well, maybe they'll listen better to their robot teacher! And instead of having several different human teachers for different subjects, one humanoid robot (that never gets tired or asks for a pay rise) could master and teach all those disciplines, and more.

K. Sports

RoboGames is the world's largest open robot competition, in which competitors from all over the world compete in over fifty different events, including combat robots, walking humanoids, soccer bots, sumo bots, and more. And RoboCup is an international robotics competition that aims to develop autonomous soccer robots with the intention of promoting research and education in the field of artificial intelligence.

L. Medical

Humanoid robots can be used for medical research and training. Better to practice your surgery skills on a human-like machine, than make a deadly or costly slip up with a real patient. Androids that mimic the human body are also ideal in medical education. Humanoid nurses will take care of patients and routine tasks. And since robots can perform more accurate and precise actions, they will also be ideal to perform very delicate surgery.

M. Entertainment

Robots that act and perform like humans are already a reality. Humanoid robots can and will be used in the place of human actors and entertainers. They will never be late or sick, or make excessive demands on the director and they'll be cheaper. These robotic actors and stage performers will also give consistently good performances, day after day.

Affetto, a child robot born to Osaka University researchers, is capable of making realistic facial expressions so that humans can interact with it in a more natural way. Nao is a little French humanoid created by Aldebaran Robotics, in Paris. It talks, tracks faces, and with 25 degrees of freedom, it can perform Michael Jackson choreography and Darth Vader impressions. The French firm has been developing Nao over the past five years, turning an initially obscure robot with a quirky name into a widely adopted research and education platform used to study human-robot communication, help treat hospitalized children, and play soccer. The Nao shows off Michael Jackson moves, doing Star Wars impressions, and performing an eight minute synchronized dance choreography. Nexi is the size of a 3-year-old child and was conceived at MIT's Media Lab. With a 15-degrees-of-freedom face, this little social bot can show you when it's happy, sad, mad—or bored.

N. Robot Competitions

A currently more viable application for humanoid robots is robot competitions. RoboCup and FIRA, for example, feature competitions for humanoid soccer robots. These robots are fully autonomous and play together as a team. When they fall, they get up by themselves and continue playing. The participating research groups either construct their own robots or they use commercial humanoid robot kits available, e.g., from Robotis and Kondo. RoboCup also selected the Aldebaran Nao humanoid robot as successor of the Sony Aibo in the Standard Platform League. Another popular competition for humanoid robots is Robo-One, where teleoperated robots engage in martial arts.

V. WHY WE SHOULD BUILD HUMANLIKE ROBOTS?

People often ask why to build humanlike robots. Why make robots that look and act like people? Why can't robots be more like appliances? On the tree of robotic life, humanlike robots play a particularly valuable role. It makes sense. Humans are brilliant, beautiful, compassionate, loveable, and capable of love, so why shouldn't we aspire to make robots humanlike in these ways? Don't we want robots to have such marvelous capabilities as love, compassion, and genius?

VI. *FUTURE OF HUMANOID ROBOTS*

Talking of robots there is always a new improvements and also new technology that are will be a great advantage to human life. Robots have wide usage in our life. In medication technology for examples, doctors are using robotic arm to help them during a delicate surgery that will need a precise movement and does not tolerate any minor mistakes. Police officers are also using robot technology to help them while conducting life risk job, defusing a bomb for example. There are many types of robots that are used in our life, but the humanoid form is the one that people are usually talked about. A robot with a human form or we call it humanoid robots probably will become our best friend in the future. Nowadays humanoid robots are able to help people in doing their job. For example there is a robot that is placed inside a museum to guide the visitor around the museum, though the robot are not very much like a human, but it is quite helpful. Hopefully in the future there are many humanoid robots that are able to make us easier in living our life. It is not impossible that someday in the amusement park there are many robots that are able to help us in maximizing our time in enjoying the fun, or even there will be a police robot that will help a kid who is lost. I prefer to think the best part of a robot can brings us rather than a robot that used as a war machines, though that is probably already become the military plans.

VII. Prospects

After four decades of research on humanoid robots impressive results have been obtained, but the real-world capabilities of humanoids are still limited. This should not discourage further research. In fact, research on cognitive robots, including humanoids, is gaining momentum. More and more research groups worldwide are targeting this application. A good part of the difficulties humanoid robots face comes from perception. Here, more advanced methods are developed every year to cope with the ambiguities of sensory signals..

References

[1] M. Vukobratovic and B. Borovac. Zero-moment point, thirty _ve years of its life. Int. J. of Humanoid Robotics, 1:157{173, 2004.

[2] T. McGeer. Passive dynamic walking. International Journal of Robotics Research, 9(2):68{82, 1990.

[3] S. Collins, A. Ruina, R. Tedrake, and M. Wisse. E_cient bipedal robots based on passive-dynamic walkers. Science 307, pages 1082{1085, 2005.

[4] R. Playter, M. Buehler, and M. Raibert. BigDog. In Proc. Of SPIE Unmanned Systems Technology VIII, 2006.

[5] J. Rebula, F. Canas, J. Pratt, and A. Goswami. Learning capture points for humanoid push recovery. In Proc. of IEEE/RAS 7th Int. Conference on Humanoid Robots, 2007.

[6] B. Verrelst, R. Van Ham, B. Vanderborght, F. Daerden, and D. Lefeber. Pneumatic biped Lucy actuated with pleated pneu-matic arti_cial muscles. Autonomous Robots, 18:201{213, 2005.

[7] T. Minato and Y. Yoshikawa et al. CB2: A child robot with biomimetic body for cognitive developmental robotics. In Proc.of IEEE/RAS 7th Int. Conference on Humanoid Robots, 2007.

[8] S. Nishio, H. Ishiguro, and N. Hagita. Geminoid: Teleoperated android of an existing person. In Humanoid robots – new devel-opments. I-Tech, 2007.

[9] R.O. Ambrose, R.T. Savely, and S.M. Goza et al. Mobile ma- nipulation using NASA's Robonaut. In Proc. of IEEE Int. Conf. on Robotics and Automation, 2004.

[10] K. Wyrobek, E. Berger, H.F.M. Van der Loos, and K. Salisbury.Towards a personal robotics development platform. In Proc. of

[11] IEEE Int. Conf. on Robotics and Automation, 2008.