Intelligent Systems and Society

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Abstract

We live in an era in which more and more automated systems are giving us access to massive quantities of information by means of robots, search engines, websites, digital helpdesks and speaking computers. We are witnessing a transformation of change almost taking place in all aspects of human activities from the way we communicate with each other, the way we learn, the way we work, and the way we interact with others (i.e., family relationships, friendship life and business practices) to the quality and delivery of education, healthcare and other human services. Though the technology is moving fast and breaking the things, yet the main question for society is to know how the outcomes of such improvements can affect all aspects of social life and human behavior.

In this paper, we have addressed a handful of the latest achievements in regard to science and technology as well as the way they can benefit the society by helping human related problems in countless ways. Consequently, we have discussed a versatile variety of technological capability and capacity applied in many human activities.

1. Introduction

Over the last 60 plus years nearly all Information Technology (IT) has been applied to organizational issues and problems. Most IT applications have had

the goal of improving efficiency, reducing costs, increasing revenue, improving information processing in terms of speed and accuracy, reducing manpower requirements, increasing the quality of products and services, etc. But over the last several years IT has begun to provide solutions for societal and human related problems. It is predicted that in the future IT will be increasingly utilized to resolve societal and human related issues. [1]

Over the last several decades, there has been a great deal of research into intelligent systems and robotics. Although much of the research has been directed towards specific technical issues, advances in these areas have led to systems and solutions that have and impacted society and have a potential for future societal impacts as well. Many of the advances in robotics and intelligent systems are because of the exponential improvements in information technology and networks. Computer scientists expect continued exponential growth of memory and bandwidth for the next 10 to 20 years exceeding Moore's law which states that the processing power of computer chips will double every 18 months. These exponential improvements in speed and capacity will lead to terabyte storage devices and terabytes-per second bandwidth at a very low cost. The application of robotics and intelligent systems using these technology improvements will impact the well being of our society, transforming how we live, how we learn, and how we work as well as how we do business and are govern [1].

The question for society is: what will we do with these improvements in technological capability and capacity? How will it affect the way we live, the way we learn, the way we work and the way we do business, as well as how we interact with each other and how we are govern? Some things will only change by a small amount such as the food we consume, the clothes we wear, our religion, and so forth. Other behaviors, such as how we learn, work, and interact with others; family relationships, business practices and the quality and delivery of healthcare and other human services will in all likelihood change greatly. The most important impact of using intelligent technologies in the service of humanity will be: robotics, speech recognition, computer vision, human-computer interaction, natural language processing, and artificial intelligence. In what follows, a discussion of how intelligent systems and the use of robotics could impact areas such as care for the elderly, help with rescue operations, changes in the way we educate people in the world, changes in the way we deliver health care to remote regions of the world, how we can provide world wide information using native languages. We are already seeing the impact of technology on the way we conduct business, and the way we are govern. The following are examples of how advances in IT technology and intelligent systems are beginning to impact several critical areas of our world-wide society.

2. Robotics for Elderly Care

As the life expectancy of the world's population increases, more than 10 percent of the population will soon be over the age of 70. This age group will, in general, have disabilities impacting their quality of life, which can be grouped into three broad categories, namely; sensory deficits, cognitive processing capability, and motor skills. It is expected that robotics and intelligent systems will be able to help with these elderly disabilities. The dramatic increase in the elderly population along with the exponential increase of nursing-home costs creates difficult challenges for society. Currently, care for the elderly is considered inadequate, and in the future, there will be fewer young people to help older adults cope with the challenges of aging. It is quite likely that we will have robots that can act as care givers and can guide and keep pace with a human, moving neither too fast nor too slow because safety while navigating in the presence of an elderly person is very important. Given the limitations of current vision systems, an eldercare robot might not always detect obstacles beyond its field of view and could accidentally run into objects or hit a person. Also, the eldercare robot must be able to understand and respond to voice commands intelligently. The robot must have voice as well as graphical display response capability. Current speech recognition and speech synthesis technologies are sufficient to make this possible, but several problems exist, such as not being able to comprehend continuous open-domain speech consisting of confusing words, having trouble following who is speaking when multiple people are involved in the conversation, and not being able to block out environmental noise [6].

As an example of what an eldercare robot can accomplish, Martha Pollack of the University of Michigan using the Pearl Robot of Carnegie Mellon University has demonstrated care for the elderly in several assistive-care situations. The Pearl robot provides a research platform to test a range of ideas for assisting the elderly. Two Intel Pentium 4 processor-based PCs run software to endow it with speech and the ability to navigate, and a differential drive system propels it. A Wi-Fi network connection helps the robot communicate as it travels along, while laser range finders, stereo camera systems, and sonar sensors guide Pearl around obstructions. Microphones help her recognize words, and speakers enable others to hear her synthesized speech. An actuated head unit swivels in lifelike animation. Currently, the Pearl robot can walk across carpets and tile floors, and it includes a handheld device that prompts people to do certain (preprogrammed) things. It also acts as a walker, guiding an elderly person through pathways to reach a bathroom, bedroom or kitchen. Researchers hope that such an autonomous mobile robots will have endless possibilities and one day live in the homes of chronically ill elderly people to perform a variety of tasks, such as monitoring physical conditions, reminding them to visit the bathroom, take medicine, drink, and see the doctor. A robot could operate appliances around the home such as the refrigerator, washing machine, or a microwave. It could also provide certain social functions because many elderly people are forced to live alone deprived of social contacts. An intelligent robot could help elderly people feel less isolated [2].

Connecting patients, especially those at remote locations or without transportation facilities, with caregivers through the Internet could be a critical capability. A robot or other intelligent system can be a platform for tele-presence technology whereby professional caregivers can interact directly with remote patients, reducing the frequency of doctor and nurse visits. An intelligent caregiver system could collect data and monitor patient health related functions. Emergency conditions, such as heart failure or high blood-sugar levels, could be avoided with systematic data collection and analysis and the transmission of alerts to an emergency facility or doctor.

3. Robots and Drones for Help with Rescue Operations

Natural and manmade disasters present unique requirements for effective collaboration of human, robotic and intelligent systems. Many disaster locations are too dangerous for human exploration or are unreachable. Additional constraints such as the availability of rescuers, extreme temperatures, high rain and snow conditions, and hurricane-force or blizzard winds often result in significant delays before human rescuers can start searching for victims. In most cases, rescuers need to retrieve victims within 48 hours to enhance survival rates. In many disasters situations human rescue efforts alone aren't enough, resulting in unnecessary loss of life. Currently several organizations are actively participating in designing small rescue robots that can carry a human-sized payload. A rescue robot is a robot that has been designed for the purpose of aiding rescue workers. Common situations that employ rescue robots are mining accidents, urban disasters, hostage situations, and explosions. Rescue robots were used in the search for victims and survivors after the September 11 attacks in New York. The benefits of rescue robots to these operations include reduced personnel requirements, reduced fatigue, and access to otherwise unreachable areas [3].

Some systems can maneuver over land, water and air and detect sounds and some robots have cameras with 360-degree rotation that can send back high-resolution images. Some rescue robots are also equipped with specialized sensors that can detect body heat or colored objects. For example, rescue robots must be adaptable to water clogged tunnels such as mines, collapsed building rubble, extreme heat and cold and so forth. Also, the robots should be able to adjust to lighting and be resistant to extreme temperatures such as in a volcano or on an icy mountain [8].

The US military has used similar tactical mobile robots called PackBots to explore Afghan caves. Also, since the turn of the 21st century, the American Association for Artificial Intelligence has conducted an annual rescue robot competition to identify the capabilities and limitations of existing rescue robots. Continued research and development is required to enhance rescue robotic systems and eliminate their limitations. It is difficult to build intelligent, robust rescue robots that can deal with a disaster site's unexpected complexity.

A search and rescue drone is an unmanned aircraft used by emergency responders, such as police officers and firefighters, ideal for searching vast areas for missing persons and crime victims in need of rescue. Wilderness First Responders are emergency medical professionals specially trained to assist in emergency medical situations in the wilderness or other remote areas. Intelligent robots are being used for as variety of situations such as:

(1) Public Safety – transported in the trunk of a police vehicle, the back of a fire truck or carried in a backpack, a small UAS (Unmanned Aircraft System) can provide immediate situational awareness to first responders, giving them a birds-eye view of the situation, day or night, to save lives and protect property.

(2) Wildlife and Environmental Monitoring – already used to monitor sensitive wildlife areas and populations, small UAS (Unmanned Aircraft System) are increasingly providing a means of collecting important information in inaccessible areas to facilitate more effective resource management.

(3) Infrastructure Management – dams, pipelines, offshore oil platforms, microwave transmission towers, power plants and ports are some examples of large, sometimes remote infrastructure that can be accessed easily and safely by small UAS (Unmanned Aircraft System) to provide color and thermal video for rapid visual inspection.

(4) Scientific Research – peering into a volcano is made easier and safer with small UAS (Unmanned Aircraft System), and is just one example of the new ways this technology is helping scientists gain a better understanding of the way the earth and its biosphere operate.

4. Speech Recognition and Synthesis as a Reading Tutor

It is estimated that over a billion people in the world can't read or write, and it's likely that more than two billion are functionally illiterate in that they can't understand the meaning of the sentences they read [1]. Advances in speech-recognition and speech synthesis technologies provide an opportunity to create a computer-based solution to illiteracy [5]. The solution involves an automated reading tutor that displays stories on a computer screen and listens to children read aloud using speech-recognition technology. Until 15 years ago, speech recognition systems weren't fast enough to recognize the connected sentences spoken in real time. A reading tutor application that can discover and correct mispronunciations requires not only speech-recognition capabilities but it must also be able to detect changes in stress, duration, and spectral properties from that of native speakers. Systems to analyze a student's oral reading are currently available. The Reading Tutor system intervenes when the reader makes mistakes, gets stuck, clicks for help, or is likely to encounter difficulty. It responds with assistance modeled after expert reading teachers but adapted to the technology's capabilities and limitations. To realize the potential of this technology information technology must minimize speech-recognition errors and develop systems that can understand non-native speakers, local dialects, and the speech of children. These teaching systems must also track user involvement using response times and enable the system to propose a mentoring approach for a specific student by modeling that student's behavior [4].

5. E-Learning

E-learning is the use of computers and networks to transfer skills and knowledge to learners. E-learning applications and processes include Web-based learning, computer-based learning, virtual education opportunities and digital collaboration. Content is delivered via the Internet, intranet/extranet, audio or video tape; satellite TV, DVDs and CDs. It can be self-paced or instructor-led and includes media in the form of text, image, animation, streaming video and audio. Some e-learning environments take place in a traditional classroom; while others allow students to attend classes from home or other locations. Virtual school enables students to take courses anywhere there is an internet connection. Cyber schools allow for students to maintain their own pacing and progress, course selection, and provide the flexibility for students to create their own schedule. [7]

E-learning is increasingly being utilized by students who may not want to go to traditional brick and mortar schools due to severe allergies or other medical issues, fear of school violence and school bullying and students whose parents would like to home school but do not feel qualified. Cyber schools create a safe haven for students to receive a quality education while almost completely avoiding these common problems. Cyber charter schools also often are not limited by location, income level or class size in the way brick and mortar charter schools are.

The more established cyber charter schools offer students a full range of additional programs which not only enhance the curriculum choices that are offered, but they also provide support for students so that they can become as successful as possible in an on line environment. Some of these additional programs include: Student assistance programs for students who may be struggling with other areas in their life beyond academics; open tutoring for those students that require extra support and special programs to help students improve their math and reading skills to prepare them for state testing, and college entrance and scholarships.

6. Computer Vision and Intelligent Vehicle Cruise Control

Over a million people die annually in road traffic fatalities nearly 50,000 in the US alone. The annual repair bill for the cars involved in these accidents in the US exceeds over $58 billion. Sensing, vision, planning, and control technologies made possible by advances in computer vision and intelligent systems could reduce deaths and repair costs by a significant amount. Forty percent of vehicle crashes can be attributed in some form to reduced visibility due to lighting and weather conditions. Physical sensors could alert a driver when glare, fog, or artificial light exists in the environment. Over 70 percent of accidents are caused by human driving errors—usually speeding, driver fatigue, texting or driving under the influence of alcohol or drugs. An autopilot that could temporarily take control the vehicle in such situations and navigate it to safety could reduce casualties. To accomplish this would require dependable sensitivity and perception— critical components in building cruise-control systems The next generation of cruise control systems will require sensors that use light, sound, or radio waves to detect and analyze the physical environment. These sensors must gather data such as the speed, distance, shape, and color of objects surrounding the vehicle. These systems will need efficient object-classification techniques to extract the shape of objects from this sensor data and accurately classify them based on various criteria such as shape and color. These systems will also require real-time object-tracking capabilities that can continuously monitor and predict the paths of these vehicles and drivers over time. Based on this sensory and directional information, designers should be able to develop scene recognition algorithms that can recognize interactions between objects in the environment and predict a possible collision scenario. In addition to perception modules, these systems will also need control mechanisms and actuators to steer a vehicle.

These vehicles will need feedback control systems with proportional control to help the vehicle maintain a safe speed by automatically adjusting the acceleration based on the current speed. This will require efficient path-planning and localization techniques so the vehicle can navigate a safe path. Once these technologies are in place, it will be possible to build collision-warning systems with intuitive interfaces that warn drivers of imminent dangers well in advance of a collision and take actions as necessary to avoid a collision [9].

7. Human-Computer Interaction

Over four billion people in the world subsist on less than $2500 per year. Most of these people don't know how to speak English and more than a billion are totally uneducated. Most PC designers assume that the user knows English or a couple of other languages of industrial nations such as French or Spanish [11]. Thus, it's not necessarily the technology that acts as a barrier to wide acceptability of and accessibility to computers, but more than likely the organizations that target their designs at the more affluent and literate consumers in industrial nations. Almost anyone can learn to use a telephone or a television or learn to drive a car, even though these are some of the more complex technologies available in our societies. The way to make technology easy to use is to hide the complexity of such systems and devices by using a simple interface. By adding a television tuner chip, a PC can become a television and Digital Video Recorder (DVR). Adding a camera and microphone to a PC allows video and audio inputs, which enable telephone functionality as well as video phone, video capabilities, as well as video and voice email which are capabilities currently not available to users in industrial countries. The crucial improvement is to have a radically simple user interface that doesn't require literacy—what is frequently called an appliance model. So, even if users can't read or write, they can easily learn to use voice or video mail. If they can't use a text-based help system, they can benefit from a video chat. Such solutions demand more bandwidth, computation, and memory, which present an interesting dilemma. To be useful and affordable for those who are poor and illiterate, we need computing devices with 100 times more computing power at one-tenth the cost. There are no technological reasons why increased memory and bandwidth cannot be provided at a nominal cost. Projected exponential growth in computing and communication technologies should make this possible. It's a research challenge that is worth undertaking not only as a societal good deed but also as good business [12].

8. Natural Language Processing for Non-English Languages

Natural language processing provides tools for indexing, retrieval, translation, summarization, document clustering, classification, and topic tracking, as well as other capabilities. In combination, these tools are essential for the successful wide spread use of the vast amount of information being added to digital libraries. Although basic technologies and tools for natural language processing have been demonstrated for the English language, the necessary linguistic support isn't yet available in many other languages. As a result, automatic translation and summarization among many languages is not satisfactory thereby making information unavailable to a vast number of people in our world society. To overcome these problems researchers must develop low-cost, fast, and reliable methods for producing language-processing systems for many languages of low commercial interest. Natural language processing systems must resolve ambiguities at the lexical, syntactic, semantic, and contextual levels to generate better-quality output. Also, most language-processing systems are computationally intensive and as a result there is a need for effective ways of making these systems scale up in real time. The first step to realizing such ambitious goals in natural language processing is to create a rich digital content repository. Many initiatives have begun to act as a test bed for validating concepts of natural language research (CMU, IBM, Google, Yahoo, MSN, etc.) Unfortunately, most of these will be in English and thus won't be readable by over 80 percent of the world's population. Even when books in other languages become available online, their content will remain incomprehensible to most people. Natural language processing technology for translation among languages promises to provide a way out of this situation. A resource such as a universal digital library, supported by natural language processing techniques, makes knowledge available to a worldwide population by making digital libraries usable and available regardless of the language [10].

9. Artificial intelligence and Neonatal Care

In many developing countries, neonatal care isn't available to many newborn children because hospitals are inaccessible and/or too costly. Worldwide, more than 3 million newborns die each year [13]. The causes of many newborn deaths such as infections, birth asphyxia or trauma, prematurity, and hypothermia are preventable with the proper medical treatment. The underlying health related issues include poor pre-pregnancy health, inadequate care during pregnancy and delivery, low birth weight, breast-feeding problems, and inadequate newborn and postpartum care. Typically, in remote villages, health workers trained in neonatal care make home visits to control diarrheal diseases, respiratory infections, offer immunizations, and provide nutrition informational such as the use of micronutrients. Unfortunately, scalability and sustainability of such services have been problems, including ready access to a health worker, identifying and training health workers, and providing support and medicines in a timely manner. It is believed by many that the poor, sick, and uneducated masses on the other side of the rural digital divide have more to gain from information and communication technologies than the many people who already have these technologies [14]. Artificial intelligence based approaches such as expert systems and knowledge-based systems that have been used in medical diagnosis and therapy applications for the past 40 years could prove to be effective in the developing world and help provide timely intervention, saving lives and money. Creating an expert system for neonatal care in rural environments is probably much more difficult than in other application domains. The cost to use such a system must be extremely low, and a number of technical challenges exist. Such a system would require an information device that could host an expert system and hold a dialog with a village housewife in a locally spoken language. Cell phones have become powerful enough to provide this functionality. It will also require developing high performance speech recognition, synthesis, and dialog systems for local languages. In addition, it will also require the creation of an expert system with a database of answers to common questions and problems, in the form of voice and video responses as well as textual responses. When an answer isn't available using the local system, the user should be able to search a global database with more comprehensive and complete frequently asked questions and answers. This, in turn, will require a multilingual search and translation capability. It should also be possible for a query to be referred to a human-expert task force for generating an answer for immediate and future use [15].

10. Summary

In this paper, we have addressed versatile topics in regard to new achievements of science and technology. The technologies discussed above can benefit society and help human-related problems in many ways. As an instance, more sophisticated generation of robots nowadays are able to provide intensive care required by care home residents and also can conduct routine tasks without significantly reducing the human contact people need. Similarly, the complex terrain robots are up to undertake firefighting operations in areas with radiation and chemical contamination. Robots and drones can be used in rescue operations as well. In the rest of the paper, we aimed to shed light into the new aspects of E-learning, human-computer interaction, natural language processing for non-English languages, and artificial intelligence and neonatal care issues. This is obvious that in the future, information technologies will be applied to many human activities.

References

[1] Reddy, Raj. "Robotics and Intelligent Systems in Support of Society." IEEE Intelligent Systems. www.computer.org/intelligent. Vol. 21, No. 3 May/June 2006

[2] M.E. Pollack, "Intelligent Technology for an Aging Population: The Use of AI to Assist Elders with Cognitive Impairment," AI Magazine, vol. 26, no. 2, 2005, pp. 9–24.

[3] Wikipedia. "Rescue Robot." http://en.wikipedia.org/wiki/Rescue_robot, retrieved 5/7/2013.

[4] Helmer Strik. "Computer-based Learning: What Automatic Speech recognition has to Offer". Dept. of Linguistics, Radboud University Nijmegen. http://hstrik.ruhosting.nl/wordpress/wp-content/uploads/2013/03/a158-CALL-LESLLA.txt. retrieved 5/7/2013.

[5] Sixto Ortiz Jr. "The State Of Voice Recognition", Processor, February 25, 2005 • Vol.27 Issue 8. http://www.processor.com/editorial/article.asp?article=articles%2Fp2708%2F30p08%2F30p08.asp

[6] Stelluto, Georgia C. "Geriatric Healthcare Technology Offers Hope for 'Aging in Place" http://www.todaysengineer.org/2004/Jun/geriatric-care.asp. Retrieved 5/7/2013

[7] Schlechty, Phillip C. "Shaking Up the Schoolhouse: How to Support and Sustain Educational Innovation," from the Library of Congress website. Retrieved 5/7/2013.

[8] "Qube: Public Safety Small UAS", http://www.avinc.com/uas/small_uas/qube. Retrieved 5/7/2013.

[9] Ioannou, P.A.and Chien, C. C. "Autonomous Intelligent Cruise Control." IEEE Transactions on Vehicular Technology, Vol. 42, issue 4, pages 657-672, 1993.

[10] Google. “Natural Language Processing.” http://research.google.com/pubs/NaturalLanguageProcessing.html. Retrieved 5/7/2013.

[11] Shah, Anup. “Poverty Facts and Stats.” Global Issues. 07 Jan. 2013. http//www.globalissues.org/article/26/povert-facts-and-stats

[12] Rodden, Tom. “Human Computer Interaction In The Year 2020”, Medical News Today, 4/7/2008. http://www.medicalnewstoday.com/releases/102984.php. Retrieved 5/7/2013.

[13] Thairu,L.; Wirth, M.; and Lunze, K. “Innovative Newborn Health Technology for Resource-Limited Environments.” Tropical Medicine and International Health. Volume 18, No. I, pp 117-128, Jan. 2013.

[14] Murray, S.F. “Neonatal Care in Developing Countries.” National Center for Biotechnology Information, U.S. Library of Medicine. http://www.ncbi.nlm.nih.gov/pubmed/9423426. Retrieved 5/9/2013.

[15] Pakenham-Walsh, Neil and Bukachi, Fredrick. “Information Needs of Health Care Workers in Developing Countries; a Literature Review with Focus on Africa.” Human Resources for Health. Vol 7, 2009. http://www.human-resources-health.com/content/7/1/30. Retrieved 5/9/2013