Theme 3: Most Advanced Technologies of Robots:

An investigation of the most advance technologies for robots, both usefulness and novelties…

How has Robots been improved and how it will revolutionize the World?

Pressented by: Waialua Robotics Program

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Waialua High & Intermediate School (Waialua, HI)

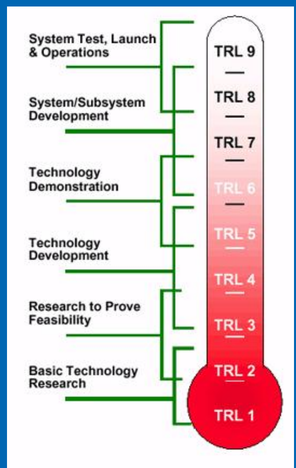
Group #12

Who We are…………………………………..

- Presented by:
  - Glenn Lee
    - Robotics Lead Teacher (1999-present) and Coordinator (2003-present)-CTE Industrial Engineering Technology Career Pathway
    - STEM Learning Center Coordinator, Career Technical Education Coordinator, former Extended Learning Opportunity (ELO) Project Director, School Technology Cadre and Leadership Team, Fine Arts/PE/AV/CTE dept. head.
    - Degree in Electrical Engineering, minor in Math, M.B.A., Teaching Certificate in Secondary Education (Mathematics, Science, and Industrial Engineering & Technology)
  - Waialua, Hawaii and the Waialua Robotics Program
    - Established in August 1999 as part of a STEM initiative to encourage students to major in Science, Technology, Engineering and Mathematics. In 1999, only 1 student from the graduating class applied for an engineering program.
    - Waialua, Hawaii is a rural community Many of the current families living in Waialua are the results of agricultural industry which began in the early 1900s. During the late 1980s and into the 1990s, the sugar production decreased as increasing labor and production costs caused producers to move overseas. Many of the families brought to Waialua during the sugar rush remained here and many of their descendants reside there today.

Technology Readiness Level….

Technology Readiness Levels (TRL) are a method of estimating technology maturity of Critical Technology Elements (CTE) of a program during the acquisition process. They are determined during a Technology Readiness Assessment (TRA) that examines program concepts, technology requirements, and demonstrated technology capabilities. TRL are based on a scale from 1 to 9 with 9 being the most mature technology. The use of TRLs enables consistent, uniform, discussions of technical maturity across different types of technology



Most Advanced Technologies of Robots…………..Artificial Intelligence (AI)

Artificial Intelligence (Autonomous)

- What is Artificial Intelligence (AI)?

-It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable. Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines.

-Intelligence involves mechanisms, and AI research has discovered how to make computers carry out some of them and not others. If doing a task requires only mechanisms that are well understood today, computer programs can give very impressive performances on these tasks. Such programs should be considered ``somewhat intelligent''.

-AI is not only about simulating human intelligence. We can learn something about how to make machines solve problems by observing other people or just by observing our own methods. On the other hand, most work in AI involves studying the problems the world presents to intelligence rather than studying people or animals. AI researchers are free to use methods that are not observed in people or that involve much more computing than people can do.

Artificial Intelligence (AI)-Examples and Applications…….

Examples include:

- Kitchen Robot by Moley Robotics-Technology Readiness Level (TRL) 7, Usefulness Purpose

THE WORLD'S FIRST ROBOTIC KITCHEN

Moley has created the world's first robotic kitchen. Featuring an advanced, fully functional robot integrated into a beautifully designed, professional kitchen, it cooks with the skill and flair of a master chef. The prototype was premiered to widespread acclaim at Hanover Messe, the international robotics show.

The consumer version set for launch in 2017 will be supported by an iTunes' style library of recipes.

Artificial Intelligence (AI)-Examples and Applications…….

Examples include:

- Autonomous Google Car-Technology Readiness Level (TRL) 7, Usefulness Purpose

Google self-driving cars are designed to navigate safely through city streets.

They have sensors designed to detect objects as far as two football fields away in all directions, including pedestrians, cyclists and vehicles—or even fluttering plastic shopping bags and rogue birds. The software processes all the information to help the car safely navigate the road without getting tired or distracted.

Artificial Intelligence (AI)-Examples and Applications…….

Examples include:

- Insect-like Drones-Technology Readiness Level (TRL) 7, Usefulness Purpose

One of the current areas of research reportedly being undertaken in the scientific/military field is the development of micro air vehicles (MAVs), tiny flying objects intended to go places that cannot be (safely) reached by humans or other types of equipment.

Some efforts in MAV research have involved trying to mimic birds or flying insects to achieve flight capabilities not attainable through other means of aerial propulsion.

Artificial Intelligence (AI)-Examples and Applications…….

Examples include:

- ALO the Robot Botlr in Aloft Hotels by Savioke-Technology Readiness Level (TRL) 7, Usefulness Purpose
- The robot is approximately 3 feet tall, weighs less than 100 lbs., has a carrying capacity of 2 cubic feet, and is designed to travel at a human walking pace. It can even travel independently between floors via the hotel elevator. When Aloft's A.L.O. arrives at the appropriate guest room, it phones the guest to announce its arrival, delivers the goods and makes its way back to the front desk. A.L.O. will know when a guest opens the door via an onboard camera. Once the door opens, A.L.O. will unlock, open its lid and provide instructions through onscreen prompts for guests to remove the item and close the lid.

The Impact and Future of Artificial Intelligence (AI)………….Pre-Study

Specific Examples Studied:

- Robot butlers can provide a specific set of automated skills, and one that could work, literally around the clock.
- Imagine if everyone could get around easily and safely, regardless of their ability to drive.
- Aging or visually impaired loved ones wouldn't have to give up their independence. Time spent commuting could be time spent doing what you want to do. Deaths from traffic accidents—over 1.2 million worldwide every year—could be reduced dramatically, especially since 94% of accidents in the U.S. involve human error.
- Insect Drones can be used as one of the primary military applications envisioned for MAVs is the gathering of intelligence (through the surreptitious use of cameras, microphones, or other types of sensors); among the more extreme applications posited for such devices is that they may eventually be used as "swarm weapons" which could be launched en masse against enemy forces.
- After more than 50 years after robots appeared in specialised manufacturing facilities, the advancements in automation, sensors and advanced software systems and associated cost curves mean we are at the point where robots will be seen more and more in the domestic environment.
- This is an opportunity for people to enjoy very good food, and for a reasonable price.
- You can download a recipe and reproduce it exactly as a Master Chef would have cooked it, wherever you are in the world.

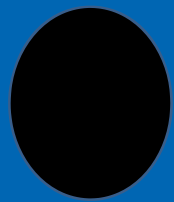
Research Investigation Findings in iREX exhibition hall…… Artificial Intelligence (AI)

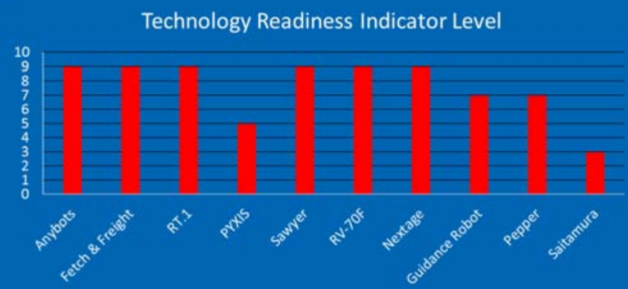
Booths Visited:

- FETCH Robotics, Mitsubishi, Rethink Robotics, RT Works, Kawada Robotics, NSK, Softbank Robotics, Tokyo Metropolitan Industrial Technology Research Institute, Pacific Systems

Summary:

- Overall the average technology readiness level is a 7.6, ranging from 3 to 9. Most technologies utilizing artificial intelligence have surpassed the design stage and is now an industry comprised heavily of prototype robots. However, this technology is advancing daily to increase our knowledge of automation. This advancement will help not only industries but hospitals, homes, and transportation as well. Artificial intelligence decreases the risk of injury and human error as well as helping to create independence among the elderly and handicapped.





Most Advanced Technologies of Robots………….3D Printing

3D Printing Technology

- What is 3D Printing?

-***3D printing or additive manufacturing*** is a process of making three dimensional solid objects from a digital file. The creation of a 3D printed object is achieved using additive processes. In an additive process an object is created by laying down successive layers of material until the entire object is created. Each of these layers can be seen as a thinly sliced horizontal cross-section of the eventual object.

The **American Society for Testing and Materials** (ASTM) group "**ASTM F42 – Additive Manufacturing**" developed a set of standards that classify the Additive Manufacturing processes into **7 categories** according to **Standard Terminology for Additive Manufacturing Technologies**.

The 7 categories are:

- **Vat Photopolymerisation**
- **Material Jetting**
- **Binder Jetting**
- **Material Extrusion**
- **Powder Bed Fusion**
- **Sheet Lamination**
- **Directed Energy Deposition**

3D Printing-Examples and Applications…….

Examples & Applications of 3D printing in Robot Industries:

- **Medical industry**-Technology Readiness Level (TRL) 9, Usefulness Purpose

  The outlook for medical use of 3D printing is evolving at an extremely rapid pace as specialists are beginning to utilize 3D printing in more advanced ways. Patients around the world are experiencing improved quality of care through 3D printed implants and prosthetics never before seen.

  Bio-printing-Technology Readiness Level (TRL) 7, Usefulness Purpose

  As of the early two-thousands 3D printing technology has been studied by biotech firms and academia for possible use in tissue engineering applications where organs and body parts are built using inkjet techniques. Layers of living cells are deposited onto a gel medium and slowly built up to form three dimensional structures. We refer to this field of research with the term: bio-printing.
- **Automotive industry**-Technology Readiness Level (TRL) 9, Usefulness Purpose

  Although the automotive industry was among the earliest adopters of 3D printing it has for decades relegated 3d printing technology to low volume prototyping applications.
  Nowadays the use of 3D printing in automotive is evolving from relatively simple concept models for fit and finish checks and design verification, to functional parts that are used in test vehicles, engines, and platforms. The expectations are that 3D printing in the automotive industry will generate a combined $1.1 billion dollars by 2019.

The Impact and Future of 3D Printing………..Pre-Study

- **Future**

  It is predicted by some additive manufacturing advocates that this technological development will change the nature of commerce, because end users will be able to do much of their own manufacturing rather than engaging in trade to buy products from other people and corporations.

  3D printers capable of outputting in color and multiple materials already exist and will continue to improve to a point where functional products will be able to be output. With effects on energy use, waste reduction, customization, product availability, medicine, art, construction and sciences, 3D printing will change the manufacturing world as we know it.
- **Services**

  Not everybody can afford or is willing to buy their own 3D printer. Does this mean you cannot enjoy the possibilities of 3D printing? No, not to worry. There are 3D printing service bureaus like Shapeways, Ponoko and Sculpteo that can very inexpensively print and deliver an object from a digital file that you simply upload to their website. You can even sell your 3D designs on their website and make a little money out of it!

  There are also companies who offer their services business-to-business. When, for instance, you have an architecture practice and you need to build model scales, it is very time consuming doing this the old fashioned way. There are services where you can send your digital model to and they print the building on scale for you to use in client presentations. These kind of services can already be found in a lot of different industries like dental, medical, entertainment and art.

  3D Marketplaces
- If you don't have the skills to design your own 3D models, you can still print some very nice objects. 3D marketplaces such as Pinshape and CGTrader contain 3d model files you can download for a small charge or for free.

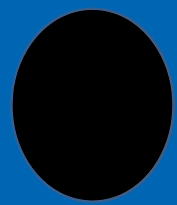
Research Investigation Findings in iREX exhibition hall…… 3-D Printing

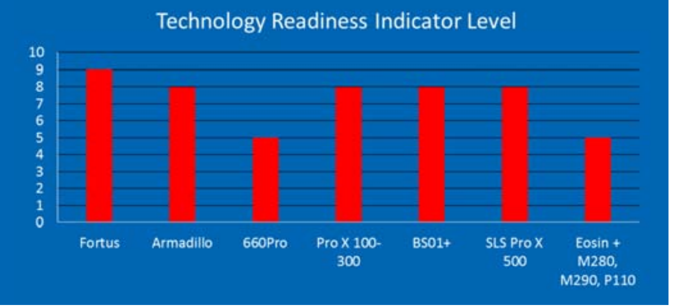
Booths Visited:

- Altech Co. Ltd, Stratasys, Hakuto, Mutoh, J3D, Bonsai Lab

Summary:

- Overall the average technology readiness level is a 7.4, ranging from 5 to 9. 3-D Printing is a valuable tool for prototyping and manufacturing. The technology allows for a low cost eco-friendly material which can be formed into almost any shape and size. The 3-D Printers are capable of creating entire robot frames, prosthetics, novelties, and hardware. With this technology industries are able to create complex objects due to the software's ability to develop structures which would be otherwise impossible to create with other methods.

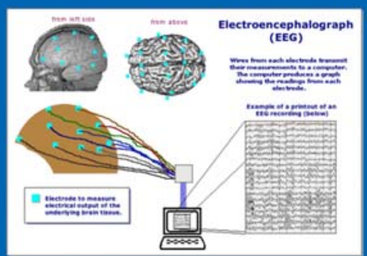




Most Advanced Technologies of Robots............Electroencephalography (EEG)

What is EEG?

Electroencephalography (**EEG**) is an electrophysiological monitoring method to record electrical activity of the brain. It is typically noninvasive, with the electrodes placed along the scalp, although invasive electrodes are sometimes used in specific applications. EEG measures voltage fluctuations resulting from ionic current within the neurons of the brain. In clinical contexts, EEG refers to the recording of the brain's spontaneous electrical activity over a period of time,[1] as recorded from multiple electrodes placed on the scalp. Diagnostic applications generally focus on the spectral content of EEG, that is, the type of neural oscillations (popularly called "brain waves") that can be observed in EEG signals.



Electroencephalography (EEG)-Example and Application……….

- Mind-Controlled Robot Arm-Technology Readiness Level (TRL) 7, Usefulness Purpose :

  The US Defense Advanced Research Projects Agency (DARPA) presented the achievements it'd had to date in building a robot arm that can be controlled by a human brain. A little over two months later, the agency had announced at another conference that it's managed to update the technology to give the wearer the feeling of actually being able to sense things with the arm.

  The robotic arm is connected by wires that link up to the wearer's motor cortex—the part of the brain that controls muscle movement—and sensory cortex, which identifies tactile sensations when you touch things. The wires from the motor cortex allow the wearer to control the motion of the robot arm, and pressure sensors in the arm that connect back into the sensory cortex give the wearer the sensation that they are touching something.

  According to the project's program manager, Justin Sanchez, the team blindfolded the first person connected to the robot arm, and lightly touched his fingers. He was able to recognize which of his fingers had been touched, even when the team tried to trick him by touching two fingers at once. "He responded in jest asking whether somebody was trying to play a trick on him," Sanchez said in a release. "That is when we knew that the feelings he was perceiving through the robotic hand were near-natural."

The Impact and Future of Electroencephalography (EEG)…Pre-Study

Specific Examples Studied:

- A quadriplegic might use a house-bound arm to feed herself without having to rely on a human helper.
- Musicians might be able to eliminate the need for tools and interfaces like sheet music—or even playing an instrument—by simply creating music directly with their thoughts.
- Filters can screen incoming calls of busy mobile phone users by simply monitoring the state of the user's brain.
- An object to be created by thought alone—paired with the growing power of the latest 3-D printing machines.
- For the disabled, the ability to move about using the power of their minds could be life changing. Scientists have worked for years on wheelchairs and other devices that could restore mobility to those who had lost control of their own bodies b
- Human machine interfaces are becoming part of the human body. One new prosthetic even provides a sense of "touch" like that of a natural arm, because it interfaces with the wearer's neural system by splicing to residual nerves in the partial limb.
- The prosthetic sends sensory signals to the wearer's brain that produce a lifelike "feel," allowing users to operate it by touch rather than by sight alone. This ability enables tasks many take for granted, like removing something from inside a grocery bag, and knowing how hard to grip items with the prosthetic hand.

Technology Readiness Level (pre-study research) Summary……………….

1. **Artificial Intelligence-Technology Readiness Level 7, Usefulness Purposes**

2. **3D Printing-Technology Readiness Level 9, Usefulness and Novelty Purposes**

3. **Electroencephalography (EEG)-Technology Readiness Level 7, Usefulness Purposes**

Impact and Challenges of the Advancement of Technologies in Robots………

- The major challenge for the commercialization of these sci-fi prosthetics is the cost. Michael McLoughlin is head of the DARPA effort at Johns Hopkins University's Applied Physics Lab (APL), where the work on Revolutionizing Prosthetics has been under way since 2006. McLoughlin says that engineers are well on their way to solving the technical challenges of building such a thing. Instead, he singles out cost as the main barrier to commercialization.
- Another issue is simply the neuroscience, says NYU neuroscientist and brain-machine interface researcher Robert Froemke, who is not affiliated with DARPA. "We don't understand how the brain generates movement signals. We understand that a little bit, particularly in work from animal models, but there's limited data in humans." In other words, more testing needs to be done on brave research projects like those participating in Revolutionizing Prosthetics.
- Challenge 1. Biological systems can adapt to new environments--not perfectly, they die in some environments, but often they can adapt. Currently our programs are very brittle, and certainly a program compiled for one architecture cannot run on another architecture. Can we build a program which can install itself and run itself on an unknown architecture? This sounds very difficult. How about a program which can probe an unknown architecture from a known machine and reconfigure a version of itself to run on the unknown machine? Still rather difficult, so perhaps we have to work up to this by making some "blocks worlds" artificial architectures where we can do this. This might lead to some considerations of how future architectures might be designed so that software is self-configurable, and then even perhaps self-optimizing.

Impact and Challenges of the Advancement of Technologies in Robots continued………

- Minsky (1967) was foundational in establishing the theory of computation, but after Hartmanis (1971) there has been a fixation with asymptotic complexity. In reality lots of problems we face in building real AI systems do not get out of hand in terms of the size of problems for individual modules--in particular with behavior-based systems most of the submodules need only deal with bounded size problems. There are other ways theory could have gone. For instance one might try to come up with a theory of computation based on how much divergence there might be in programs given a one bit error in either the program or data representation. If theory were based on this fundamental concern we might start to understand how to make programs more robust.
- Recent work with evolutionary system has produced some tantalizing spectacular results, e.g., Sims (1994). But it is hard to know how to take things from successes and apply them to new problems. We do not have the equivalent of the Perceptron book (Minsky and Papert 1969) for evolutionary systems. (Note that these evolutionary systems are much more that straight genetic algorithms as there is both a variable length genotype and a morphogenesis phase that produces a distinctly different phenotype.) We need such a new book of mathematics so that we understand the strengths and weaknesses of this exciting new approach.
- We have been living with the basic formalizations made by McCulloch and Pitts (1943) for over fifty years now. Their formalization included that the activity of the neuron is an "all-or-none" process, that a certain fixed number of synapses must be excited within the period of latent addition in order to excite a neuron at any time, and this number is independent of the synapses' previous activity and position on the neuron, that the only significant delay within the nervous system is synaptic delay, that the activity of any inhibitory synapse absolutely prevents excitation of the neuron at that time, and that the structure of the net does not change with time. With the addition of changing synaptic weights by Hebb (1949) we pretty much have the modern computational model of neurons used by most researchers. With 50 years of additional neuroscience, we now know that there is much more to real neurons. Can newer models provide us with new computational tools, and will they lead to new insights to challenge the learning capabilities that we see in biological learning?
- Over time we become trapped in our shared visions of appropriate ways to tackle problems, and even more trapped by our funding sources where we must constantly justify ourselves by making incremental progress. Sometimes it is worthwhile stepping back and taking an entirely new (or perhaps very old) look at some problems and to think about solving them in new ways. This takes courage as we may be leading ourselves into different sorts of solutions that will for many years have poorer performance than existing solutions. With years of perseverance we may be able to overcome initial problems with the new approaches and eventually leapfrog to better performance. Or we may turn out to be totally wrong. That is where the courage comes in.

Impact and Challenges of the Advancement of Technologies in Robots continued………

- Despite some early misgivings (Selfridge 1956) back when chess playing programs had search trees only two deep (Newell et al. 1958), our modern chess programs completely rely on deep search trees and play chess not at all like humans. Can we build a program that plays chess in the way that a human plays? If we could, then perhaps we could prove how good it was by getting it to play GO--tree search just cannot cut it with GO.
- All of the competitive speech understanding systems today use hidden Markov models. While trainable, these systems have some unfortunate properties. They have much higher error rates than we might desire, they require some restriction in domain, and they are often inordinately sensitive to the choice of microphone. It seems doubtful that people use HMM's internally (even if one doesn't believe that generative grammars are the right approach either). Can we build a speech understanding system that is based on very different principles?
- We live in an environment where we make extensive use of non-speech sound cues. There has been very little work on noise understanding. Can we build interesting noise understanding systems?
- Can we build a system by evolution that is better at a non-trivial task than anything that has been built by hand?

The End

Waialua Robotics Program

Waialua High & Intermediate School (Waialua, HI)