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SySTEM Alert!

Tomorrow is almost here.

Punching Plants!

Humans have farmed for thousands of years. During that time, weeds have been a constant irritation. These rogue plants grow among the crops, making them harder to access and stealing their resources. In recent history, farmers and scientists have come up with many ways of keeping the weed population in the fields under control.

The most direct way of doing this is simply to have humans pull the weeds out by hand. But to do this task over a whole field means long hours of physically uncomfortable work. More efficient methods have been invented, but some of these are controversial. Chemicals called herbicides act as poisons to weeds, but they also get on the crops and into the soil, causing further environmental damage.

Here's an option that you probably hadn't considered: why not have a robot drive over the ground, punching the weeds as it goes, while leaving the desired crops alone?

A company called Deepfield Robotics has created a robot with this ability. The robot is only a prototype (a test model), so don't expect these to be swarming a farm near you anytime soon. But still, the idea is interesting. Could this be a regular sight on farms of the future?

The four-wheeled robot drives over the ground with its eyes (cameras) pointed toward the soil. The robot scans for weeds as it goes, detecting them by analyzing the shapes of the leaves. Teaching computers to recognize objects is an important goal for artificial intelligence researchers. Great strides have been made in this area.

When a weed is located, the stamping tool does its work. The tool is a rod that swiftly strikes down onto the unwanted plant from above. The tool punches hard enough to push plants about three centimeters under the surface of the soil.

Not surprisingly, it is easier to pummel newly sprouted weeds. One good wallop can do it, and this is where the robot really shines. But it does have a straightforward solution for handling larger weeds as well: pounding them over and over quickly.

The robot was tested on a carrot crop. Though the carrots grew close together and the weeds grew between them, the robot was easily able to handle the weeds. In this test, the researchers calculated that an average of 20 weeds were growing in each square meter of ground. The robot will take a longer or shorter amount of time to do its work based on the number of weeds, but its ability tops out at around two weeds per second (actually a little less, 1.75).

Deepfield Robotics, which was launched by the company Bosch, has big plans for the robots. Or, it might be more accurate to say that the robots are part of a much bigger plan. The company plans to create different types of farm-labor robots that can be used together in swarms.

One way or another, robots will almost certainly be an increasingly important part of the future of farming.

Will farms of the future be tended by autonomous robots? Deepfield Robotics envisions swarms of robots taking care of different tasks.

Credit: Deepfield Robotics

Online quiz and electronic version now available. Visit www.pitsco.com/SySTEMalert.

Walking toward the future

Baby giraffes are able to walk within an hour of being born. They often run on their first day. The same is true of many other animals, from guinea pigs to chickens to turtles. Other species take a little longer to become mobile. Kittens, about three weeks after birth. Humans, roughly a year.

It has taken robots a little longer to get the hang of it.

There have technically been walking machines since ancient times, but compared to animals, these walkers were limited and clumsy. A wooden machine made in China in the third century is said to have been able to walk on four legs and even carry items, but it had to be pushed by hand. By the 1960s, robots were walking by their own power, but these walkers were poor at handling uneven terrain. By the 1980s and '90s, robots were becoming capable walkers. But let's face it: their abilities still fell far behind animal locomotion.

Perhaps we are due for another revolution in robotic walking.

ATRIAS is the name of a robot designed by the Oregon State University Dynamic Robotics Laboratory. ATRIAS is a bipedal (two-legged) walker that has shown good ability to stay upright and handle uneven terrain.

And what makes it especially impressive compared to other modern-day walkers is its efficiency. (Efficiency is the amount of work that can be done with the energy available.) According to the Dynamic Robotics Lab, it takes the average humanoid robot about 16 times as much energy to walk as it does a human. ATRIAS is still not as efficient as a human, but it is up to three times more efficient than other walking robots.

HOW IT WORKS

The key to ATRIAS's success is spring-mass technology, a fairly new idea in robotics, which OSU professor Jonathan Hurst predicts will be the future of legged robotic locomotion.

The physics of spring-mass technology share much with the way humans and other animals walk. But the designers have an even clearer comparison: a pogo stick. Think of what happens when a pogo stick meets the ground. Because of the weight of the person on the stick, the spring compresses, meaning that the coils are pushed close together. This stores potential energy that is quickly used when the spring uncoils, launching the stick (and the person riding it) back into the air.

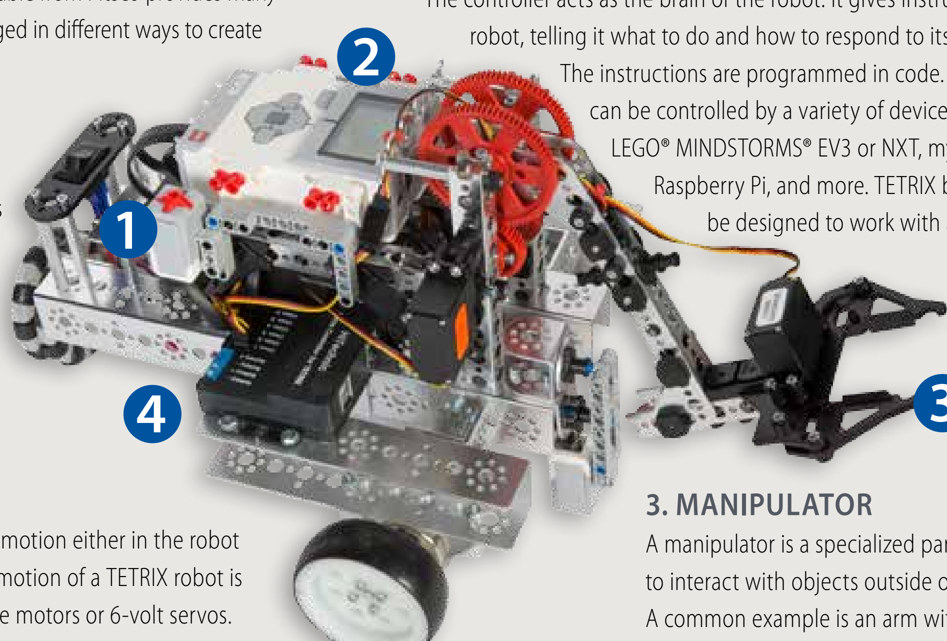
ATRIAS uses fiberglass springs mounted to its legs. The springs give the robot extra bounce

> You can see numerous tests of the ATRIAS robot on YouTube. (Here is a great video to start with: www.youtube.com/watch?v=dI7KUUVHC-M)

Core components of a robot

CHECK OUT:
www.TETRIXrobotics.com

Robots are created for all sorts of purposes, but many share common features. The TETRIX® Building System available from Pitsco provides many of these common parts. They can be arranged in different ways to create an endless variety of builds.



1. SENSORS

Sensors enable a robot to receive feedback about its environment. Many robotic sensors mimic the five human senses – most commonly sight and touch. For example, a robot designed to follow a line drawn on the ground might have a sensor that can detect color. A bump sensor can let a robot know when it has encountered a wall.

2. CONTROLLER

The controller acts as the brain of the robot. It gives instructions to the robot, telling it what to do and how to respond to its environment. The instructions are programmed in code. TETRIX robots can be controlled by a variety of devices such as LEGO® MINDSTORMS® EV3 or NXT, myRio, Arduino, Raspberry Pi, and more. TETRIX builds can also be designed to work with a remote control.

3. MANIPULATOR

A manipulator is a specialized part designed to interact with objects outside of the robot. A common example is an arm with a gripper.

4. DRIVE SYSTEM

A robot's drive system creates motion either in the robot as a whole or in its parts. The motion of a TETRIX robot is powered by either 12-volt drive motors or 6-volt servos.

for each step. And you can see this in the way it walks. It even bounces in place when standing in one spot! The spring in ATRIAS's step also works like a suspension system in a car, absorbing the shock that comes from impacting the ground with its feet.

THE OLD AND THE NEW

According to Hurst, "Other robotic approaches may have legs and motion, but don't really capture the underlying physics. We're convinced this is the approach on which the most successful legged robots will work. . . . This is the way to go."

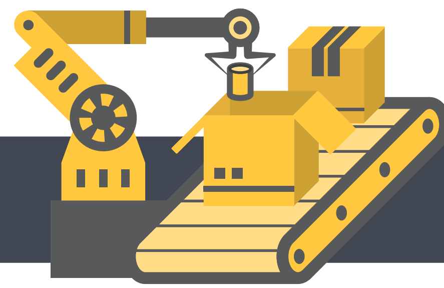
Animals don't have springs in their legs, but they do have muscles, tendons, and bones that work together with similar effect. The result might appear more graceful in animals, but the researchers were inspired by what nature has already provided.

Like animals, ATRIAS walks well over uneven surfaces. It can do this despite walking blind (having no knowledge of its terrain). ATRIAS also resists being knocked over. And how did the researchers test this? They pummeled it with dodgeballs, of course. Never fear! ATRIAS kept right on walking.

Though ATRIAS is protected by a support system that will catch it if it loses its balance during tests, ATRIAS is very capable of walking without it.

Credit: Oregon State University

Career Fields
- Robotics engineer
- Anatomist



Fact

All around the world, robots are used on factory floors to manufacture products. Many of these robots are mounted in place and use an arm or arms to interact with products. A robot's range of movement is called its work envelope. The work envelope consists of every location the robot can reach to do work.

University of Washington researchers have reconstructed 3-D models of celebrities such as Tom Hanks from large Internet photo collections. The models can be controlled by photos or videos of another person.

Photo Credit: University of Washington

Career Fields
- Photographer
- Computer scientist

Tom Hanks and the intelligent machine

"Hello. I like to eat ketchup sandwiches while standing on my head," said actor Tom Hanks.

OK, he didn't actually say that. But someday we will be able to use computers to easily create convincing footage of real people saying things they never said. And then, oh boy – watch out, Tom Hanks! Just such a program is being developed by researchers at the University of Washington (UW).

Technology that can do this already exists, but it isn't simple to use. It often requires bringing the person into a studio, scanning their face, and taking many careful photos of different facial expressions.

The system at UW instead creates its 3-D model from collections of 2-D (flat) photos found on the Internet. For this, the researchers developed a special algorithm. (An algorithm is a process that a computer follows.) This algorithm needs at least 200 images to do its work.

The algorithm shows the computer how to map a person's face by carefully analyzing the images. It learns to mimic different expressions and to portray the person in three dimensions. Using photos that already exist rather than ones specifically tailored for the purpose is a great challenge. The algorithm must be much more adaptable. This type of machine learning is called learning "in the wild."

The researchers envision that someday computers might even be able to create convincing 3-D simulations of our friends and relatives based on personal photos.

A meeting of the minds

Humans have a talent for coming up with solutions to difficult problems. More and more, however, artificial intelligence systems are learning to lend a hand.

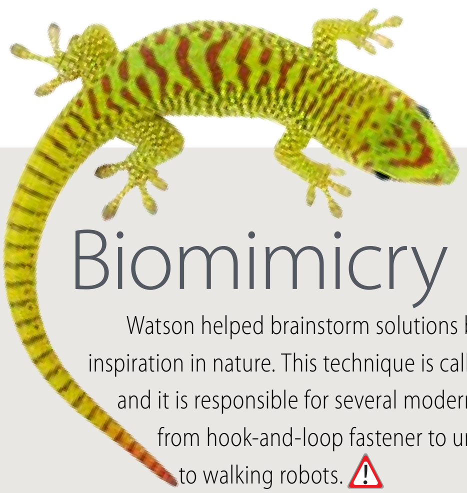
SySTEM Alert! previously reported on the IBM computer system Watson. Watson first made headlines by beating human champions on the game show *Jeopardy!* A couple of years later, Watson made another splash as a tool for medical professionals, helping to quickly sort through information related to lung cancer.

Recently, Watson was involved in an interesting experiment that shows another way humans and computers can work together to come up with creative solutions. Six teams of students at the Georgia Institute of Technology chatted with Watson to come up with innovative ideas to deal with big challenges.

What makes Watson special is its ability to use human language to answer questions and to quickly search through and interpret huge amounts of information. For this experiment, Watson prepped by consuming hundreds of articles about biology. This was Watson's store of knowledge. The students then asked Watson questions relating to the challenges they were trying to solve.

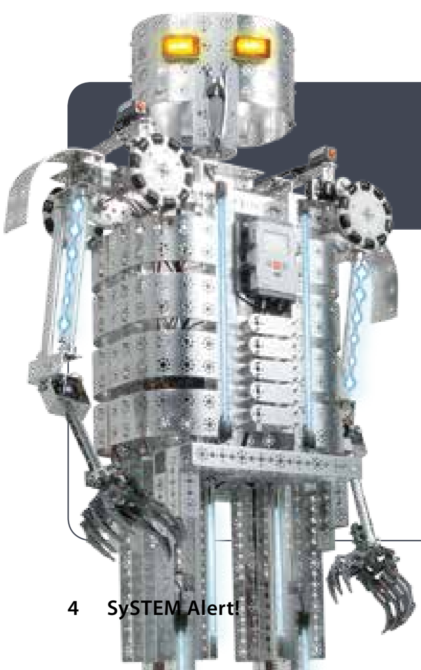
For example, students asked about developing solar cells for long-term space travel. Watson scoured the biology articles and turned up information about plants in harsh environments that insulate themselves and regulate their temperatures. Is this a good solution for solar cells? Maybe, maybe not. But what is really interesting is the technique of human-computer cooperation that led to the answer.

Watson doesn't truly understand the questions it is asked or the answers it gives – at least not in the way humans do. But it does sort through information very efficiently. And of course, Watson's replies are only as good as the data it has to work with. In this case, because it was prepared with biology articles, the solutions it helped generate were related to biology.



Biomimicry

Watson helped brainstorm solutions by looking for inspiration in nature. This technique is called biomimicry, and it is responsible for several modern innovations from hook-and-loop fastener to underwater tape to walking robots.



Fact

The word robot *came to the public from a 1920 play called* R.U.R. (Rossum's Universal Robots). *The word related to words meaning "work" and "labor" – and also to the unpaid serfs that performed labor in those days.*

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Student name: ______________________ **Class/Hour**: __________

SySTEM Alert! Quiz (Volume 4, Number 4)

This quiz covers the information in *SySTEM Alert!* Volume 4, Number 4. Circle the letter of the correct answer or write the letter by the question number.

1. Spring-mass technology has been compared to which toy?
   A. Slinky
   B. pogo stick
   C. paddle ball
   D. Xbox

2. A model or version that is used to test an idea is called a _______.
   A. prototype
   B. automaton
   C. serf
   D. controller

3. _______ is the amount of work that can be done with the energy available.
   A. Envelope
   B. Drive system
   C. Locomotion
   D. Efficiency

4. How did researchers test ATRIAS's balance?
   A. They hit it with padded baseball bats.
   B. They tested it in a simulated earthquake.
   C. They threw dodgeballs at it.
   D. The placed it in a wind tunnel.

5. At about what age do kittens begin to walk?
   A. one day
   B. one week
   C. three weeks
   D. six weeks

6. Biomimicry is a technique of creating technology that imitates _______.
   A. human behavior
   B. nature
   C. language
   D. atoms

7. Which 1920 play introduced the word *robot* to the public?
   A. *R.U.R.*
   B. *Waiting for Godot*
   C. *Death of a Salesman*
   D. *Romeo and Juliet*

8. A robot's range of movement is called its _______.
   A. reach
   B. work envelope
   C. ability sphere
   D. influence vector

9. A(n) _______ is a process that a computer follows.
   A. algorithm
   B. path
   C. programming language
   D. decision tree

10. What is the role of a robot's manipulator?
   A. to act as the brain of the robot
   B. to power the motion of the robot
   C. to give the robot information about its environment
   D. to interact with objects outside of the robot

Bonus question:
Are there any skills you believe robots will never be able to perform? Why or why not?