Then and NOW

KOREAN ROBOTICS

by Tom Carroll

Korea has ambitious plans to implement robotics in education, medicine, and in the military. Growth in robotics research and sales in Korea is predicted to increase from $1 billion (US) in 2007 to $10 billion (US) in 2010, though the international recession may cut that back a bit.

Scientific breakthroughs abound as Korean universities and high-tech companies continue to develop amazing products for the world, including robots. The Hubo-Einstein robot developed by the Korea Advanced Institute of Science (KAIST) back in 2004 has astounded audiences around the world.

One of South Korea's major goals is to have a robot in every South Korean home by the year 2020, and they just might accomplish this goal.

Korea Reinvents Itself

Let's step back a few years and see how Korea became the center of industry that it is today. Prior to World War II and even back into the 19th century, Korean 'experimenters' and novelty makers built wind-up automatons similar to ones built in Japan and China. Korea was truly a Third World country a century ago and struggled to feed and clothe its citizens.

After the Korean War (which technically is not over), Korea was determined to become an industrial force and rid itself of "Third World" status. Since this war, Korean industries have been grouped into "chaebols," or what we might call conglomerates or monopolies, all sanctioned by the Korean government. Grouping was frequently under 'semiconductors,' 'heavy machinery,' and similar classifications.

Samsung, Hyundai, Lucky Goldstar (now called LG), Hanjin, Daewoo, and other large industries form the core of Korea's industrial capability. Unfortunately, to achieve their lofty status, most of these companies have suffered disgraces from bribery and money mismanagement charges.

Spot welding robots imported from Japan were first used in a Hyundai automobile plant in 1978. In 1986, Daewoo Heavy Industries produced the Yaskawa NOVA-10 robot in Korea — a series of manufacturing robots that were shipped world-wide. During the Asian financial crisis of 1997-98, a shift was made away from the industrial robot sector to the development of service and intelligent robots.

Robotics follows automobiles, consumer electronics, and computers as the main thrust of Korean industries, with personal/service robots and robotic appliances a main part of that industrial sector.

More Robot Vacuum Cleaners

Korean companies have developed some interesting robotic devices to assist the homemaker. Korean electronics giant, Samsung has manufactured several robot vacuum cleaners that have been sold in Asian countries, but very few in the US. Samsung took into account some of the issues with the world's best selling Roomba and introduced the VC-RP30W at the end of 2003. Figure 1 shows this unit which is quite a bit taller than a Roomba.

Touted as having a "3-D mapping capability," it supposedly could map a specific room and determine the location of furniture and other obstacles, then accurately cover the floor area in one pass. It did not use the random 'grazing sheep' pattern adopted by others.

As with all high-end robotic cleaners, the VC-RP30W could be programmed manually, but this unit could also be remotely programmed through a computer. It could cross thresholds to enter and clean a separate room. It could also automatically dock and recharge itself after 50 minutes of operation.

It included some of the features of iRobot's Connect-R in that it had a camera attached for remote viewing,

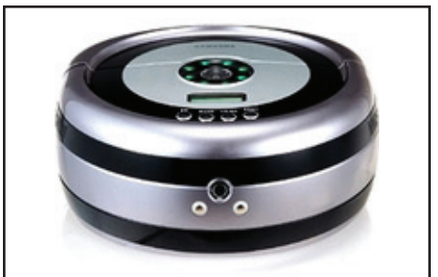


FIGURE 1.

FIGURE 2.

FIGURE 3.

FIGURE 4.

and as a final touch, it released negative ions to purify the air as it cleaned the floors.

In mid 2006, Samsung announced two new robot vacuum cleaners: the VC-RS60 and the VC-RS60H 'premium model' priced at $945 and $1050, respectively. Though only available in Korea at that time, it has since spread to other distributors for sale in other countries.

These newer units use UV lighting to detect dirt and debris not seen by human eyes. A remote control can allow the user to override the robot's operation to re-clean an area that an operator feels needs more attention. Having the same connectivity as the previous models, a person can call their home and direct the robot to clean a specific room using speech recognition. All of these robot vacuum cleaners are better suited to hardwood and non-carpeted floors.

The latest (2008) Samsung robot vacuum cleaner model is the VC-RE70V from their line of Hauzen 'premium home appliances.' Figure 2 shows the VC-RE70 with two sets of revolving brushes (similar to Roombas). This new offering from Samsung also uses a camera to visually look where it has already vacuumed and where to avoid on the next pass.

Samsung is not the only Korean company to produce consumer robot floor cleaners. Microrobot (not to be confused with the old US experimental robot arm company, Microbot) brought out the UBOT robot vacuum cleaner shown in Figure 3. It bests the offerings from Samsung in that it vacuums, sweeps, and mops hard floors in one pass. It also applies an antibacterial agent in the process.

Another unique feature is that it can read invisible barcodes pre-printed on specially designed floorboards to align its sweeping passes — a technique Microrobot calls their "2-D Barcode Navigation System." The UBOT's larger battery allows it to sweep continuously for four hours before following the barcodes back to its station for recharging. Like the Roomba, it talks to its users with a synthesized voice. The vacuum boasts a 60 watt motor and is quite a bit taller than the Roomba series.

There are several other Korean robot vacuum cleaners such as the 'Steamer' that sounds a bit like the UBOT in that it also vacuums and then mops, but one that caught my eye back in late 2006 was a cute-looking robot vacuum marketed by the Korean company, ETRI. Called the ROMI, it has endeared many people because it seems to look more like a robot than the flat saucer-shaped discs of all the others.

Reportedly, not only does the ROMI shown in Figure 4 do a good job of cleaning floors, its camera eyes and a microphone allow a remote user to see and communicate by Wi-Fi or through a CDMA computer link. Though it has a hand-held remote control like most of the better robot floor cleaners, the ROMI can also be controlled by voice commands. I feel that its robot-like appearance will appeal to more people as time goes on, despite the inability of the ROMI to clean beneath any furniture due to its large size.

ETRI also developed a strange-looking 'penguin' robot called POMI (Figure 5) that uses artificial intelligence and 'five-senses-mounted emotional expression.' Developed by Korea's Electronics and Telecommunications Research Institute, POMI can emit two 'unspecified' odors (I'm not sure what that implies), can create different facial expressions according to its moods, and should be on sale now.

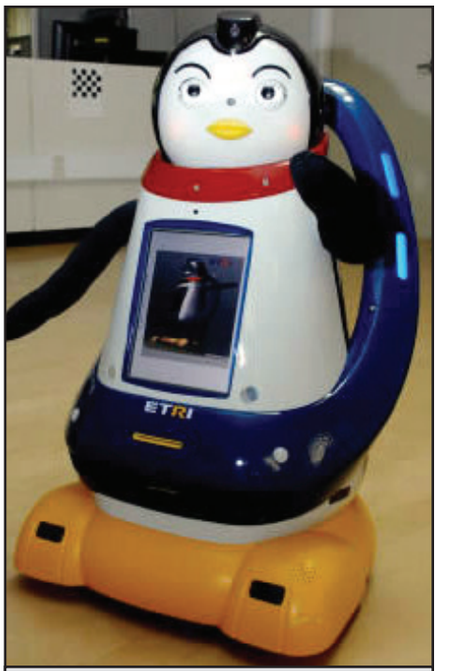


FIGURE 5.

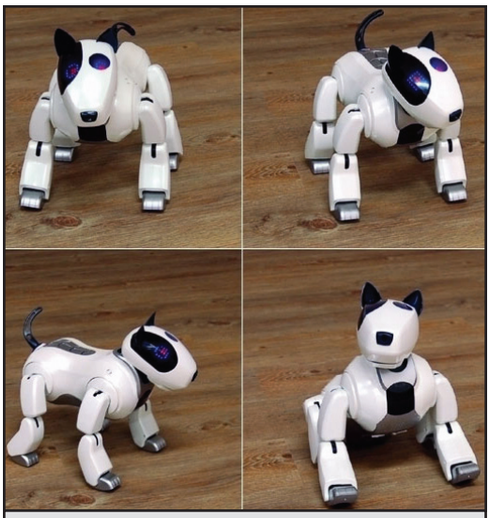


FIGURE 6.

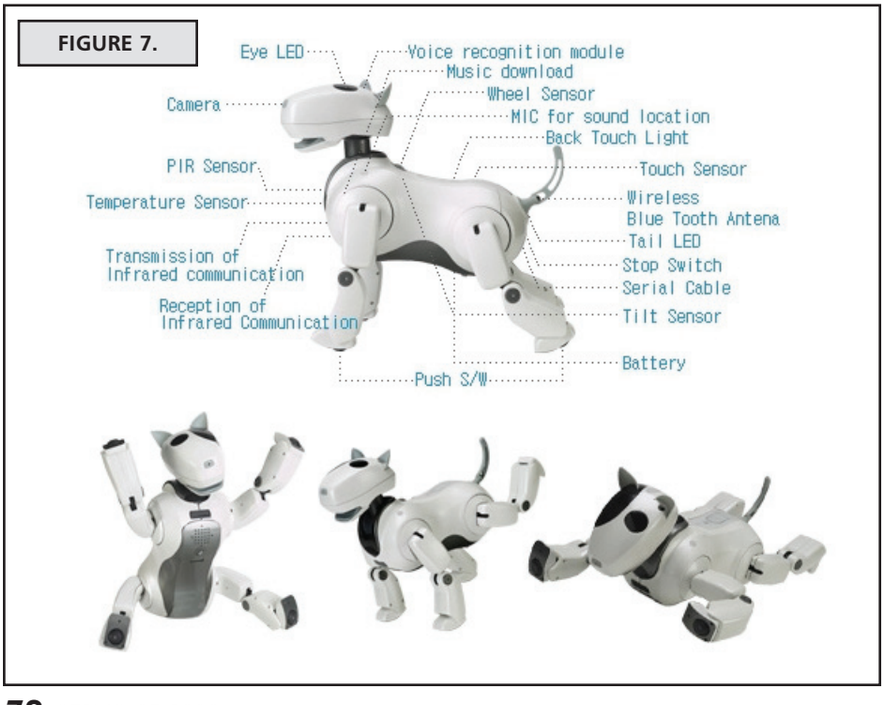
Genibo, a follow-on to Aibo and i-Cybie

As with most Asian countries, all types of robots appeal to the consumers, especially robots that resemble other animate objects like people and pets. DasaTech based in Korea developed an Aibo/i-Cybie lookalike robot dog back in 2006 called Genibo for 'genius' and 'robot. DasaTech has long been in the industrial robot business manufacturing mechatronic components for robotic systems and small assembly robots. The decision to build a service robot like Genibo was a departure from their standard business.

Priced between $1,700 to $2,200, Genibo certainly has more features than the i-Cybie of several years ago. Figure 6 shows the earlier proto-type version, courtesy of **iiRobotics.com** and Figure 7 illustrates its features. The robot stands about a foot high and weighs in at 1.5 kg. It can respond to 100 different word commands, including the standard "come here" and "sit." The newer models have a translucent face that shows the individual 'eye' LEDs in several different patterns, according to the mood of the pup.

The robot can emit a loud bark, has a camera in the snout, and can interact with others of its species (just like Aibo and i-Cybie). Like the others, the robot can sense when petted, can avoid obstacles, and can take a picture with its camera and transmit it via Bluetooth to a computer. When left alone, the robot will wander about like any live dog. The 17 motors driving individual joints are controlled by two CPUs, a 32-bit RISC processor, and an eight-bit microcontroller.

FIGURE 7.



Humanoid Robots

Humanoids have long been the rage in Asian countries and Korea has built some of the world's best. The Korean-designed Hubo and its Einstein version have been on all the blogs, YouTube videos, and technical news agencies since 2004, but that was just one of many humanoid robots to have been designed and built there.

Starting at robots for the home and especially for children, there are the two robots from Yujin Robotics. The iRobi prototype is shown in Figure 8 and its twin, Jupiter, is shown in Figure 9. Both are intended to be household robots and tutors for children. Using Evolution Robotics' NorthStar robot navigation system sensor mounted on top and NorthStar projectors to fit a home environment, the robot can move autonomously about the home. Yujin cooperated with the Korean Ministry of Information and Communication to develop this $1,000 US robot companion.

The original intent was to have the educational robot read stories to children and possibly sing and dance to keep their attention. Multiple robots in a school situation could be interconnected through a broadband server network to minimize the robot's onboard functions and overall cost.

Initially, 64 prototype units were placed in households for testing. The NorthStar system projected IR spots on the ceiling for the robot to locate and orientate itself within the home. Each IR light spot was coded so the robot could know its exact location. The same NorthStar system is being investigated for use in robot vacuum cleaner navigation.

Service Robot Platform Initiative (SeRoPi)

Another remarkable humanoid robot built by researchers at the Korea

Institute of Industrial Technology bears little resemblance to the Hubo bipedal humanoid developed by KAIST. SeRoPi uses a far more stable wheeled mobile base than Hubo and Asimo's bipedal structure. SeRoPi's wheels allow it to move about at a fairly fast 4.5 mph — a fast walk for humans.

What distinguishes SeRoPi from the others is its dexterous arms and 'hands' that allow it to reach down to the floor to pick up objects. Using dual stereoscopic camera eyes to recognize objects, SeRoPi can use both hands to manipulate these objects using computer vision.

The 132 pound, 50 inch tall robot maneuvers itself around on two differentially-driven wheels with a passive castor wheel for balance.

FIGURE 8.

FIGURE 9.

The Robotis Dynamixel Actuators

Robotis Bioloid Dynamixel servos are different from all the other model-aircraft types of servos because of their onboard intelligence. In fact, they're referred to as actuators instead of servos.

The basic AX-12 Dynamixel actuators (see Figure 10) have the usual motor and associated geartrain that we are all familiar with, but the similarity ends there. Each AX-12 actuator has its own serial ID over a 'Robotis TTL multi-drop digital packet communications network' and because of this, a single set of three wires — data, 9.6V VDC, and ground — runs to all actuators in series. Or they can be daisy chained together as shown in Figures 11A and 11B (courtesy of CrustCrawler).

FIGURE 10.

There are two identical Molex type connectors on the sides to allow each successive actuator to be connected with a jumper cable. Typical PWM model aircraft servos usually require three leads to each individual servo, or at least an individual 1.0-2.0 ms PWM signal lead to each, and shared power and ground leads.

Digital packet communication is possible with all Dynamixel actuators to control direction, speed, and torque with actual feedback of these parameters and — depending on the model — outputs of internal temperature, voltage, light, and sound detection. The individual user manuals are very well written. The higher-end models — DX-117, EX-106, RX-10, RX-28, and RX-64 — use RS-485 network communication and have metal gears.

The Dynamixel AX-S1 smart sensor module integrates a three-directional infrared distance sensor, an infrared remote control receiver, a sound sensor, a light sensor, and a buzzer, as well as the network interface to communicate with the actuators and controller. It can also detect small internal temperature changes, the system's voltage, and convey all readings into a range of 1,024 increments at up to 1 Mbps. It utilizes the same daisy chain interconnections as the series of actuators.

As with the AX-12, the recommended operating voltage for the AX-S1 is 9.6 volts; not the 4.8 to 6 volts with model aircraft servos. The sensor module shown in Figure 12 looks a lot like the AX-12 and is mounted in a similar manner, but the round flange is just a mounting area, not a rotating disc.

The Robotis CM-5 main controller is based on the popular Atmel ATMega 128 (128K of Flash memory) running at 17 MHz. Also configured for 9.6 VDC, it can communicate with the AX series of Dynamixels, their two-axis gyro module, the AX-S1, the Zigbee ZIG-100 standard, RS-232 or RS-485 serial, and by six command buttons on the panel. The controller also has an LCD display for data display and control. There is a stand-alone CM-2+ evaluation board with the same Atmel controller and similar functions that is fully compatible with the Bioloid components for dedicated control systems.

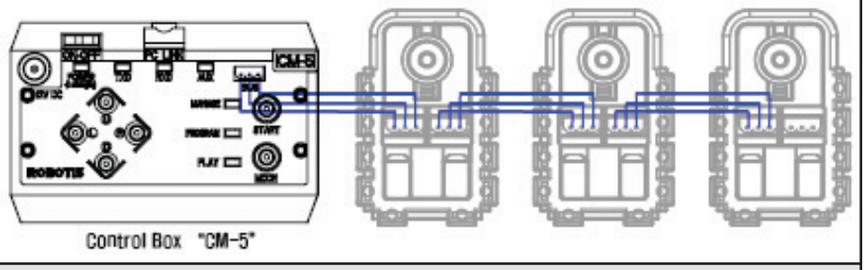


FIGURE 11A.

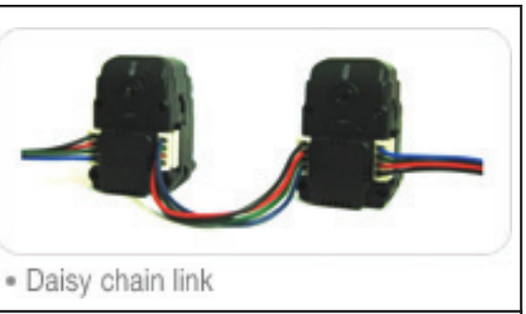


FIGURE 11B.

FIGURE 12.

Robotis Bioloid Kits

The Bioloid system components are similar to the LEGO NXT kits in that the actuators and supporting members can be assembled in 'building block' fashion to create bipedal robots, multi-axis arms (like CrustCrawler's AX-12 Smart Arm), interesting creatures, wheeled robots, commercial proof-of-concept mechanisms, or anything that you can think of that needs intelligent motion control. The Robotis Ollo kits are also very similar to the LEGO system in that they use plastic snap-together parts to assemble simple kits for younger robotics experimenters from ages 7 to 10. The Robotis Beginner's Kit priced at $349 is a great start in learning this new type of servo technology but many experimenters begin with the $899 Bioloid Comprehensive Kit shown in Figure 13.

The Comprehensive Kit comes with 18 AX-12 Dynamixel actuator servos, a CM-5 controller, an AX-S1 sensor module, and over 100 plastic structural brackets with associated fasteners from which you can create over 12 different robots. These include the popular bipedal humanoid robot, a quadruped puppy, robot dinosaurs, six-legged insect robots, and an autonomous exploratory robot.

Unlike dedicated kits, these kits can be configured in any fashion you desire in developing a robotic, computer-controlled mechanism. The top end "Expert Kit" at $2,999 is a bit beyond most experimenter's budgets but has found uses in university and industrial applications. Robotis is proud that it furnished 50 kits to the US Naval Academy.

You can go to **robotis.com** to look over their line of products or to **crustcrawler.com** or **robotshop.com** to buy a kit. As mentioned earlier, their downloadable manuals are easy to understand with few translation problems.

FIGURE 13.

Final Thoughts

There are many amazing robotic products made in Korea. The EveR-1 and EveR-3 female humanoids from KITECH that first made the scene back in 2006 will evolve into the EveR-4, which is expected to debut in 2010, as well as a male version.

Newer versions of the HUBO are seen on TV and in the news around the world. Robot home appliances from Korea are first rate and very functional. It appears Korea will be in the forefront of robotics for years to come, both in industrial and domestic applications. SV

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