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DARwIn's Evolution: Development of a Humanoid Robot

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Abstract— **The Dynamic Anthropomorphic Robot with Intelligence (DARwIn), a humanoid robot, is a sophisticated hardware platform used for studying bipedal gaits that has evolved over time. Three version of DARwIn have been developed, each an improvement on its predecessor. The first version, DARwIn 0.0, was used as a design study to determine the feasibility of creating a small-scale humanoid robot. The second version, DARwIn 1.0, used improved gaits and software. The third version, DARwIn 2.0 has not only even better gaits and control software, but also has artificial intelligence. The platform is primarily used as a research tool for studying bipedal and humanoid locomotion. Additionally, DARwIn 2.0 has been tailored for the international autonomous robot soccer competition, Robocup.**

I. INTRODUCTION

THE Dynamic Anthropomorphic Robot with Intelligence (DARwIn), a humanoid robot, is a sophisticated hardware platform used for studying bipedal gaits that has evolved over time. Three version of DARwIn have been developed, each an improvement on its predecessor. The first version, DARwIn 0.0, was used as a design study to determine the feasibility of creating a humanoid robot. The second version, DARwIn 1.0 (1), used improved gaits and software. The third version, DARwIn 2.0 (2) has not only even better gaits and control software, but also has artificial intelligence. The platform is primarily used as a research tool for studying bipedal and humanoid locomotion. Additionally, DARwIn has been tailored for the international autonomous robot soccer competition, Robocup. Robocup, aside from being a competition, is a venue for advancing research in humanoid locomotion and robot intelligence [1-2]

The initial design study on DARwIn 0.0 (1) showed successful integration of software and motor control of a 21 degree of freedom (DOF) humanoid robot. DARwIn 0.0 could stand up and walk under the control of software created at RoMeLa, the robotics and mechanisms lab at Virginia Tech. However, this initial design study did not use rate gyros or force sensors for feedback to control the motions.

DARwIn 1.0, was a great improvement from DARwIn 0.0. DARwIn 1.0 was controlled by more sophisticated software and gait generation techniques from [3-4], which led to stable walking motions. DARwIn 1.0 was also designed to house an onboard computer, battery power, and a rate gyro.

Fig. 1. DARwIn 1.0, DARwIn 0.0's successor

DARwIn 2.0 was an evolutionary step from its predecessors. DARwIn 2.0 used gaits generated in Mathematica and simulated as an openGL model to walk quickly and efficiently. Additionally, DARwIn 2.0 has a brain, which is comprised of a PC104+ computer, two IEEE 1394 cameras, a rate gyro, and 802.11 wireless network communications. Intelligent software used on DARwIn identifies and locates objects [5], and allows DARwIn to perform high level task, like playing soccer.

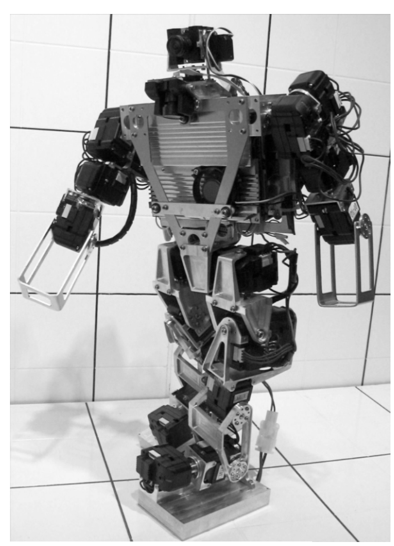

Fig. 2. DARwIn 2.0

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II. Sensor and Hardware Description

The robots' motors are controlled over a serial RS-485 network and built in potentiometers, which give back joint positions. While the robot is walking or moving, a rate gyro with acceleration and orientation information communicates over an RS-232 serial connection so the robot can modify its gait and balance in real-time.

Initially the only sensors needed for the robotic research platform were the servo motors' potentiometers and the rate gyro. However, taking part in the July 2007 Robocup competition required more sophisticated hardware and sensors. Cameras (eyes), a PC104+ computer (AI, brain), and an 802.11 port (communication) were added on to the existing stable walking robot in order to make DARwIn a competitive soccer player. The 802.11 wireless networking port allows for the robot to be completely autonomous and untethered during operation. The robot is instead controlled via a web host, which gives information including stop and start signals.

III. Software Description

Since DARwIn is primarily a research platform for studying gaits and locomotion, it is important to have software that makes it easy to deploy and test gaits. One challenge when generating mathematical formulations of the robot's locomotion is visualizing the results. Using gaits generated in Mathematica, the motions were simulated in an openGL environment to visualize the robot's gait (3). This allowed for quick visual verification of generated walking gaits.

When ready to test gaits on the physical hardware, the robot's artificial intelligence, which will be explained later, can be bypassed and emulated by a user controlled joystick. The user acts as the robot's eyes and brain, while the joystick acts as an interface to control the robots motion by sending commands like: walk, kick, dive, etc. This simplifies debugging of gaits and motion generation without simultaneously debugging the robot's behavior.

Figure 4 shows how the reactive behavior based artificial intelligence interfaces with the rest of the robotic system. The artificial intelligence runs on the PC104+ board and uses sensory data like the cameras to determine the robot's action, which is sent to the gait generator. The gait generator uses feedback from the rate gyro to create a modified stable gait to send to the servo motors of the robot. The 802.11 Wi-fi port allows the robot to communicate with a web host, which allows the public to see chosen information on the web, and allows for an operational control unit (OCU) to take over control of the robot's actions.

IV. Conclusion

DARwIn is a sophisticated robot that has evolved through three generations thus far. The result is an autonomous bipedal humanoid robot, that walk dynamically and has intelligence that allows it perform higher level tasks, like playing soccer.

References

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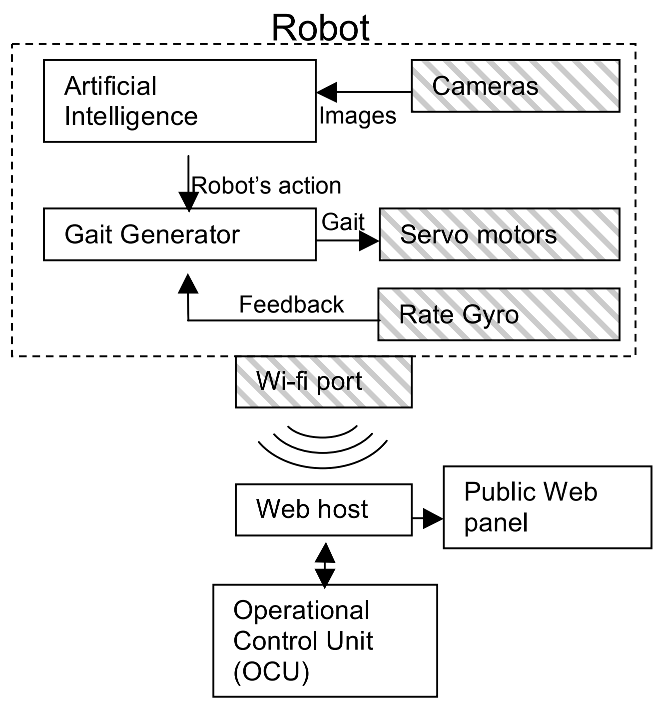

Fig. 4. Block diagram of software (white) and hardware (striped) interaction