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Robomotor White Paper

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Abstract:

The robotics industry is rapidly growing at the approximate rate of 25% annually. This represents an increase in annual sales totaling over 1 billion dollars. As robotics is incorporated into many new applications with manufacturers worldwide seeking ways to boost productivity, improve quality and lower costs, the robotics industry is sure to continue to blossom.

Furthermore, there is a growing fascination with robots among the general public. With the proliferation of robot images in commercials and motion pictures, television shows such as "Robot Wars" where robots compete with each other, and the general availability of robotic equipment to hobbyists, robot interest is on the rise. Most commonly available are wireless robots, with simple hand held controls. These operate in real time and do not allow for programming or precise repeatability of motion. Beyond wireless, robotics is more difficult to implement, requiring knowledge of electronics, motor dynamics, and programming. It has therefore been out of the hands of the average person...Until now.

This paper introduces an exciting new product that has recently been patented. This product will be a welcome addition to the growing robotics industry, as it fills a void that heretofore has not been addressed. This product opens the door to a revolution in the robotics industry, and will greatly expand the field of "Self-Programming Robotics".

This paper describes "Robomotor", the fully integrated, self-programming robotic motor.

Introducing Robomotor:

Robomotor is simply a fully integrated robotic motor that acts as a motion reproducer, having both record and playback modes. Just like a camera records and plays back sounds & images, this Robomotor records and plays back motion.

In all robotic applications, the motion-producing element is the motor. Now, suppose there was a new kind of intelligent robotic motor that one could simply place in an application, physically show it how to perform, and it would do so. That is, you could take the robotic device and move it manually by hand, while it internally recorded and memorized this motion. Then upon your command, it would playback and reproduce that motion. Why, this would be so simple that anyone, even a person without any knowledge

of electronics or programming, would be able to make a robotic device. This would be revolutionary.

The Robomotor is the motion-reproducing element inside a robotics application. The Robomotor is a rotary device that moves both clockwise and counter-clockwise. With the proper gearing and motion-transposing device, any type of motion can be produced, such as rotary and linear motion. Three motors can be linked together to synchronously control three-axis motion, thereby re-creating three-dimensional motion in time and space.

Robomotor is simply installed into a robotics application where repetitive motion is required. Robomotor is then set to the Record mode and the application is moved manually by hand to define and teach it how to move. Upon completion, Robomotor is then set to the Playback mode and the application will move as it was taught. The motion will be exact in time and space.

How Robomotor works:

Robomotor comprises a closed-loop programmable motor assembly with internal memory that is specifically configured to record rotational motion, and play back this motion upon command. The assembly consists of a bi-directional motor, shaft encoder, and control electronics consisting of position decoder, memory, and motor driver circuitry.

A typical application would have Robomotor in a rotating positioning system. Robomotor is first programmed by placing it in the record mode, and rotating the shaft manually to describe the desired motion. During this record mode, digital information describing the shaft rotation is read from the shaft encoder and stored into the internal memory. This data is recorded time-synchronously, based on an internal time pulse generator. In the playback mode, the stored position data is synchronously read by the control electronics, using the same time pulse, and the motor is driven until the desired position is reached, thus moving the application. This process continues until the end of the programmed data is reached, while the application performs the desired motion.

Theory of operation:

Record Mode:

> During the record mode the motor shaft is manually rotated to describe the desired motion of the application. An internal clock oscillator generates synchronous timing pulses (example: every $1/100^{th}$ of a second). An encoder, attached to the motor shaft, sends out position information related to the movement and position of the shaft. Each time a timing pulse is received, the encoder position is recorded into memory. Thus the internal memory has stored within it the physical positions of the shaft for every $1/100^{th}$ of a second of time. In other words, for each second of time, the memory will store 100 shaft

positions, each relating to the amount of movement that occurred within that $1/100^{th}$ of a second.

Playback Mode:

During this mode the memory is synchronously accessed with the same time increments that were used during the record mode. The memory is read by the control electronics. The control drives the motor, while monitoring the shaft encoder until the desired amount of rotation is reached. This process continues at the rate of 100 times a second until the final memory position is reached, and the motor will no longer move.

The Future of Robomotor:

Robomotor can be manufactured in various sizes to match various applications. They can be categorized according to accuracy, torque, speed and response time.

They could be sold in local hardware stores, such as Home Depot, along with application notes, thus making them available to everyone wishing to develop a new robotic product for work or home.

Just as the introduction of the home personal computer lead to new applications that we could not at first foresee, the Robomotor will open up an entire new area of robotic applications that at the onset are difficult to imagine.

Demonstration Example: "The Robotic Wagon":

A typical child's wagon with a fixed front axle attached to the pulling handle can be converted to a Robotic Wagon to perform an interesting demonstration of Robomotor's potential.

Each of the two front wagon wheels will be attached to Robomotors. The Robomotors are electrically linked together and placed in the record mode. The wagon is then taken by the handle and moved around an obstacle course on a paved smooth parking lot and stopped at a chosen location. The Robomotors record mode is stopped.

Next, the wagon is returned to the starting position, the handle is removed, and the Robomotors placed in the playback mode. The wagon will take off by itself and move around the obstacle course by itself, reproducing every turn as recorded. It will continue to run at exactly the same speed as it was shown, and will stop in exactly the same specified location.