Meet Fido

“Mans best cyberfriend”

By Kevin Byrd

EEL 5666

Intelligent Machines Design Laboratory

ABSTRACT

Fido is the next generation in household pets. Ideally, he is a versatile cyber-pet that can be programmed and reprogrammed to custom match the personality and desires of its new owner. Fido can learn and adapt to its environment, display emotion and loyalty to the ones who care for it. Fido can “grow” with its owner into a lifelong upgradable friend. Now we enter a world where pets can be ordered from the Internet to precise specifications or chosen with random personalities for that surprise new pal. Say hello to your new cyber-friend.

INTRODUCTION

Fido is a mobile robotic platform capable of object manipulation via a working mechanical neck and jaw. It has two independent drive motors that allow the robot to drive and turn in all directions. It is powered by an eight AA rechargeable battery pack and runs an EVBU board with attached ME11. It houses five infrared receivers for sensory input and 4 emitters. It is fully machined out of 6061 aluminum, stainless steel, and bronze.

Platform

The major portion of the robot's structure was made from 6061 aluminum. Aluminum was chosen for its high strength to weight ratio, durability, corrosion resistance, relatively low cost, and availability.

The lower platform was made from .063" aluminum plate. The sides were folded down to form ribs in order to give it some rigidity. The platform originally measured 5" wide by 12.5" long but was extended an addition 3" for more stability.

Wheel Assembly

In order to support the weight of the entire robot and objects to be lifted, custom hub and wheel assemblies were made. The assembly consists of a stainless steel shaft, which is threaded on one end to be bolted and pinned to the wheel. The other end of the shaft slides into an adapter that is pinned to the hacked servo. A u-shaped hub mounts on the side of the robot and houses two pressed-fit bearings that support the shaft. A final adapter plate mounts to the side of the robot between the hub and platform plate.

This assembly is very important because it carries all of the weight of the robot. The drive motors may be removed without any hindrance to the robots ability to support itself or roll. Mounting the wheels directly to the servomotors will cause excessive wear and eventual failure.

Neck Mechanism

The neck consists of a four-bar linkage and a gear driven servo to correctly position the head and jaw for proper object manipulation. The kinematics were done in AutoCad using several different linkage configurations and iterations to define a specific path that the head would follow. The neck needed to swing forward yet simultaneously swivel down at a faster rate than what would be encountered in a single pivot swing-arm mechanism. A non-parallel or inverted four-bar linkage was chosen because of its ability to solve this problem.

The base supports were made from .125" aluminum angle with a .75x.75" square tubing spacer to obtain proper gear clearance. The top support was machined from a solid piece of billet aluminum to form a channel. The linkage pieces were machined from .25x.5" extruded aluminum stock. All of the pivot points were separated by nylon washers to reduce friction and wear.

A Futaba FP-S134 servomotor was used for the neck motion. A stainless steel adapter was made to bolt onto the plastic factory output on the servo. The adapter has a .125" diameter shaft that houses an output gear and protrudes into a support bearing made from Oilite®, an oil impregnated bronze. The support bearing is very important as it prevents the servo shaft from flexing and wear due to loading from the gears.

A gear reduction of 3.7:1 was used on the neck to give the servo more torque to lift the long and heavy assembly. The full range of 180 degrees by the servo translated into approximately 45 degrees of linkage motion and a corresponding 90 degrees of head swing. A return spring was connected from the head to the base to support the weight of the assembly. This allowed the servo to control only the motion of the neck without straining to simultaneously hold up its weight.

Head

The head and jaw mechanism was made up of four sets of parallel four-bar linkages that connect an upper and lower bucket to a u-shaped bracket that houses the Futaba-S134 servo actuator.

The linkage parts were made from .25x.5" extruded aluminum stock. Attached to two of the outer opposing bars were two similar gears for the opening and closing of the jaw. One of the geared bars attached directly to the servo which was mounted inside the head.

The upper and lower jaws were made from .063" aluminum sheet. They were sheared, bent, and welded to obtain the proper shape and dimensions.

The u-shaped housing was made from three pieces of .125" aluminum sheet. They were cut, welded, and then machined to allow mounting of the servo and linkages.

ELECTRONICS

The basic computer board used for the robot was the EVBU board and ME11. Both boards were mounted together, then fixed to the rear section of the platform with several # 4-40 machine screws.

Modifications

A series of three pin male headers were added along the side of the EVBU board running with the ground and positive trace. This header can hold up to eighteen different 3-pin input/output connections. Currently, eleven of these are being used- 5 for the IR receivers, 2 for the servos, 1 power supply to the servos, and 2 grounds for the IR emitters. Wire wrapping was used to connect the headers to the appropriate ports on the EVBU.

The supplied 1000 ohm resisters used for the 40 kHz outputs were replaced with 200 ohm resisters to improve the resolution of the IR sensors.

Sensors

Currently, five IR sensors and 4 IR emitters are being used for obstacle avoidance and object location. Several limit and bump switches are ready to be added for more sensory input. Also, mercury switches are to be added for stability input to be used in behavior modification.

Behavior

The Fido robot is an excellent platform to experiment with different types of behavior. It has an inherently visible appeal in that it mechanically mimics several different types of existing animals enough to allow an individual to imagine its behavior in a real creature (whether it be a dog or dinosaur).

By having a working jaw and neck, these motions add to the machine's ability to display behavior with subtle gestures, motions, and combined actions. The jaw can be used to eat, speak, show signs of aggression, hunger, or being hot or tired, chew, etc. Likewise, the neck can be used to enhance or add to these and other behaviors. A lowered neck can easily show signs of submission or finding a stick when playing fetch.

The basic sensor inputs are ready to be added and subtracted based on the bahavior(s) that are desired. The programming can be added to and modified to achieve any combination of desired behaviors. For the demo, a few simple behaviors were shown as examples of the many possibilities that await future creativity. Such simple behaviors shown were object manipulation, eating and chewing, obstacle avoidance, and what could be considered fear or shyness- backing away from an outstretched hand.

CONCLUSION

The idea behind Fido was to create an animal-like platform that would leave plenty of room for future exploration in the area of displayed behavior and possibly simple learning from the use of its sensors combined with intelligent algorithms.

APPENDIX

Drawings
Code