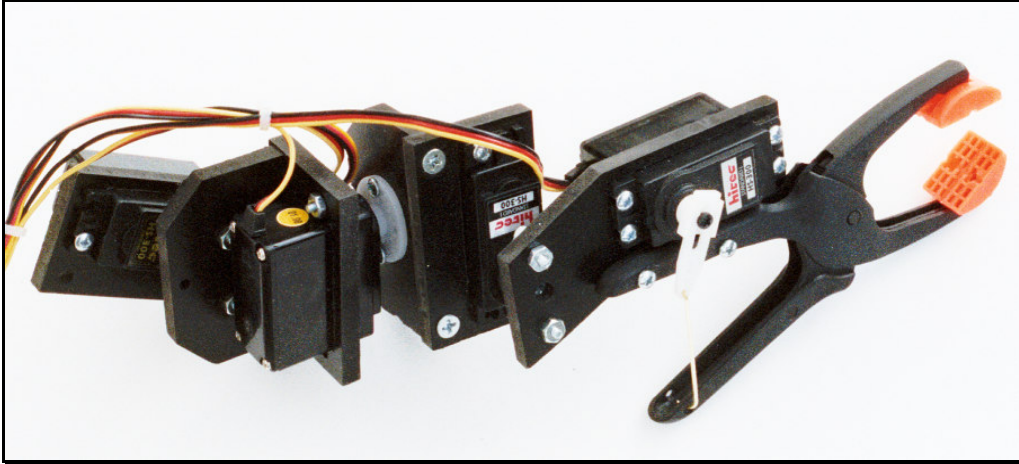


Budget Robotics Gripper and Wrist Kits Assembly Instructions



The Budget Robotics Gripper and Wrist kits offer a simple and low-cost solution to building your own robotic end-effector. Assembly is simple, and takes less than 15 minutes.

Both kits (sold separately) are intended for use with any standard-size servo of approximately 1 1/2" x 7/8" x 1 3/8". Popular standard-size servos include the Hitec HS-311 and HS-322, Futaba S-148 and S3003, Cirrus CS-36, GWS S03, and many others. Servos are not included in the basic kit, but can be purchased locally and online. A list of discount servo sources appears at the end of these instructions.

The Gripper and Wrist kits work well with economy servos. For added strength, you may wish to select a high-torque model -- standard-size servos average about 44 oz-in of torque at 6 volts, but higher torque versions offer torques of 50-70 oz-in, and above. However, even with servos of average torque, the gripper is able to put a significant "squeeze" on any object up to about one inch in girth. The high amount of pressure is made possible by the lever action of the clamp used as the gripper. The wrist mechanism can pick up and hold objects weighing 10-12 ounces; higher weights are possible by using higher torque servos. Additionally, increased torque can be achieved by powering the servos at 6 and even 7.2 volts. (Higher voltages are not recommended, unless you thoroughly test the limits of your servos.)

The Gripper kit comes with a pre-cut and pre-drilled plastic gripper mount, a high-impact clamp, and assorted hardware. The Wrist kit comes with pre-cut and pre-drilled plastic servo and servo horn mounts, and hardware. The plastic pieces are constructed using precision CNC routers. The plastic material used in the kits is strong but lightweight rigid expanded PVC.

The Wrist kit is designed to mimic the three degrees of freedom (DOF) of the human wrist and forearm - technically, radial flexion-ulnar flexion and flexion-extension movements of the wrist, and pronation-

supination of the forearm. The Gripper kit provides a single DOF of "finger closure." Combined, the Gripper and Wrist kits offer four DOF. The assembly, which weighs approximately 11 ounces with servos, can be mounted on a mobile or stationary robot.

The Gripper kit contains the following parts:

Quantity	Description
1	Pre-cut, pre-drilled plastic gripper mount
6	4-40 x 1/2" machine screws
2	4-40 x 3/4" machine screws
8	4-40 nuts
1	2" length stiff piano wire, bent to serve as a linkage

The Wrist kit contains the following parts:

Quantity	Description
3	Pre-cut, pre-drilled plastic servo mounts
2	Pre-cut, pre-drilled plastic servo horn mounts
10	4-40 x 1/2" machine screws
10	4-40 nuts
4	#6 x 3/4" self-tapping screws

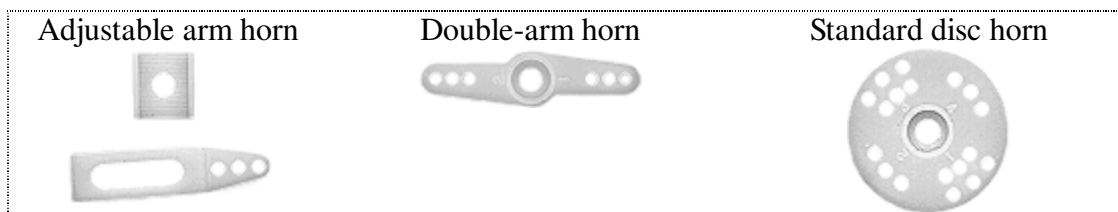
To complete the Gripper, you will need:

- 1 standard-size servo, with double-arm or adjustable arm horn.

To complete the Wrist, you will need:

- 3 standard-size servos, with (3) double-arm horns, or with (1) double-arm horn and (2) standard disc horn.

Example horns:



The gripper, servo, and horn mounts are pre-drilled for typical hole spacing in both Futaba- and Hitec-style servo horns. You will need to enlarge the holes in the horns to accommodate the 4-40 machine screws used in the kits. This can be done using a 3/32" drill bit.

Should the pre-drilled hole spacings in the gripper, servo, and horn mounts not match up with existing holes in your servo horns, you can readily drill new holes in either the mounts, or the servo horns.

Assembly Steps - Wrist

Step 1

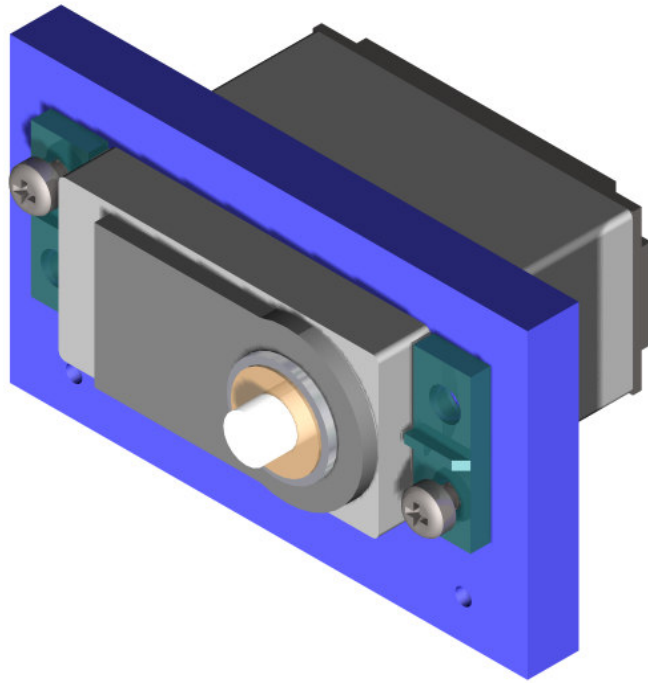
Using 4-40 x 1/2" machine screws and nuts, secure each of the three servos onto servo mounts, as shown.

Note: There is usually no need to use four machine screws for each servo. Two screws, on opposite corners of the servo mounting plate, are sufficient.

For some makes and models, the fit of the servos in the mount may be tight. As necessary, you can slightly enlarge the mounting hole using a small file.

Observe the orientation of the servo output shaft, along with the remaining two mounting holes of the mount. When viewed from the front, the shaft should be on the right, and the two mounting holes should be on the bottom.

When finished, you will have three servos in three mounts.

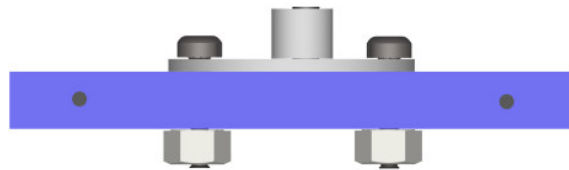
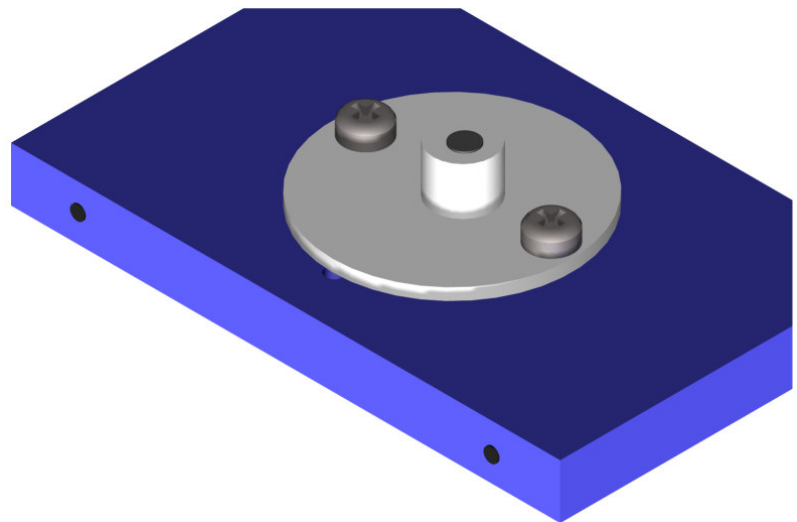


Step 2

Using 4-40 x 1/2" machine screws and nuts, attach a disc-shaped servo horn on a servo horn mount.

Repeat for the second servo horn mount.

When finished, you will have two servo horns on two horn mounts.



Side View

Step 3

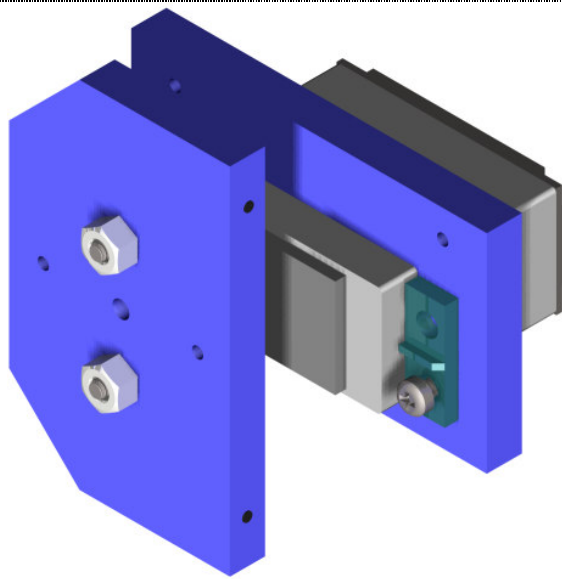
Take one mounted servo and orient as shown (holes facing the top).

Center the servo shaft to its midpoint. (You can temporarily mount a long-arm style horn to the servo so that you can turn the servo shaft. Rotate the shaft slowly so that the internal gears are not damaged.)

Note the orientation of the servo horn mount. The chamfered side should be on the left, as shown.

Insert the horn retaining screw (it comes with the servo), through the horn mount, and into the servo output shaft. *Do not over-tighten.*

This assembly is the wrist rotator.

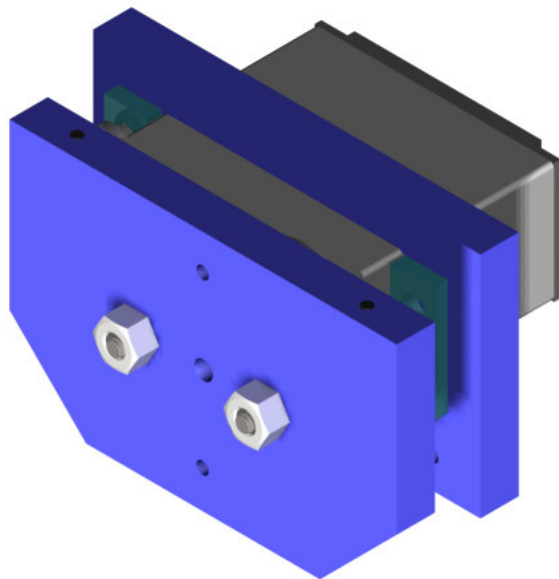


Step 4

Repeat step 3, above (including centering the servo), except:

- Orient the servo so that the holes in the mount are on the bottom, rather than the top.
- Attach the servo horn mount so that the chamfered side faces bottom.

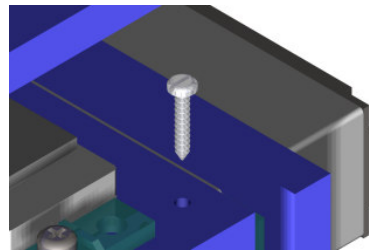
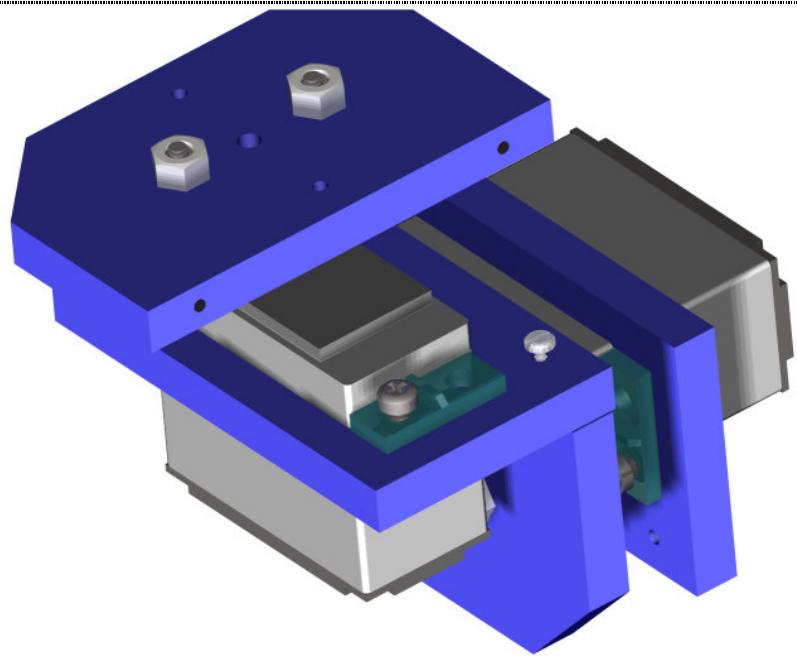
This assembly is the wrist flexor/extender.



Step 5

Attach the wrist rotator and the wrist flexor/extender subassemblies, as shown, using two #6 x 3/4" self-tapping screws.

The screws are flat-head, and should be tightened so that they are fairly flush with the surface of the plastic.



Self-tapping Screw Construction

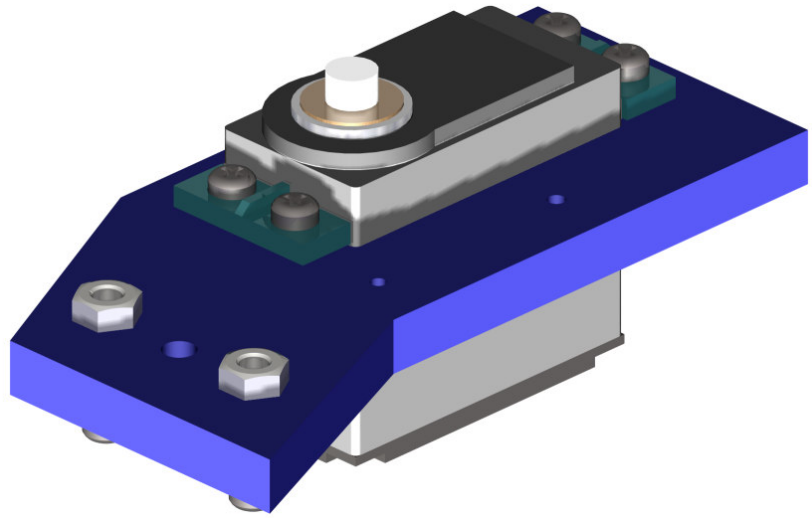
Assembly Steps - Gripper

Step 6

Using 4-40 x 1/2" machine screws and nuts, attach a servo to the gripper mount, as shown.

The angled portion of the mount should face toward the right. The servo shaft should be closest to the angled portion of the mount.

Additionally, attach a double arm horn to the angled portion of the mount, also using 4-40 x 1/2" machine screws and nuts. The nuts should be on the "top" of the mount (same side as the servo output shaft), and the horn should be on the bottom.



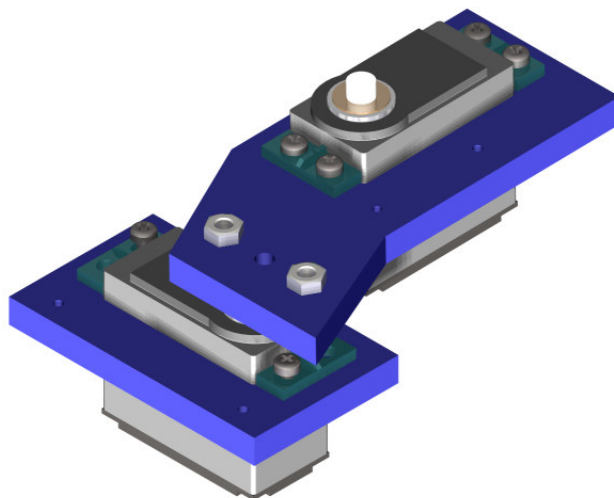
Step 7

When assembling the Gripper to the Wrist kit:

On the third and remaining mounted servo: center the servo shaft to its mid-point.

Attach the servo to the horn on the gripper mount.

Insert the horn retaining screw (it comes with the servo), through the gripper horn mount, and into the servo. *Do not over-tighten.*



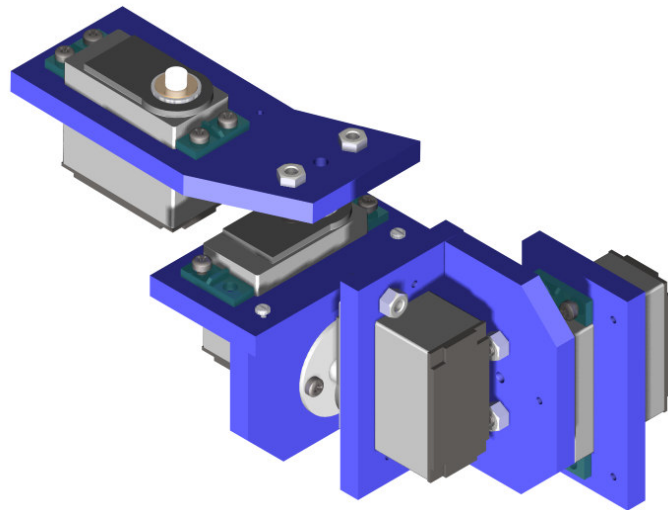
Step 8

Using #6 x 3/4" self-tapping screws, attach the gripper and servo from Step 7 to the previously constructed wrist subassemblies, as shown.

When completed, the Gripper and Wrist kits form a 4 DOF articulation that resembles the action of the human wrist and forearm.

Note the natural limitations of the mechanism. The Gripper and Arm kits are designed to accommodate a 60 degree arc for each servo. This arc is typical of servos operated by a radio controlled transmitter and receiver.

When operated from a computer or microcontroller, it is possible to extend the arc of the servos up to 180 degrees. Care should be taken that the extended arc does not cause the mechanism to bind or rub against itself.

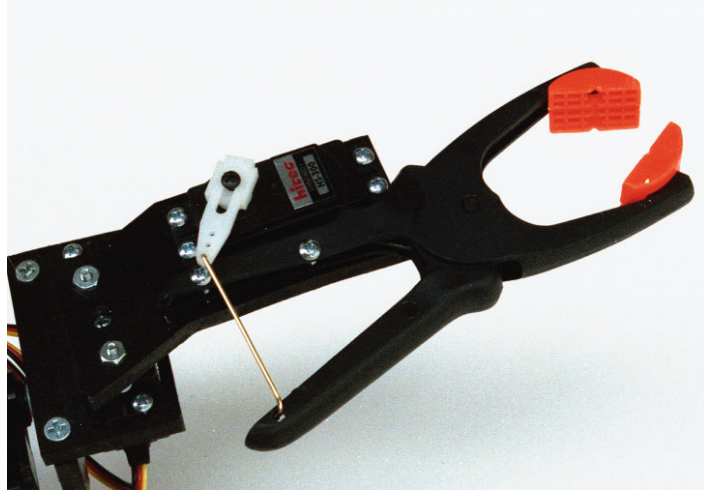


Step 9

The gripper is completed by attaching the clamp to the gripper mount using 4-40 x 3/4" machine screws and nuts.

Center the gripper servo to its mid-point, then attach a double-arm horn or adjustable arm horn. (When using a double-arm horn, cut off the opposite arm.)

Link the servo arm to the clamp using the supplied length of music wire. The wire comes pre-bent at the ends; after you have verified that the clamp opens and closed as the servo rotates, use a pair of pliers to cinch the wire securely in place.



Discount Servo Sources

Servos for the Gripper and Wrist kits are available from local hobby shops, as well as online. Here are some online sources of inexpensive servos:

Balsa Products

www.balsapr.com

Reseller of the low-cost Grand Wing servos, including the powerful (but slow) BP148T, rated at 100 oz-in.

Budget Robotics

www.budgetrobotics.com

Selection of Hitec and Cirrus brand servos.

Lynxmotion

www.lynxmotion.com

Hitec servos.

Servo City

www.servocity.com

Reseller of Hitec and Futaba servos.

Tower Hobbies

www.towerhobbies.com

Slightly higher prices than the others, but good selection and customer service.

For More Information...

The Gripper and Wrist kits are from:

Budget Robotics

PO Box 5821

Oceanside, CA 92056

**[http://www.budgetrobotics.com/
orders@budgetrobotics.com](http://www.budgetrobotics.com/orders@budgetrobotics.com)**

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