New Years Eve Ball Drop
Created by Ruiz Brothers

https://learn.adafruit.com/new-years-eve-ball-drop

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Since 1907, the Times Square Ball has been an annual spectacle that signals in the New Year. Commonly referred to as the ball drop, this 12-ft diameter glowing geodesic sphere descends from a flagpole at 11:59pm and takes 60 seconds. The ball itself has been redesigned over the years to reflect the latest in lighting technology.

DIY Ball Drop

This project is a scale replica of the Time Square Ball. It features a 180mm (7 inch) 3D printed geodesic sphere that is illuminated with NeoPixel LEDs. The ball is supported by a 2020 aluminum extrusion and suspended via a pulley and linear rail. A continuous servo turns and unwinds a rope tied to the ball allowing it to be lowered.
and raised. An on-board speaker at the base plays "Auld Lang Syne ()" synonymous as the New Years Eve Anthem. As the ball is lowered, a 10-sec countdown occurs followed by fireworks, crowd cheering and music playing.

When the device is triggered the neopixels cycle through colors illuminating the ball. The geodesic sphere can smoothly slide up and down the railing with the aid of precision ball bearings.

The build is mostly comprised of 3D printed brackets, fixtures and adapters with some additional hardware and supplies.

Electronic Components

- Adafruit Feather M4 Express ()
- RTC Precision FeatherWing ()
• Prop-Maker FeatherWing ()
• FeatherWing Tripler ()
• NeoPixel Strip – 30 LED (2 meters) ()
• Servo Continuous Rotation ()
• 16mm push button ()
• 3W 4Ohm Speaker ()

Hardware & Supplies

• Neodymium Magnets Discs – D41 - 1/4" dia 1/16" thick ()
• Precision Ball Bearings 10x15x4mm ()
• Slotted Aluminum Extrusion 610mm ()
• Slim T-Nuts () or Oval T-Nuts ()
• M4 x 8mm Button Hex Machine Screws ()
• M3 x 12mm standoffs ()
• M3 metric hex jam nuts ()
• M3 x 8mm Flat head machine screws ()
• M3 x 16mm button head machine screws ()
• Black Nylon M2.5 Standoffs Kit ()
• 28AWG Silicone cover ribbon cable ()
• pico blade speaker cable ()
• 3-pin JST cable ()
• NITTO double-sided tape ()
• Jumper Ring with Clasp

Prerequisite Guides

If you’re new to Adafruit Feather M4 Express, CircuitPython or soldering, take a moment to walk through the following guides to get you started.

• Adafruit Feather M4 Express ()
• Welcome to Circuit Python ()
• Adafruit NeoPixel Uber Guide ()
• Adafruit Precision RTC FeatherWing ()
• Adafruit’s Guide to Excellent Soldering ()

Going Further

The circuit, code and mechanics of this project could be applied to different themes. It's basically a motorized lamp with sounds effects that can be triggered via some sort
of input. Think of an On-Air sign or traffic signal that can announce audible alerts. Make it an IoT project by connecting online – Custom triggers for the motor, lights and sounds.

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**Circuit Diagram**

This provides a visual reference for wiring of the components. They aren't true to scale, just meant to be used as reference. This diagrams was created using Fritzing software.

**Adafruit Library for Fritzing**

Use our Fritzing parts library to create circuit diagrams for your projects. Download the library or just grab the individual parts. Get library and parts from GitHub Adafruit Fritzing Parts.

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**Circuit**

The Feather M4 Express, Prop-Maker Wing and Precision RTC FeatherWing are snap onto a Tripler FeatherWing. This PCB features additional pinouts and power rails that make it easier to connect wires. The button and servo are wired to the Tripler PCB via a JST PH 2-pin/3-pin connection for easy assembly.

**Prop-Maker FeatherWing**

- Speaker to speaker port
• NeoPixel Data In pin to NeoPixel port
• NeoPixel GND pin to NeoPixel port
• NeoPixel 5V pin to NeoPixel port
• Button to Switch Ground Pin
• Button to Switch Pin

Tripler FeatherWing

• GND from servo to ground pin
• Signal from servo to A1 pin
• Voltage from servo to USB pin

Powering

The Adafruit Feather M4 Express can be powered via USB. Use a micro USB cable and connect to a 5V USB battery pack or wall adapter.

Software

Setup Adafruit Feather M4 for CircuitPython

Your Adafruit Feather M4 should already come with CircuitPython but maybe there’s a new version, or you overwrote your board with Arduino code! In that case, see the below for how to reinstall or update CircuitPython. Otherwise you can skip this and proceed with the build.

Install CircuitPython for Adafruit Feather M4
CircuitPython Libraries

Install the following Adafruit libraries for Circuit Python by downloading the latest bundle. Unzip the file and locate the needed libraries. Drop the libraries into a folder named "lib" on the CIRCUITPY drive.

Required CircuitPython Libraries:

- adafruit_bus_device
- adafruit_ds3231
- adafruit_motor
- adafruit_register
- debouncer.py
- neopixel.mpy

Before continuing make sure your board's lib folder or root filesystem has the library files copied over.

Download Latest Adafruit Circuit Python Library Bundle

Download code bundle

The full code listing is available here

You can download all the project source code by clicking below, it even includes the WAV file!

Download NYE Ball Drop Code

Summary

When the time is 11:59, the continuous rotation servo slowly turns and lowers the ball. A 10-second countdown audio file plays over the speaker while neopixels cycle through colors. "Auld Lang Syne" plays after the countdown while neopixels display a show of firework effects.
If you want a more in-depth explanation of how this project works, check out Dave Astel's guide on CircuitPython state machines. It goes into a lot more detail of how he got this code structured and working!

Audio Files

Two separate audio wave files are used. The main song file name is "Auld_Lang_Syne.wav" – This audio can be changed, just make sure the code reflects any file name changes. The crowd cheering audio file name is "countdown.wav" likewise, can be changed.

Original audio sources:

- Auld Lang Syne New Year's Eve
  - [https://commons.wikimedia.org/wiki/File:Auld_Lang_Syne_New_Year%27s_Eve.ogg](https://commons.wikimedia.org/wiki/File:Auld_Lang_Syne_New_Year%27s_Eve.ogg)

- Countdown crowd audio sample
  - [https://freesound.org/people/FreqMan/sounds/88002/](https://freesound.org/people/FreqMan/sounds/88002/)

Test/Reset Mode

A momentary pushbutton can be used to trigger the servo and run through the states. This is used to trip the ball drop for on-demand testing.

- Single press will activate the countdown followed by song with fireworks.
- Press to pause while sequence is running. Press again to resume.
- 2-second press and hold will activate reset mode turning servo to wind up ball with rope.

Setting The Time

The time must be set on line 87 – This sets up the initial time in the internal clock. Follow the comments above for year, month, day, minute, etc. Use the test_trigger function on line 288 to adjust the trigger time – This is when the ball drops.

For testing the RTC, we set the trigger time 10 seconds before the initial time to trip the ball drop shortly after powering on the circuit.
Adjust the values in the code to reflect your desired trigger time.

```python
t = time.struct_time((2018, 12, 31, 23, 58, 55, 1, -1, -1))
```

```python
if test_trigger or (t.tm_mday == 31 and
t.tm_mon == 12 and
t.tm_hour == 23 and
t.tm_min == 58 and
t.tm_sec == 45):
```

Modify Parameters

Common parameters to tweak are the number of pixels, ball drop speed, and duration. Read the comments in the code to see more.

```python
# Implementation dependant things to tweak
NUM_PIXELS = 78               # number of neopixels in the strip
DROP_THROTTLE = -0.03         # servo throttle during ball drop
DROP_DURATION = 10.0          # how many seconds the ball takes to drop
RAISE_THROTTLE = 0.1          # servo throttle while raising the ball
FIREWORKS_DURATION = 30.0     # how many second the fireworks last
```

Upload The Code

Copy and paste the code below into a new text document (we recommend using Mu () as your editor, which is designed for CircuitPython.). Save the file and name it as code.py

How To: Installing Mu Python Code Editor

Once the files has been uploaded to the drive, the board will automatically reboot and run the code.

In order for the code to function properly, the FeatherWings must be connected to the Feather M4 via the Triper FeatherWing or similar.
3D Printing

3D Printed Parts

Parts are designed to be 3D printed with FDM based machines. STL files are oriented to print "as is". Machines with dual extrusion or single extrusion setups are listed below with parts name and description. Parts require tight tolerances that might need adjusting slice setting. Reference the suggested settings below.

Domes Halves

The geodesic sphere is comprised of two 3D printed domes. The dome can be 3d printed using a multi-material tool head or a single extrusion 3d printer. The dome models can be 3d printed without any support material.

Build Requirement: 182mm (7in) x 82mmm (3in)

CURA Slicing

The multi-colored dome was slice using Ultimaker's CURA 3.x for an Ultimaker S5 and 3. The model does not require a prime tower or any additional support to print properly. Parts A and B are assigned to extruder 1 and 2 with respects to the preloaded colored filament. The B labeled model is indented for translucent filament.

Printing Times

A tool head with larger diameter nozzle can dramatically speed up the printing time. Here’s some time estimates comparisons of printing the dome with a 0.4mm and 0.8mm nozzle (single and dual extruded). Note thicker layer height. Another trick to reduce print time is to set infill to 0%.
Single Extruded Domes

- 17h 42m – 0.2 layer height 0.4mm nozzle
- 4h 51m – 0.4 layer height 0.8mm nozzle

Dual Extruded Domes

- 6h 37m - dual extruded dome - 0.4 layer height / 0.8mm nozzle
- 21h 38m – 0.2 layer height 0.4mm nozzle

Parts Assemblies

There are several parts in this build. Below are the subassemblies sectioned out with file names of each part. The thumbnail gives a visual of the part.

Download CAD Files

Base Assembly

Most of the main components are mounted to the stand. The speaker, button and triper featherwing mounting plates are secured the stand using standoff and machine screws. The base box covers the components and snap fits onto the stand.

base-plate.stl
base-box.stl
button-plate.stl
tripler-mount.stl

Servo Assembly

Parts for the servo mount. The tabs are used as spacers in between the servo mounting tabs.

servo-mount.stl
servo-brace.stl
servo-hub.stl
servo-tab.stl
Idler Assembly
The spikes are super glued to the grooves on the side of the idler.

idler-adapter.stl
idler-cap.stl
idler-pulley.stl
idler-pulley.stl
idler-mount.stl

Roller Assembly
This sub assembly will need to be 3d printed twice. Each dome will need a roller assembly so make two sets.

dome-frame.stl
pixelcore.stl
roller-idler.stl
roller-plate.stl
roller-wheel.stl

Sphere Assembly
The domes are dual extruded in dark and translucent material. Optionally, 3D print a unified version for a single extruder.

geodesic-A.stl
geodesic-B.stl
geodesic-dome.stl

Tap Mounting Holes
I used a set of screw taps to create threads in the various mounting holes. This greatly improves fastening screws. of the A mix of metric sizes are used here. M2.5 and M3 taps for the various mounts.
Design Source Files

The enclosure assembly was designed in Fusion 360. This can be downloaded in different formats like STEP, SAT and more. Electronic components like the board, displays, connectors and more can be downloaded from our Fusion 360 CAD parts github repo.

Download Adafruit CAD Parts

FeatherWing Assembly

PCBs and Hardware
Gather the hardware needed to secure the Triper FeatherWing to the PCB mounting plate. Solder the headers to the Triper and Feather Wings if you haven't already. Here's a quick list of screws used.

- 4x M2.5 x 5mm standoff
- 4x M2.5 hex nuts
- 4x M2.5 button head machine screws
- 3x M3 x 5mm standoff
- 3x M3 hex nuts
- 3x M3 x 5mm flat head machine screws

Install PCB Standoffs

Start by fastening the M2.5 nylon standoffs to the four mounting holes on the corners of the PCB mounting plate. Insert and fasten hex nuts to the standoffs and then hand tighten.
Mounting Plate Standoffs

Install the three M3 standoffs onto the mounting plate. Insert them on the other side of the mount, so they are protruding away from the M2.5 nylon standoffs. Fasten M3 hex nuts to secure the standoffs to the mounting plate.
Tripler FeatherWing

Place the Adafruit Tripler FeatherWing over the four nylon standoffs and line up the mounting holes. Insert and fasten 4x M2.5 x 5mm nylon screws to secure the PCB to the standoffs. Be cautious not to over tighten the nylon screws.
Installing FeatherWings

The mounting holes on the corners of the Triper FeatherWing are symmetrical, so it can be secured in reversed. (if needed). The Prop-Maker FeatherWing, M4 Express and Precision RTC FeatherWing can be installed onto the headers of the Adafruit Tripler FeatherWing. Just be sure to match up the rows of headers before snap fitting them on top.
Speaker Button

Speaker Button Parts
Gather the speaker, button, mounting plate and hardware needed. The speaker will need a pico blade cable () soldered to it. The pushbutton uses a JST PH 2-pin () cable set.

- 3x M3 x 12mm standoffs
- 3x M3 x 5mm flat head machine screws

Install Standoffs

Start by fastening flat head screws into the three holes on the mounting plate. Insert and twist to fasten the standoffs onto the threads of the three screws.
Install Speaker & Button

Remove the washer ring and hex nut from the button. Press fit the button into the 16mm hole on the mounting plate. Insert and fasten the washer and hex nut back onto the button to secure onto the mounting plate. The speaker is press fitted into the 40mm diameter hole – a square slit cutout allows the contact leads and wiring to pass through.

Assembled Speaker Button Plate
And now we have our subassembly for the speaker and button, yay!
Servo Parts & Hardware
Gather the servo mounting parts and hardware.

2x M3 x 16mm button head screws
2x M3 lock nuts
3x M3 x 5mm button head screws
3x M3 x 10mm standoffs

Install Mounting Tabs

Two additional tabs are used as spacers for securing the servo to the mounting bracket. Press them onto each tab and fasten screws to secure them in place – Reference photo for best placement. Grab the servo brace and place it under the mounting hole. Insert and fasten an M3 screw to secure the brace to the servo mounting bracket.
Secure Servo

Fit the body of the servo onto the mounting bracket so the tabs and holes are aligned and matching – Reference the photo for best placement. Insert and fasten nylon lock nuts to the two 16mm long M3 screws.
Install Bracket Standoffs

Insert and install the remaining 2x M3 screws into the tabs on the sides of the servo bracket. Insert and twist to fasten the M3 x 10mm standoffs to secure them to the bottom of the servo bracket.
Servo Assembly

We now have the servo assembly, nice! Remember that little extra brace? We’ll need to adjust it a bit once we install it onto the stand, so don’t over tighten it.

Stand Assembly

Aluminum Extrusion Stand
Get the 2020 extrusion ready because we’re going to install it onto the stand. The stand is designed to press fit onto the end of the extrusion – It features geometry that slides into the t-slot of the profile.
Install Stand

Insert the extrusion into the stand by press fitting through the center. You can slide an oval t-nut through one of the t-slots, insert through the bottom. These oval t-nuts are designed to fit the extrusion. Push in until screw hole matches mounting hole on the stand. Insert and fasten an M4 screw – The screw thread needs to catch the t-nut, so make adjustments as necessary. Fasten the screw tightly to secure the extrusion to the stand. The t-nut won't be visible once installed.

Install Speaker Button Assembly

Grab the assembly and get it ready to fit onto the stand. The mounting holes on the stand might appear randomly placed, so reference the photo for correct placement. Place the standoffs over the stand and line up the mounting holes. Flip the assembly over and drive M3 flat head machine screws through the bottom of the stand to secure the standoffs on the speaker assembly.
Install Tripler Assembly

Get the tripler ready to install. Place it over the stand and line up the standoffs with the mounting holes. Flip assembly over and drive 3x M3 flat head machine through the bottom of the stand. Hold speaker button assembly in place while fastening screws.
Install Servo Assembly

Grab the servo and place it on top of the stand. Orient the servo assembly so the drive shaft is positioned in-line with the t-slot. The mounting holes should line up with the standoffs on the servo assembly. With the assembly positioned, flip it over and drive the screws to secure in place.
Secure Servo Brace

Remember the extra brace we added to the servo mount? Line it up with the remaining mounting hole on the stand. Then, drive an M3 flat head screw through the bottom of stand so it goes through the tab on the end of the brace. To secure the brace to the stand, add a nylon lock nut and tighten.
Roller Assembly

Gather the parts and hardware for assembling the roller. We'll need the following hardware:

- 2x precision ball bearings
- 6x M3 x 6mm button head metric screws

Install Bearing Pegs

The precision ball bearings are affixed to these cylindrical pegs. The pegs will need to be secured to the roller plate using machine screws. Place the peg over the roller plate and line up the mounting holes. While holding peg in place, insert and fasten machine screws to secure. Repeat process for second peg. The parts are symmetrical so orientation can be in either direction.
Install Plate to Frame

Now we need to secure the roller plate to the dome frame. Place the roller plate over the frame and line up the four mounting holes. Mounting holes are symmetrical and parts can be flipped over if needed. While holding parts together, insert and fasten M3 x 6mm button head machine screws.
Ball Bearing Wheels

Grab the two precision ball bearings and press fit them into the roller wheels. The tolerances should be tight and snug fit. Insert the wheeled bearings onto the two pegs of the roller plate.
Install Pixel Core

The pixel core is to be secured onto the roller plate. This cylinder goes over the roller wheels. Place it over the assembly and line up the tabs with the mounting holes on the plate. Insert and fasten 2x M3 x 6mm button head machine screws.
Test Rollers

Now is a great time to test out the rollers with the 2020 t-slotted aluminum extrusion. Insert the roller assembly through the aluminum extrusion with the roller wheels inserting through the t-slots. These should roll freely along the railing.
Make A Second Roller Assembly

We'll need a second roller assembly to complete the build. The 2nd roller is exactly the same as the first one — The assembly is mostly composed of symmetrical parts so you just need to 3D print out the exact same parts, just twice. You will also need a second pair of hardware.

NeoPixel Wiring

NeoPixel Planning

I suggest using a low-density NeoPixel strip (). These contain 30 pixels, per meter of length. A 2-meter long reel of NeoPixel strips will work best for providing the sphere with total coverage of glowy. Take the whole strip and cut it on half so that you have two 30 pixel strips.
Solder Cable to NeoPixel Strips

These strips will need cables soldered to them. One of the strips will need both ends wired (The data in and data out connections). I used JST PH 3-Pin connectors with 2 8-AWG silicon covered stranded wire to create a 20in (50cm) long cable. This lengthy cable is connected to the strip that will act as the very first neopixel in the chain. A second cable, 2in (5cm) long is connected to the end of the strip with the data out connection. This second cable features a male JST PH 3-pin connector.
Top Halve NeoPixel Strip

The second neopixel strip only needs one end wired (data in). I used a female JST PH 3-pin connector, with a wire length of 5cm. This cable plugs into the data out connections on the first neopixel strip.

3-Pin JST PH

It's important to match the colors of wires with connections. Follow this order: red colored wire connects to voltage (5+), black wire to ground (GND) and white wire to data (DIN / DOUT).
The LED strips will need to be affixed to the pixel core. I used double-sided NITTO tape to adhere the back of the flexible PCB from the NeoPixel strips. I applied short strips of tape across the cylinder in a staggered pattern. I found NITTO tape has a strong hold and doesn't leave behind residue.

The placement of the LED strips needs to be considered and planned. The top and bottom halves of the geodesic sphere ought to have a linear flow – data in flowing to data out. The assembly in this photo shows the bottom half. The long cable connects to the very first neopixel strip and will feed out the bottom of the geodesic sphere. The strip wraps around the cover in a clockwise direction.

The second LED strip is attached to the second pixel core cover using more NITTO tape. Adhere the strip so that it follows the same direction of data flow as the first LED strip. Position the first pixel (with soldered cable) near the bottom of the cover and wrap the rest around the cylinder.
Double NeoPixel Cores
Here are the two neopixel strips laid out in the proper arrangement. The beginning of the chain starts on the left with the first neopixel connecting to the longer cable. The last pixel on that strip connects to the first pixel on the second core. Note the data flows in a consistent direction across both strips. (The core on the right side actually has a medium-density neopixel strip which was left over from prototyping).

Take this moment to adjust the arrangement of the neopixels. Check and ensure the strips are adhered to the cylinder. Are the connectors able to plugin across the two strips?

Pixel Double Stack
Here's the two pixel cored stacked on top of each other, which is how they will be arranged once secured inside the geodesic sphere.

Dome Assembly
Install Magnets
The domes feature four mounting tabs with cavities. These are designed to fit neodymium magnets discs – (D41 - 1/4” dia 1/16” thick). These can be super glued to the
tabs but it's super important the polarities match across the two domes. Marking the north and south poles are a good method. I kept track of the polarities while placing by hand holding a stack – Use your preferred method!

Install Dome Framing
The pixel core roller assemblies are secured inside the domes. Place one of the cores inside one of the domes and line up the mounting tabs with the holes on the framing. Insert and fasten M3 x 10mm flat head machine screws through the tabs. Hold the framing in place while fastening the screws. Repeat this process for the remaining tabs and proceed to setup the second dome.
Glowy Domes
With both domes setup with the pixel core assembles, it's a good idea to test out the neopixel strips. To do this, I plugged in the first strip to the Prop-Maker FeatherWing and ran a neopixel strandtest. This way we can see if there's any dead pixels (fingers crossed) and if our pixel arrangement is how we want it. I must have rearranged the two at least a dozen times, so don't be too upset if you need to take it apart ;-) 

Glowing Sphere!
And here it is! Behold, a glowing geodesic sphere. Before closing up the two domes, you may need to tuck in some of the wiring – Plenty of room near the sides to stuff! You'll want to thoroughly expect the edges and make sure none of the wires are kinked.

Rope Assembly

Rope Setup

The ball is lowered with a long piece of rope/twine. The stuff I used was made from hemp, purchased from the craft store. Yoyo string is a great option. The string should be roughly 47-inches (119cm) in length – This will cover most of the 610mm long aluminum extrusion.

Tip: I used a drop of super glue to seal the tips, this prevents the strands from fraying.
Tie Rope End

A jump ring is tied to one end of the string. Any 6-10mm diameter jump rings will do. These are commonly used for jewelry crafting.
Drive Hub Assembly

Drive Hub Parts
Time to assemble the drive hub. Use the star shaped servo horn that is included with the continuous rotation servo. The two screws used to servo the horn to the drive hub are M2.5 x 10mm flat head machine screws. A single M3 hex nut is used to anchor the string.

Screw Tap Holes

Depending on the size of the screws, you'll want to tap threads into the mounting holes. Place the servo horn over the drive hub and line up the mounting holes – This gives a visual reference of which holes to use.
Secure Hub to Horn

With the holes properly tapped and threaded, hold the horn and hub together while driving the screws through the mounting holes. I used flat head machine screws because the screw heads can be flush.
Center Screw
The continuous servo comes with a few screws used for mounting. I picked one of the black ones and inserted it through the center hole of the drive hub. This will be used to serve the drive hub to the shaft of the servo.

Install Rope to Hub
The drive hub has a 3mm diameter hole in the grove. It's for anchoring the rope to the drive hub. Insert the end of the rope and pull it through. Tie the end of the rope to an M3 hex nut (or whatever is similar) so that the rope gets anchored.
Wind Up Hub

Give the rope a firm tug to ensure it's properly anchored to the drive hub. The geodesic sphere weighs ~1lb (10 oz) so it needs to be able to manage that much. The groove in the drive hub allows the rope to wind up a few times before reaching capacity.
Install Clasp
The other end of the string has the jumper ring. Go ahead and install a clasp – This will make it easier to clip it onto the roller assembly inside the geodesic sphere.

Install Hub to Servo
Grab the stand assembly and position the drive hub over the servo. Press fit the servo horn onto the shaft of the continuous rotation servo. Then, fasten the center mounting
screw until tight – The hub will begin to rotate when its fully tightened. I suggest installing the hub with the rope outside the groove.

Install Stand Cover

OK, now it's time to fit the box over the stand. To do this, you'll need to thread the rope through the center cutout in the center. Use the photo for reference. The cover will have to go over the 2020 extrusion. Insert the cover through the extrusion with it going through the center cutout (similar to the rope). Rotate the cover so the cutouts line up with the components. The cover is designed to snap fit onto the stand. Inspect the edges for any gaps or hanging wires, tuck them in if necessary.
The rope should be accessible outside the cover with the clasp affixed to the end.

Dome Rail Assembly

Thread The Rope
Grab the rope with the clasp on the end and thread it through the halve of the dome with the longer cable. Pass it through the center bottom opening and grab the end so the rope is through the dome. Ensure the rope does not catch any of the rollers.
Looping Thread

Use the clasp to clip onto the mounting near the center of the square opening. Keep the rope on hand and begin to pull to gain a moderate amount of slack. While holding onto the rope, form a loop. Grab the other half of the sphere and begin to thread the loop through the center. The rope needs to be a loop in order for the pulley mechanism to function properly. Insert the rope loop through the square opening on the roller plate. Pass it through the core and out the end of the dome while maintaining the loop. Pull the rest of the slack through so the rope is taught.

Bring the two halves together and match up the orientations so they’re mirrors of each other. When the tabs mate the magnets to snap the two halves shut. The magnets has enough hold to keep them secured. Keep the string on hand.
Install Ball to Railing

Bring the ball over to the aluminum extrusion. Orient and position the ball so the rope can function with a pulley relative to the position of the drive hub.

Insert the extrusion through the end of the ball (the side with the long cable). Fit the roller wheels onto the t-slots of the extrusion. Slide the rest of the sphere through the extrusion.

Temporarily wrap the rope loop wrap over the tip of the extrusion.

Position the sphere so the rope becomes taught.
Drive Hub Rope T Slots

The rope passes straight through the t-slots on two sides of the extrusion. Rotate the drive hub to wind up the rope. Clockwise rotation if your assembly matches orientation in the photo. With the rope taught, the rope should straight out and follow the t-slots. The sphere should freely slide along the extrusion. Keep the rope taught when positioning the sphere.

Assembly Side-Notes

This is admittedly the trickiest part of the assembly. I had issues figuring out the most efficient procedure for easy assembly so it may feel awkward. My advice is to have the pieces near by and do things slowly. Keep the rope at hand so it doesn't fall into the roller assembly – Fishing it out with tweezers can be helpful. Don't twist the sphere excessively or the bearing wheels could pop off.
Assembly Side-Notes

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Idler Assembly

Idler Bearing

The idler can be bedazzled with a 6mm diameter rhinestone and 3d printed spikes. The rhinestone is press fitted into the cavity in the center of the pillar. I super glued the spikes to the groves on the side of the idler. The idler uses a precision ball bearing and 3d printed wheel to function as a pulley system for the rope.
Install Wheel Ball Bearing

Press fit the wheel over the ball bearing (size 10 x 15 x 4mm). Place the ball bearing over the pillar in the center of the idler. Press the bearing through the peg to seat the wheel to the idler. It should rotate and spin freely.
Install Idler Adapter

The idler needs an adapter piece in order to mount it to the aluminum extrusion. Place the idler over the adapter and line up the mounting holes. Use two M3 x 8mm long button head machine screws to join the two parts. Hold the parts together and drive the screws through the mounting holes. Fasten and fully tightened.
Install Idler Cap

The idler adapter is secured to a mounting bit that is designed to fit over the aluminum extrusion. Use two M3 x 6mm screws to join the adapter to the cap. Place the cap under the idler and line up the two mounting holes. Hold the parts together and drive the screws through the mounting holes. Fasten and fully tighten.
Install Oval T-Nut Screw

The cap can be secured to the aluminum extrusion using an oval t-slot and M4 screw. These are designed to slide into the t-slots. Insert and fasten an M4 screw through the mounting hole on the side of the cap. Twist until thread is half way through – Insert oval t-nut and fasten.
Idler Assembly
And now we have our pulley assembly ready to install. The bottom of part the idler is called the cap because it will be fitted over the aluminum extrusion essentially capping it off.
Idler Rail Assembly

Install Rope Idler

Grab the pulley assembly and begin to work the rope over the wheel bearing. Pinch the rope with a finger nail into the gap between the wheel and idler. Start to rotate the wheel so the rope is guided onto the groove. Fit the rope onto the wheel and place the idler assembly over the aluminum extrusion. The idler cap is designed to fit into the profile of the extrusion. Make sure the orientation idler matches with the rope and drive hub.
Secure Idler to Rail

Press the idler onto the tip of the extrusion so it caps it off. If the idler doesn't freely slide in, the oval t-nuts might be to be adjusted so they can fit through the t-slots on the extrusion.

Idler Adjustments

Adjust the screw and unfasten to loosen the t-nut if needed. The t-nut is not 100% required - The pulley can function without it, just won't be as secure with it installed. Once it's properly installed, the screw and t-nut can be tightened to secure the idler to the extrusion.
Testing The idler
Check the rope is properly installed onto the wheel bearing and idler secured to the extrusion. The whole build can be propped upright and tested. The linear motion of the sphere should be tested along with the idler. Make any adjustments as necessary.