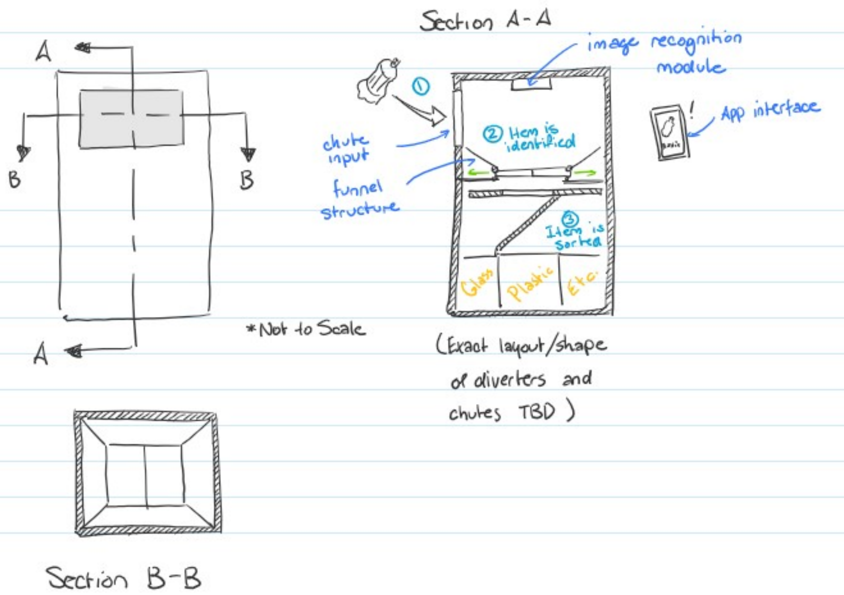
1 - Motor Selection

February 18, 2021 7:05 PM

Thurs. Feb 18 2021, 6:30 PM – 9:15 PM

https://medium.com/husarion-blog/10-steps-to-choosing-the-right-motors-for-your-robotic-project-bf5c4b997407 ← helpful



Recall:
- Avg weight of plastic (single-use) waterbottle: 9.25 g
- Avg weight of empty AT2 glass bottle (standard beer bottle): 275 g → 0.275 kg ≅ 2.7 N
- Avg weight of empty pizza box: 153 g
- Avg weight of empty soup can: 13.11 g

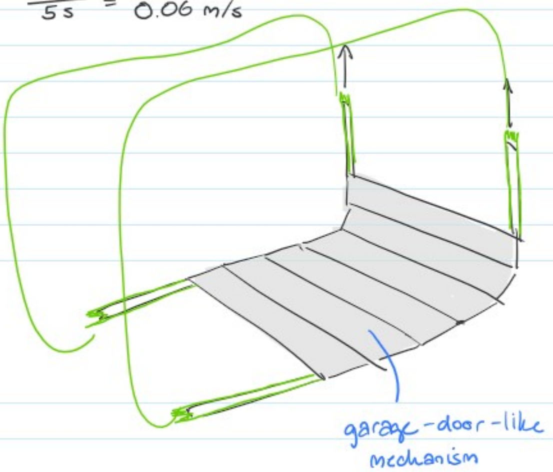
*Assuming 1 glass bottle will be heaviest load

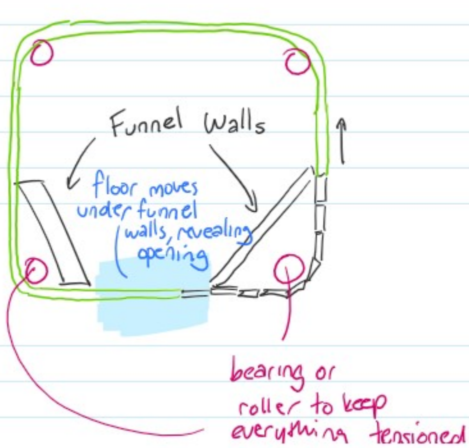
* Constraint:
  - must identify & sort min 1 object every 10 sec.
  - must accept items up to size 15x15x30 cm ← realistic?

Sorting Categories: 1) Paper 2) Plastic 3) Metal 4) Glass 5) Other

Mechanism 1: Actuating the recyclables from identification area to chute

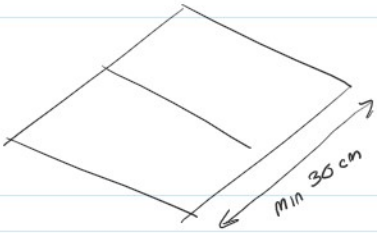
$$\frac{0.3\,m}{5\,s} = 0.06\ m/s$$

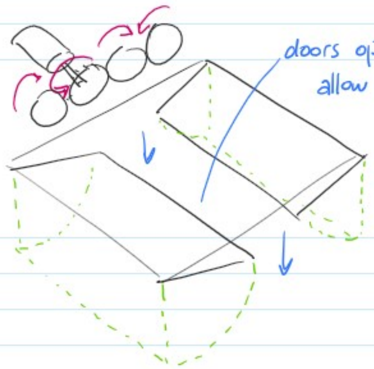




garage-door-like mechanism

bearing or roller to keep everything tensioned & moving





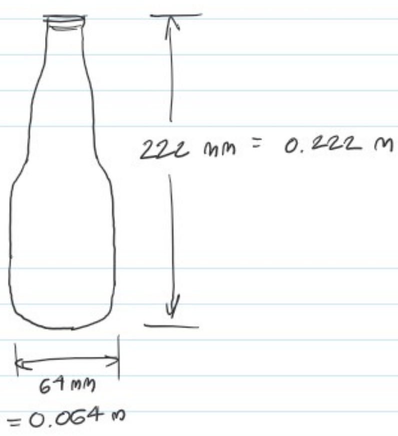
doors open to allow object to drop through

Notes:
- size constraint = realistic?
  → focus on something bottle-shaped?

Feb 19 10:45 –

• proposed new size constraint ✓ ACCEPTED

Standard AT2 beer bottle: https://unitedbottles.com/product/canadian-isb-341-ml-at2p

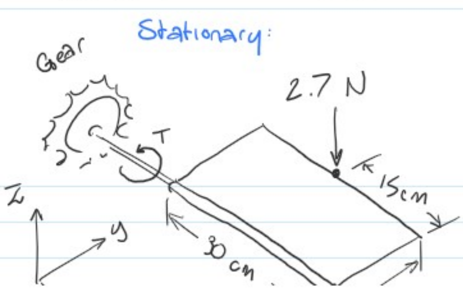


would fit on 30 x 30 trapdoor platform
→ tallest item — other objects will fit too

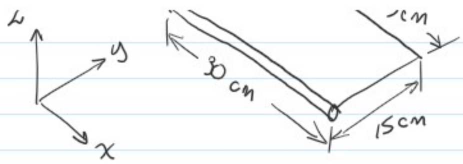
→ negligible for now

One half of trap door (neglecting weight of flap itself)

Stationary:



* Assume:
- empty AT2 beer bottle
- weight centered
- worst case scenario: weight is slightly off-center and is supported by one flap



$T = 2.7(0.15) = 0.405\ Nm = \boxed{405\ mNm}$

Slight curve contour on ramp to make for a softer impact?

impact point

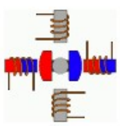
is supported by one flap
- same torque output for each flap
- bottle is placed gently
  → will roll down funnel
    → impact force will occur at small torque arm → negligible
    → safety factor should take care of this

https://www.seeedstudio.com/blog/2019/04/01/choosing-the-right-motor-for-your-project-dc-vs-stepper-vs-servo-motors/

2. Stepper Motors

Stepper motors are motors that move in slow, precise and discrete steps. Valued for their precise position control, they find a myriad of applications such as desktop printers, security cameras, and CNC milling machines.

Working Principle:



An operating Stepper motor
(Source: emmeshop)

Stepper motors have a controller system that sends electrical pulses to a driver, which interprets these pulses and sends a proportional voltage to the motor. The motor then moves in accurate and fixed angle increments, hence the name "stepper". The stepper motor works similarly to brushless DC motors, except that it moves in much smaller steps. Its only moving part is also the rotor, which contains the magnets. The polarity of each coil is controlled by an alternating current. As the polarity changes, each coil is given a push or a pull effect, thus moving the motor.

They can be controlled with commonly available and cheap microcontrollers. However, the stepper motor is a power-hungry device that constantly draws maximum current. The small steps it takes also means that it has a low top speed, and steps can potentially be skipped when high loads are used.

Advantages & Limitations:

Advantages

Precise positioning	Stepper motors have a high pole count, usually from 50 to 100, and can accurately move between their many poles without the aid of a position encoder. As they move in precise steps, they excel in applications requiring precise positioning such as 3D printers, CNC, camera platforms and X, Y plotters.
Precise speed control	Precise increments in movement enables excellent speed control, making them a good choice in process automation and robotics.
Excellent torque characteristics at low speeds	Stepper motors have maximum torque at low speeds (less than 2000 rpm), making them suitable for applications that need low speed with high precision. Normal DC motors and servo motors do not have much torque at low speeds.
Excellent torque to maintain position	Suitable for applications with high holding torque.
Easy to control	Stepper motors can be easily controlled with microcontrollers such as the ATmega chips that are readily available on Arduino development boards.

Getting rpm from stepper motor specs:

$$\frac{1\,\text{step}}{1\,\text{pulse}} \times \frac{?\ \text{pulse}}{1\,\text{sec}} \times \frac{?\ \text{degrees}}{1\,\text{step}} \times \frac{1\,\text{revolution}}{360\,\text{deg.}} \times \frac{60\,\text{sec}}{1\,\text{min}} = \underline{\qquad}\ \text{rpm}$$

$$\frac{1\ step}{pulse} \times \frac{5000\ pulse}{1\ sec} \times \frac{1.8\ degrees}{1\ step} \times \frac{1\ revolution}{360\ degrees} \times \frac{60\ sec}{1\ min} = \frac{1500\ revolution}{min}$$

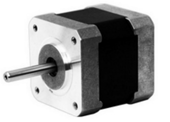
https://electronics.stackexchange.com/questions/232674/transform-pulses-per-second-pps-to-rpm

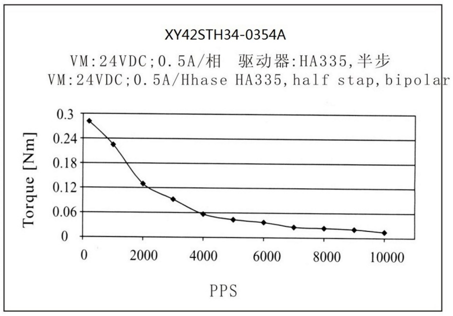
https://www.digikey.ca/en/products/detail/dfrobot/FIT0278/6588458

FIT0278
- 1.8° step angle
- 200 steps/revolution

No info on rpm???

https://www.digikey.ca/en/products/detail/adafruit-industries-llc/324/5022791
https://cdn-shop.adafruit.com/product-files/324/C140-A+datasheet.jpg





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- 1.8° step angle
- at rated holding torque (0.197 Nm)
  ~ 1200 pps ⇒ 360 rpm

* For 405 mNm at 10x reduction ratio, we're looking at ~ 6000 PPS = 1800 rpm !

Standard: Nema - stepper motors - might have torque/speed characteristics, etc.
- Nema 17 could be good for this project
- Nema 17 - XX (xx is length of casing (stators), defines torque)
  - UPDATE: chosen motor is actually Nema 17: https://www.adafruit.com/product/324