How to Design the Thread in 3D Printed Plastic

Daifeng Li

Undergraduate Student Intern from SUSTech

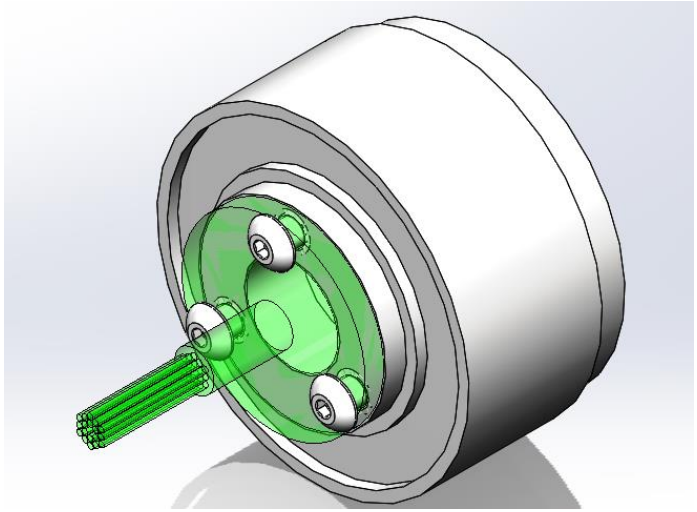
THE ROBOTICS INSTITUTE

Problem Description

Need threads for assembling slip ring

P1
P2 P3

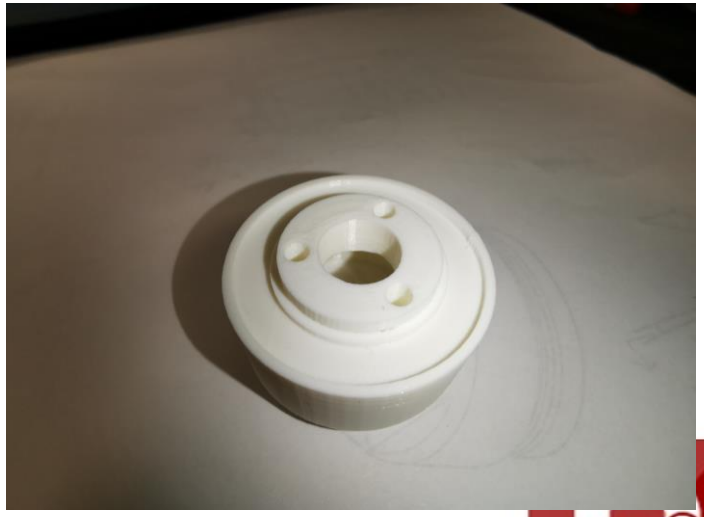
P1: CAD showing the assembly.



P2: Originally this part (not the same size) is machined so are the threads.

P3: Using 3D printing since machining costs much and not fast.

The problem is how to make threads for the 3D printed part.



7 Methods

- 3D Printed Pockets for Hex Nuts
- Direct Insert Hex Nuts
- 3D Printed Threads
- Tapping Threads
- In-Printing Hex Nuts
- Heat Insert Knurl Nuts
- Heat Insert Hex Nuts

Method #1

3D Printed Pockets for Hex Nuts

P1
P2

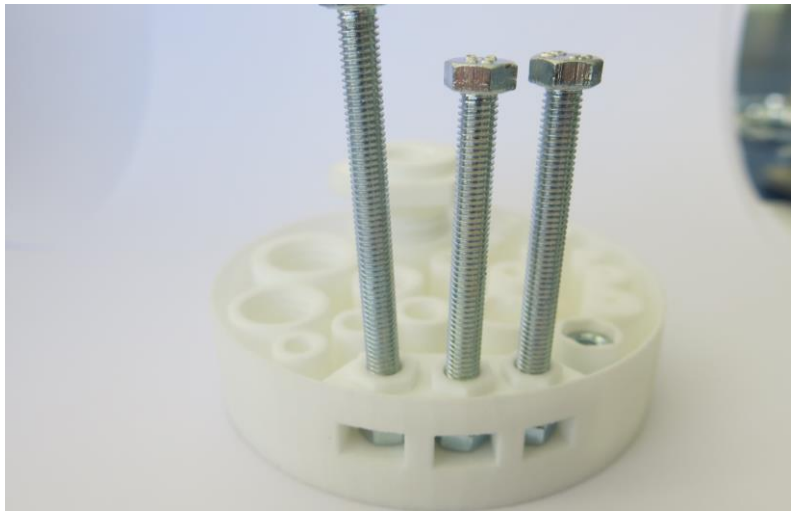
- Insert the hex nut in the pocket created on the side the object
- Make pocket be tight enough, so that the nut can’t turn in it
- Create a hole on the side of the pocket so that the nut is easy to push or take off, P2

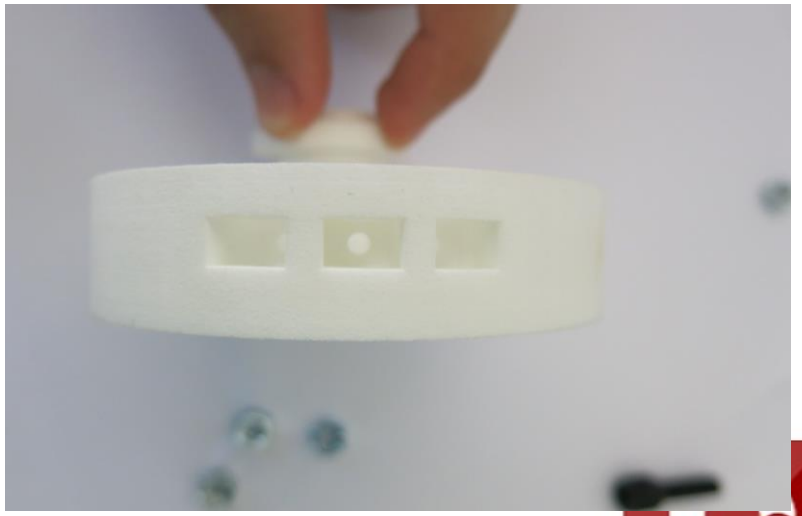
Pros:

- Good resistance
- Possibility to change the nuts and screws (while the OD same)

Cons:

- Requires several parts
- More assembly time





Method #2

Direct Insert Hex Nuts

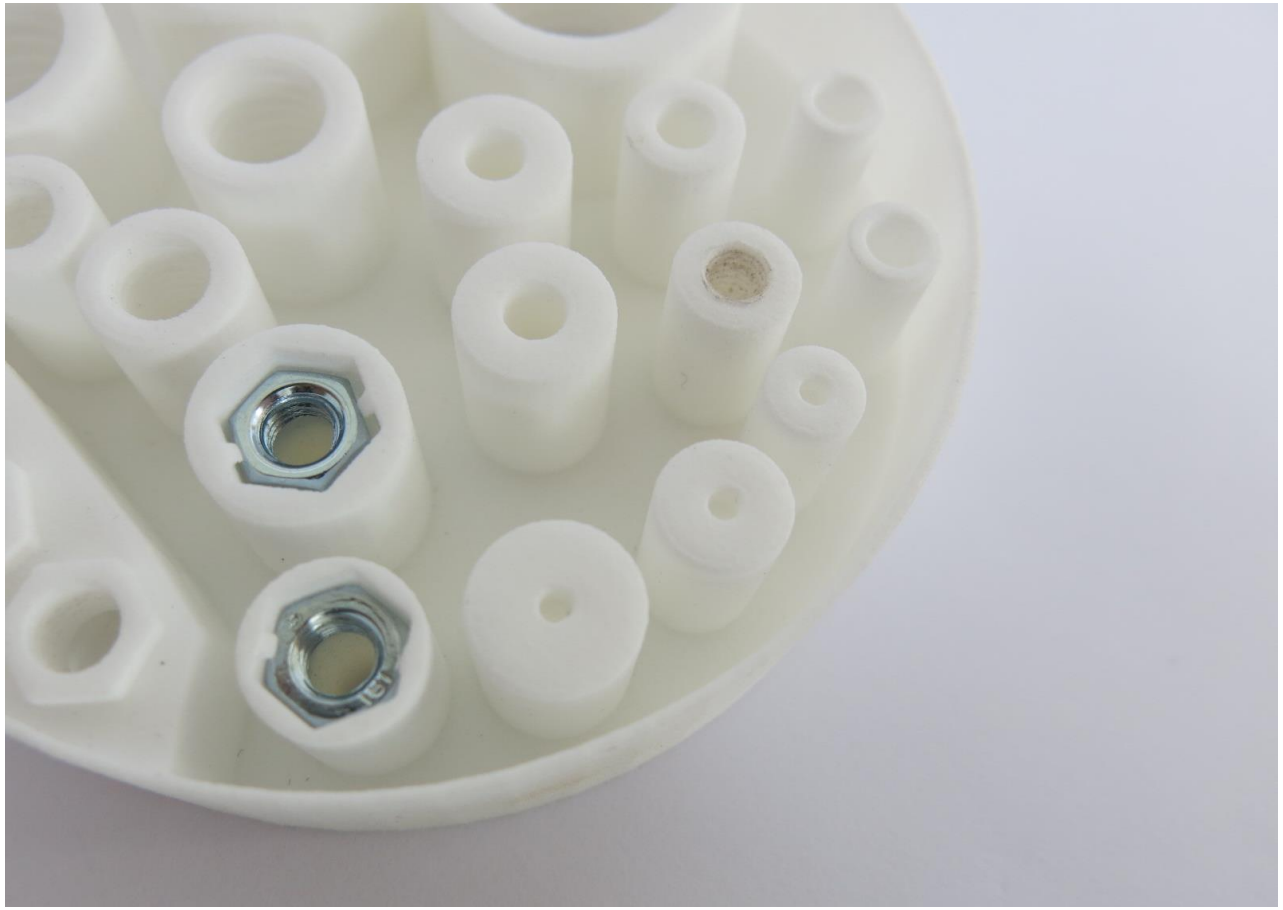
- The nut is held in place by a clipping mechanism

Pros:

- Good resistance
- Possibility to change the nuts and screws (while the OD same)

Cons:

- Requires several parts
- More assembly time
- Not easy to take off



Method #3

3D Printed Threads

- Model the threads in the CAD/STL file
- Also can print corresponding screws

Pros:

- Total freedom of design: customization with nonstandard dimensions; place a nut or a screw in an inaccessible place
- Avoiding corrosion

Cons:

- Not compatible with small dimensions (shortcoming of 3D printing)
- Less solid than metal
- More expensive for standard dimensions

Method #4

Tapping Threads

- Make the hole when modeling before printing. (if drill, no enough material to make thread, because not 100% printing)
- Hand thread tapping or auto tapping screws
- Make sure enough material around the screw. Otherwise, it can tear

Pros:

- Fast assembly
- Large design freedom

Cons:

- Very sensitive to assembly-disassembly repetitions (thread damaged)

Method #5

P1
P2

In-Printing Hex Nuts

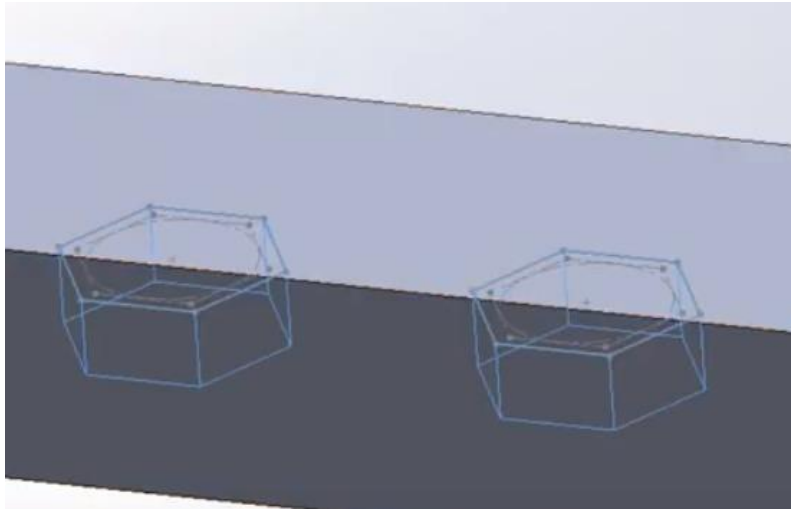
- Make the space for the nut when modeling
- Insert the nut during the printing (Cheat the printer)
- Give 45 degree chamfer on the top to avoid supports

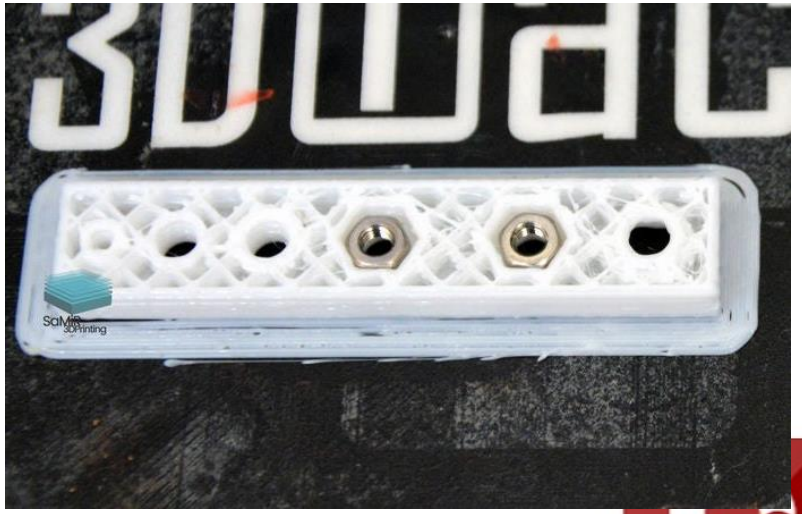
Pros:

- No additional tools required
- Strong and durable

Cons:

- Need to insert the nut at the right time





Method #6

Heat Insert Knurl Nuts

P1
P2

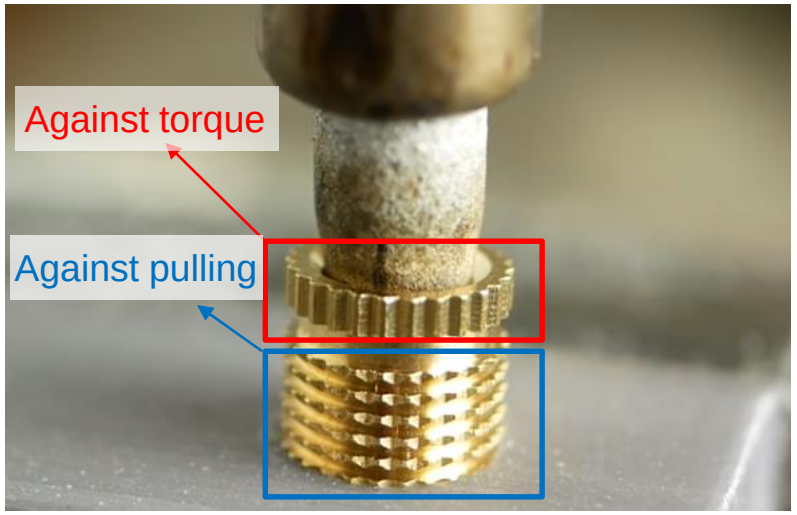
- Use soldering iron to heat the nut, once it cooled down the plastic holds it inside

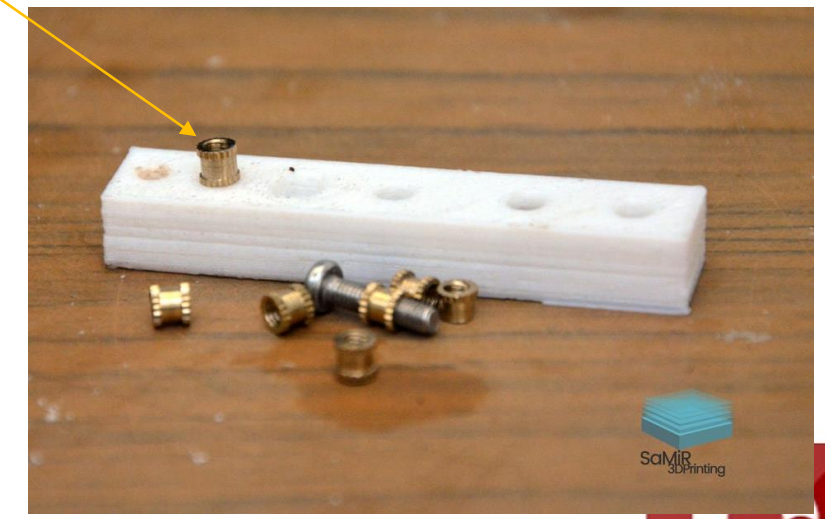
Pros:

- Very strong and very durable

Cons:

- Require solder
- Knurl Nuts cost more





Method #7

P1

P2

Heat Insert Hex Nuts

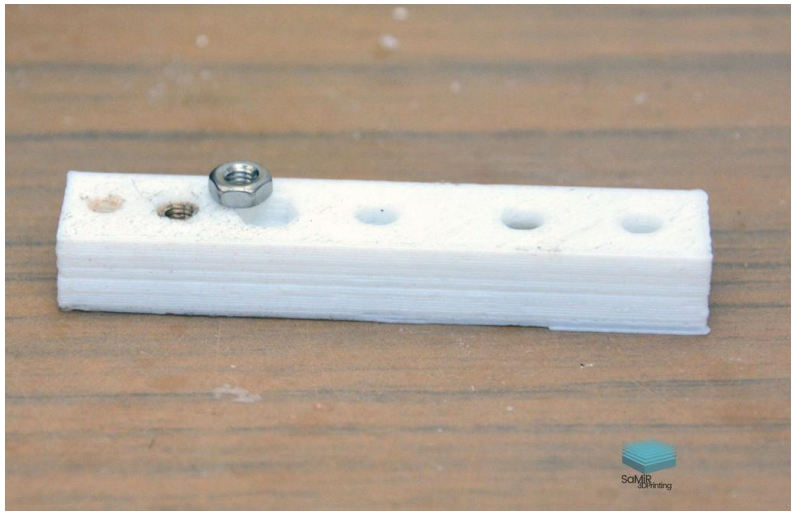
- Use soldering iron to heat the nut, once it cooled down the plastic holds it inside (same with the method #6)

Pros:

- Relatively strong and durable

Cons:

- Require solder
- Perform not well against pulling out



Comparison

	3D Printed Pockets for Hex Nuts1	Direct Insert Hex Nuts	3D Printed Threads	Tapping Threads	In-Printing Hex Nuts	Heat Insert Knurl Nuts	Heat Insert Hex Nuts
PROS	Good resistance; Possibility to change the nuts and screws (while the OD same)	Good resistance; Possibility to change the nuts and screws (while the OD same)	Freedom; Customization; Avoiding corrosion	Fast assembly Large design freedom	No additional tools required Strong and durable	Very strong and very durable	Relatively strong and durable
CONS	Requires several parts; More assembly time	Requires several parts More assembly time Not easy to take off	Not compatible with small dimensions; Less solid than metal; More expensive for standard dimensions	Very sensitive to assembly-disassembly repetitions (thread damaged)	Need to insert the nut at the right time	Require solder Knurl Nuts cost more	Require solder Perform not well against pulling out

Comparison

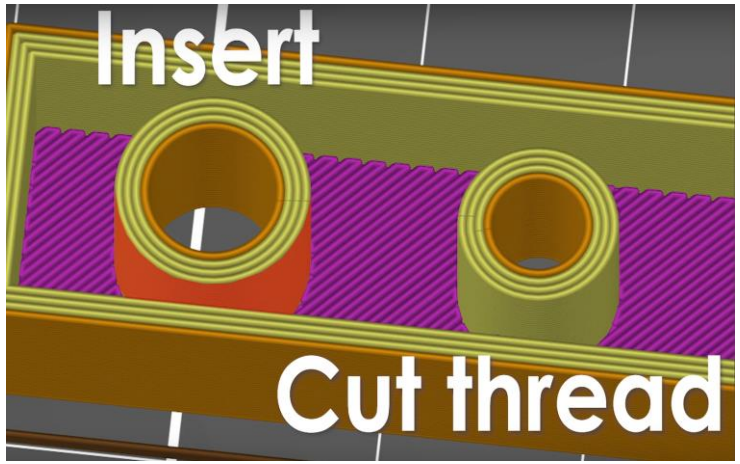
P1
P2 P3

View of mechanical property

- Torque out experiment, torques needed when cracked (P3)

Insert > 1/3 Insert ≈ Cut Thread ≈ Modeled Thread ≈ No thread <≈ ISO Recommendation

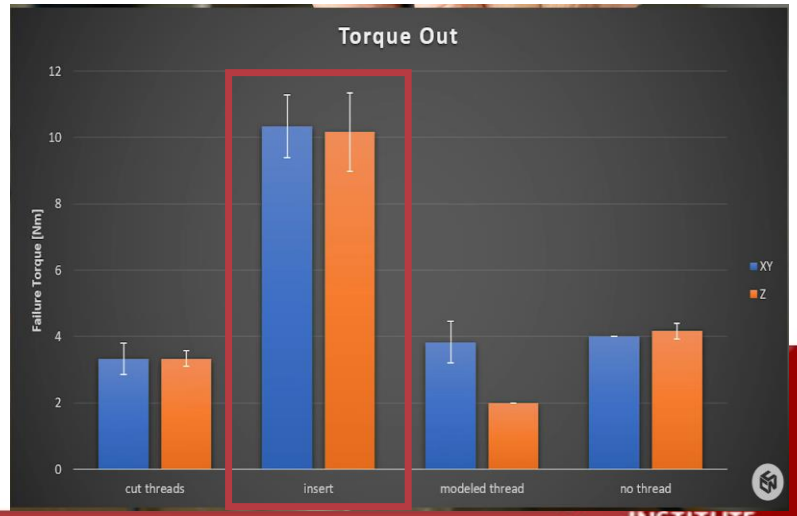
Because there is knurl around the insert knurl nuts stopping torque.



- Pull out experiment, forces needed when cracked (P2)

Insert > Cut Thread ≈ Modeled Thread ≈ No thread

Because $\tau_{shear} = \frac{F}{A}$, the periphery area of insert nuts is the largest, so the shear stress is the smallest when applying the same force, and so that it can bear more force (P1).



Notation

Cut Thread:	Tapping Thread
Insert:	Heat Insert Knurl Nuts
Modeled Thread:	Printed Thread
No thread:	Auto Tapping Thread

Summary and Decision

P1	P2
P3	P4

Decision: Heat Insert Knurl Nuts

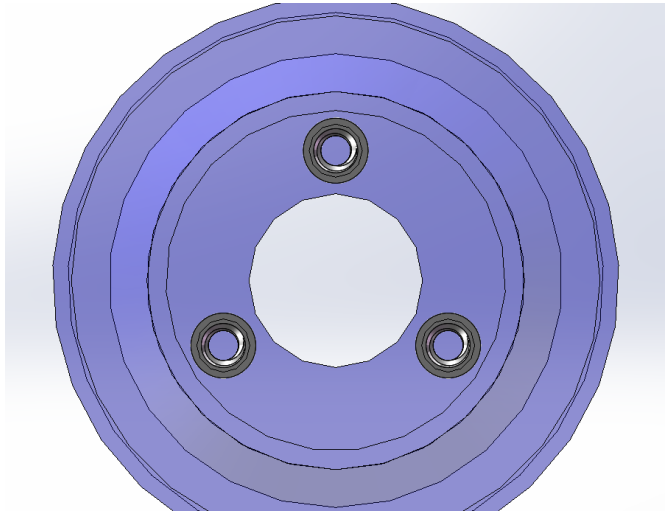
Requirements:

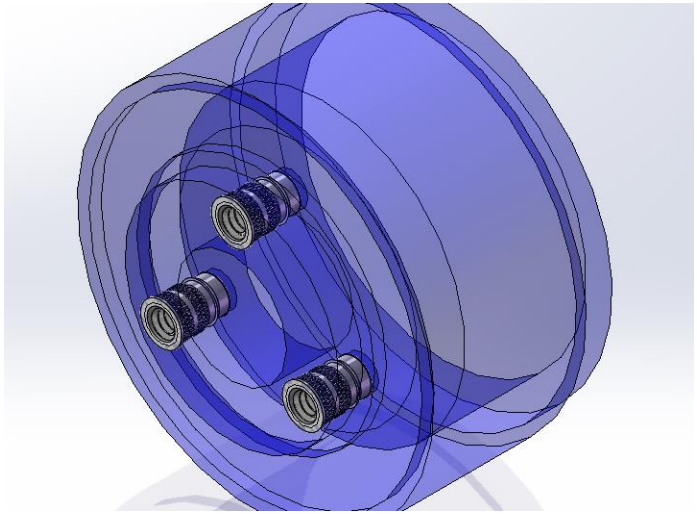
- Repeated use or durable
- Strong enough
- Easy to assembly
- For #4-40 thread, whose diameter is 0.11’’ or 2.79mm

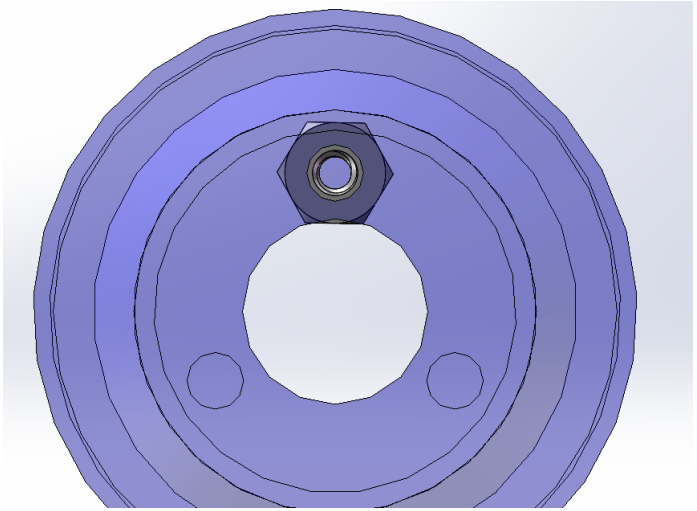
Analysis:

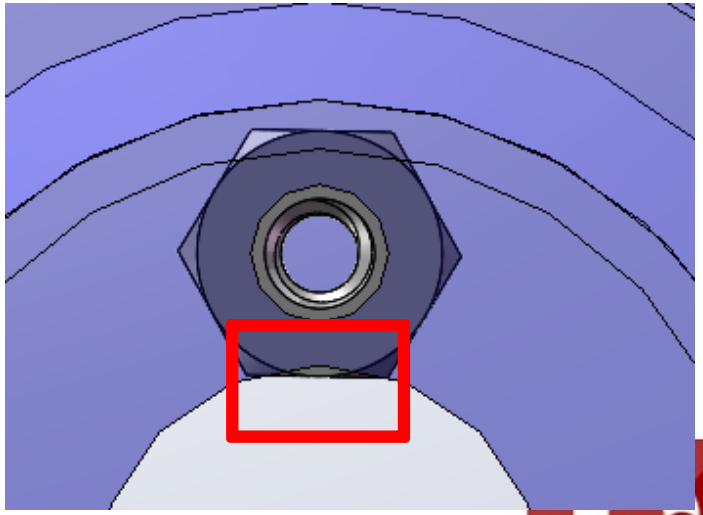
- Diameter is very small, no printed or thread.
- For durability, no tapped thread.
- Available space is too small, no hex nut insert, see P3 and P4.

Best choice: Heat Insert Knurl Nuts (P1,P2)









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