Dynamics

Dynamics analysis of choosen mechanism

- Main Task: **Analyse dynamics of the choosen gripper and choose motor characteristics**
- Written by **Ekaterina Uzbekova**.

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Tools

- Hackmd
- Matlab
- Draw.io# Mechanics and Machines.

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Tools

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- Apple Notes

Gripper

Gripper Motion Description

Motor gives a torque, which increases by "gear" or just bigger radius circle, then other links of gripper just transmit motion to grab the brick be grabbers, so when gripper have in grabbers brick it should react on brick with some forse to compensate the forse with which brock affect on the grabbers.

Assumptions

1) The brick is 250x120x65mm and it weight is 2-2.3kg.(кирпич щелевой (пустотелый) одинарный). But until no real brick we can assume that needed lenght to grab is L. 2) Masses of gripper links are negligible and that all constraints are holonomic(With these assumptions, it is possible to analyze static equilibrium of the massless system to determine the force relationships) 3) Not using direction for vectors(but all forces on next picture are vectors) 4) For know we don't know to which place the grabbers will go, and just not to make a mistake we put the forces upper than center of the brick. 5) We will use previous calculations on Kinematics to obtain need force on motor with Virual Work Principle 6) Work will be divided in 2 parts(1st - force with which brick influence on gripper, 2nd - torwque and velocity we need from choosen motor) 7) However, in every practical system we will always lose some amount of work to friction, heating and other reasons. $$n_3 = W_{out}/W_{in}$$We will playing with different values in range [80..100] for simplicity we can think about it as 100%.

1 PART

About with which force brick affect each grabbers:

Sum of all forces on X direction: $oX: -F_{3}' + F_{3} = 0$, so $F_{3}' = F_{3}$ **Sum of all forces on Y direction:** $oY: F_{fr} + F_{fr'} - G = 0$ where G = m*g g = 9,81 m/s^2.* ***Sum of moments around the center of the brick:*** *$F_{3}'*y_{3}-F_{3}*y_{3}-F_{fr}*L/2+F_{fr}'*L/2 = 0$, so $F_{fr} = F_{fr}'$

Hence: $$F_{fr} = \frac{mg}{2} = \mu*F_{3}$$ $$F_{3} = *frac{mg}{2*\mu} $$ where m - mass of our brick.

Need to know μ to determine needed force. For common materials: - wood on brick $\mu = 0.6$ - carton on brick $\mu = 0.65$ - 3d printer plastic on brick $\mu = unknown$

So, need to be determined experimentally. But for now we can take it as 0.65, so the forse $F_3 = (2.3+2)/2 * 9.81 /(2*0.65) = 16.22H$, so that force acts on each of the grabbers.

Next, we know that from brick side on grabbers exists force N, which is opposite direction and equal size, so that $N = \frac{mg}{2*\mu}$ for each of 2 grabbers. So, now we know force N => using the principle of virual work we can calculate the relationships between the force on the grabbers and the moment(torque) on the shaft.

2 PART

Applying principal of virtual work lead us to:

$δW = n_3 *Fmotor · δX - F_3*δr_3 = 0$ (1)

$Fmotor = F_3*δr_3/δX$

$$δX = aX = x0 + w/(2*pi) * h$$

Where $aX0 = 0$, by assumption of center of coordinates frame. And $δr_3$ we already computed by kinematics.

And next, we will have graph dependencies Force on motor with angle on that motor.

Data, graphs

Data based on measurements we can find in Fusion.

And so applied that we will have: Force in N.

But as we need just one force with which our brick will be in grabbers and without movement, we can figured that force, which we can achive when between grabbers distance equals L.

We need to determine equilibrium conditions under the influence of two active (external) forces.

So force we need: **87.7793-85.902H** depends on L and with some inaccuracies, also we need to consider the fact that we need some stock, so we will think that we need force = 90H.

3 part

To find which motor I need, I need to know torque which I need and rps.

Torque

$$M = Fmotor*δX$$ So, graph we had in matlab(torwue/angle): And torque I need with the force already calculated for our boundary condition at least 2.1Hm = 2137,5mHm

Examples of motors from Internet

- LRPX22 Brushless DC Planetary Gear Motor Or others with smallest torque and add some gears Link to list of motors

Additions to mechanism:

Change gripper to another one, because it will be easy to make it, so now we have some additions to existing gripper.

Not computed there for that options, because notice about that model nearly, so in other's iterations will be additions based on that.

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