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L. Molnár / A. Paróczi

Improvement of laparoscopy instrument using magnetic principle

ENGINEERING DESIGN

Introduction One of the most important development trends in the abdominal surgery is to cut the fewest and least incisions in the abdominal wall.

Either technology is the laparoscopy; we would like to minimize the number of incisions. So we have to solve some problems. The most important is the triangulation. One solution for this problem is to move medical instruments as an inside unit with an outside one with magnetism. We made an experiment with doctors how show us the model of an operation made in chitterlings of a pig. Fig.1. presents this model experiment.

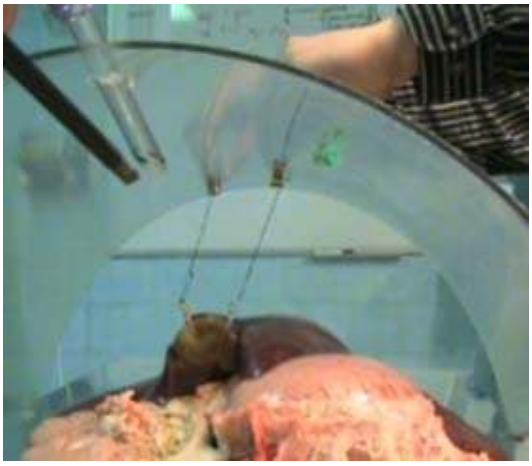
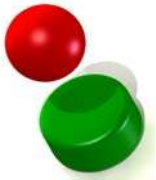


Fig.1. The model experiment

Aim and method of the research The aim of the development is reach about 8 N attractive force between the two unit. We used numerical method in line with the conventional design method. This quickens appreciably the design during the early period of product development.

Analysis of geometries The substance of the concept design is to reach suitable attract force with a suitable method. It can appear as a permanent- or electromagnet as an outside unit, magnets as an inside unit. We used Ansys Workbench 11.0 for the numerical simulations. Firstly we analysed combinations of permanent magnets, all had the same material properties, and so only the geometry has influence for the magnetism. We defined a distance of 30 mm between the inside- and outside unit; this corresponds to the thickness of the skin of the fattest person. We used the magnet type of 30H NdFeB in the simulations. You can see the summarized x directional force in Table 1.

concept				
X direct. sum. Force [N]	0,27	0,46	0,74	0,55

Tab. 1. The summary of the firs results

After evaluating the results you can say, that the summarized x directional force was too small it was between 0,27 and 0,74 N. We choose the cylinder-brick combination, because that had the biggest summarized directional force. So we started to optimize this combination.

Optimization of the geometry On the ground of the first calculations between the magnets considerably little forces awaked, we changed the cylinder-prism the following: we placed a steel flux conductor element on the outside unit. We defined as parameter the length of the outside and inside magnet, length of the flux conductor's steel legs, and the distance of the units. You can see the parameters in fig. 2. Our target function was the maximum of magnetic force's x directional component. The results and the parameters of the optimisation are summarized in table 2.

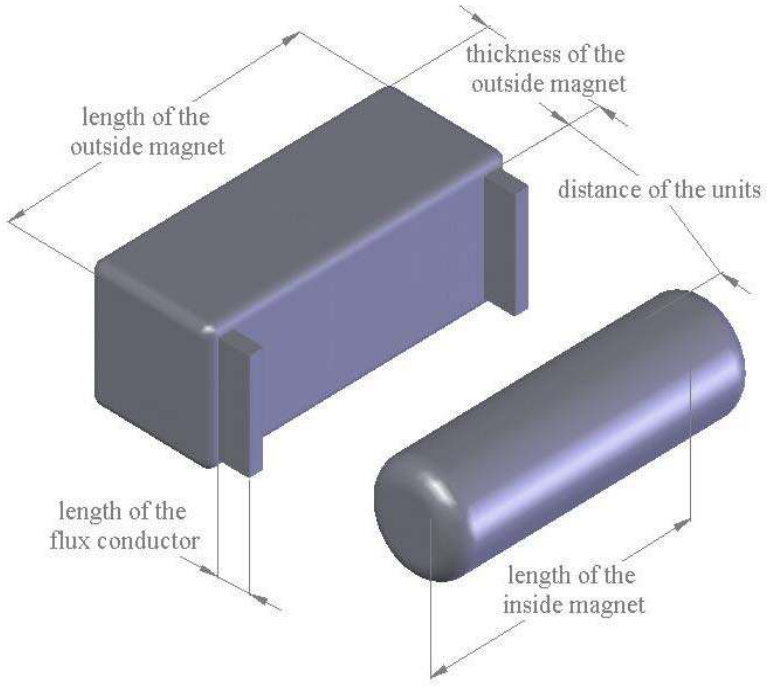
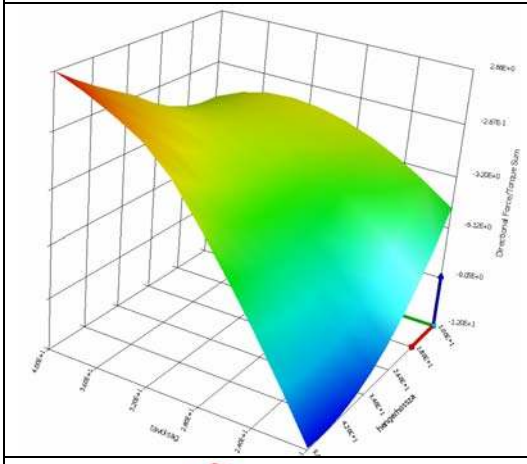
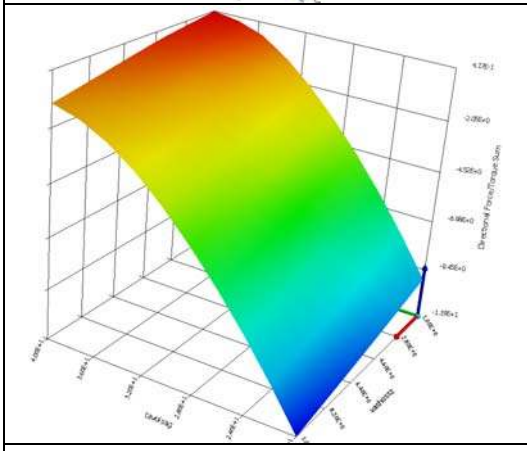
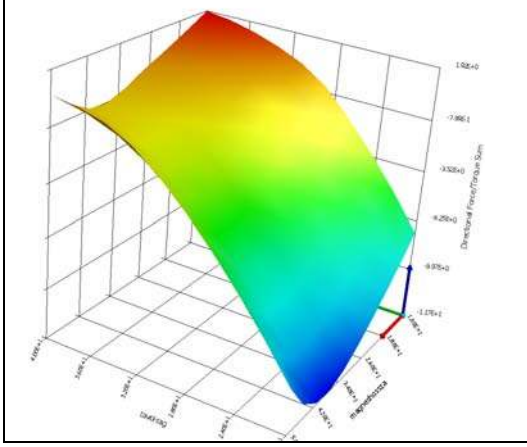


Fig. 2. The modified geometry and parameters

trait of the result	parameters	note
	In the first case the parameters were the distance between the two units and the length of the inside magnet-cylinder. The length of the flux conductor and the length of the outside magnet were fixed.	The values of the summarized directional force are in z (blue) axis, the length of the inside magnet in x (red) axis and the distance between the two units in y (green) axis. The bigger forces are next to the centre of coordinate system. The force changes between 2,6 and -12 N.
	The parameters were the length of flux conductor and the distance.	Like the previous figure the summarized force is in z axis, the distance is in y axis and the length of flux conductor changes between 1 and 10 mm started from the origin. The force changes between 0,4 and -12 N.
	The parameters were the distance between the two units and the length of the outside magnet-cylinder. The length of the flux conductor and the length of the inside magnet were fixed.	The effect of the length of outside magnet is similar to the first case. Because of the bigger size of this outside magnet this effect is more forceful. The force changes between 1,9 and -12 N in this case.

Tab. 2. The summary of the optimization

You can see the effect of the parameters in fig. 3.

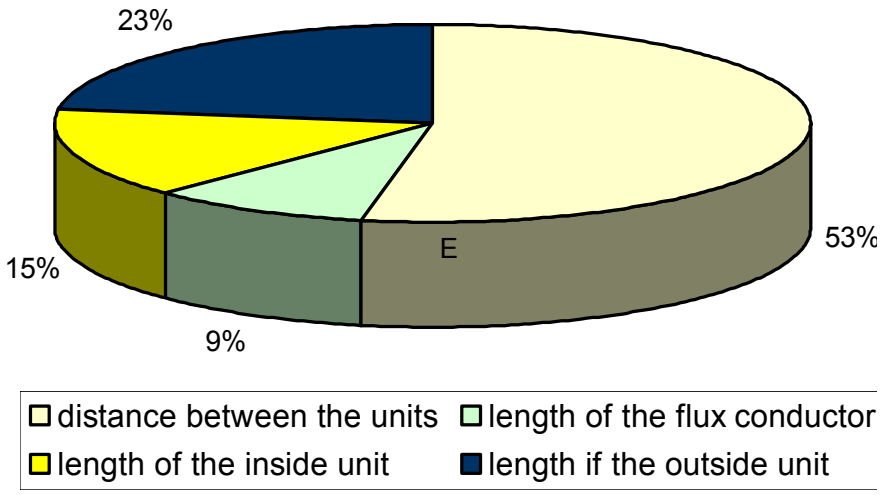


Fig. 3. The effects of the parameters

To sum up we can say that with optimization we could raise the magnetism. We reached about 4-5 N force when the distance was convenient. This does not reach the necessary force so we have to make some developing steps.

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