Like a snail through the intestinal canal

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The medical device currently used for intestinal research, the colonsope, causes patients great discomfort. At TU Delft, an alternative method has been developed, inspired by the way in which snails move. On September 18, researcher Dimitra Dodou received her PhD degree from TU Delft based on this research subject.

The intestines are an extremely difficult area to navigate through with a medical device. Yet, many people need to have intestinal examinations done to determine if, for example, they have intestinal cancer. The medical device currently used for this is the colonscope, a long, thin and flexible tube that causes patients great discomfort and pain. For this reason, researchers have been trying to develop alternative medical devices, such as, for example, a small robot that moves independently through the intestinal tract. There is a layer of slime, called mucus, on the inside of the large intestine (colon). The robots, as they move forward under their own power, ignore this layer of mucus and try, if possible, to suck or grab on to the intestinal wall, which results in the walls being stretched and the patient feeling pain and discomfort.

A better method, according to TU Delft researcher Dimitra Dodou, is in fact to use this layer of mucus and allow the robot to imitate the forward movement of a snail. A snail leaves a trail of slime behind it on the ground. This slimy material works simultaneously as a lubricant for gliding on and as a glue which the slug can grip hold of.

An intestinal robot should also have a similar layer to use. To achieve this, an adhesive layer is added to the mucus-like properties, which

allows the device to be stuck to the layer of mucus. The ability to be attached to a surface covered with lubricant is a great technological challenge, because most adhesives normally only work on 'clean' surfaces. The researchers discovered a group of polymers, so-called muco-adhesives, that are suitable for this. Dodou used a pig's intestine to evaluate how this material worked. Her findings revealed that muco-adhesives in the form of films provided by far the highest degree of friction.

Despite this, there is nevertheless no possibility of movement. A snail uses the exertions of pressure to change the characteristics of the middle layer, and thus lower the degree of friction, in order to move. In the intestine, however, pressure cannot be exerted, because this would cause the intestine to become deformed. The solution then is found in using smaller and larger surfaces that slide over each other. If a large surface coated with muco-adhesive remains still, and a relatively small surface coated with muco-adhesive begins moving in relation to the larger surface, the smaller surface has less freedom of movement. One by one the small 'hands' of the robot move forward. After this, the entire robot can be slide forward incrementally, whereupon the process of small surfaces shifting begins anew.

Additional experiments found that it is not only the size of the film surfaces, but also their shapes, which influence the degree of friction generated. It's remarkable that the degree of friction increases when the surface size decreases, as a result of holes being made in the structure of the film. It is therefore possible to influence the degree of friction by creating holes in the muco-adhesive or indeed by closing the holes.

Moreover, by selecting different shapes, which owing to their compact size can achieve high degrees of friction, the device can be made smaller. The researchers are currently building a prototype that will be tested in living pigs. We must however wait a while longer until a fully

developed medical device is available.

Source: Delft University of Technology