

4D PRINTED SOFT MAGNETIC MEMORY MATERIALS: EXPLORATION AND DESIGN

Automating the printing of magnetic memory materials and inspiring creative applications

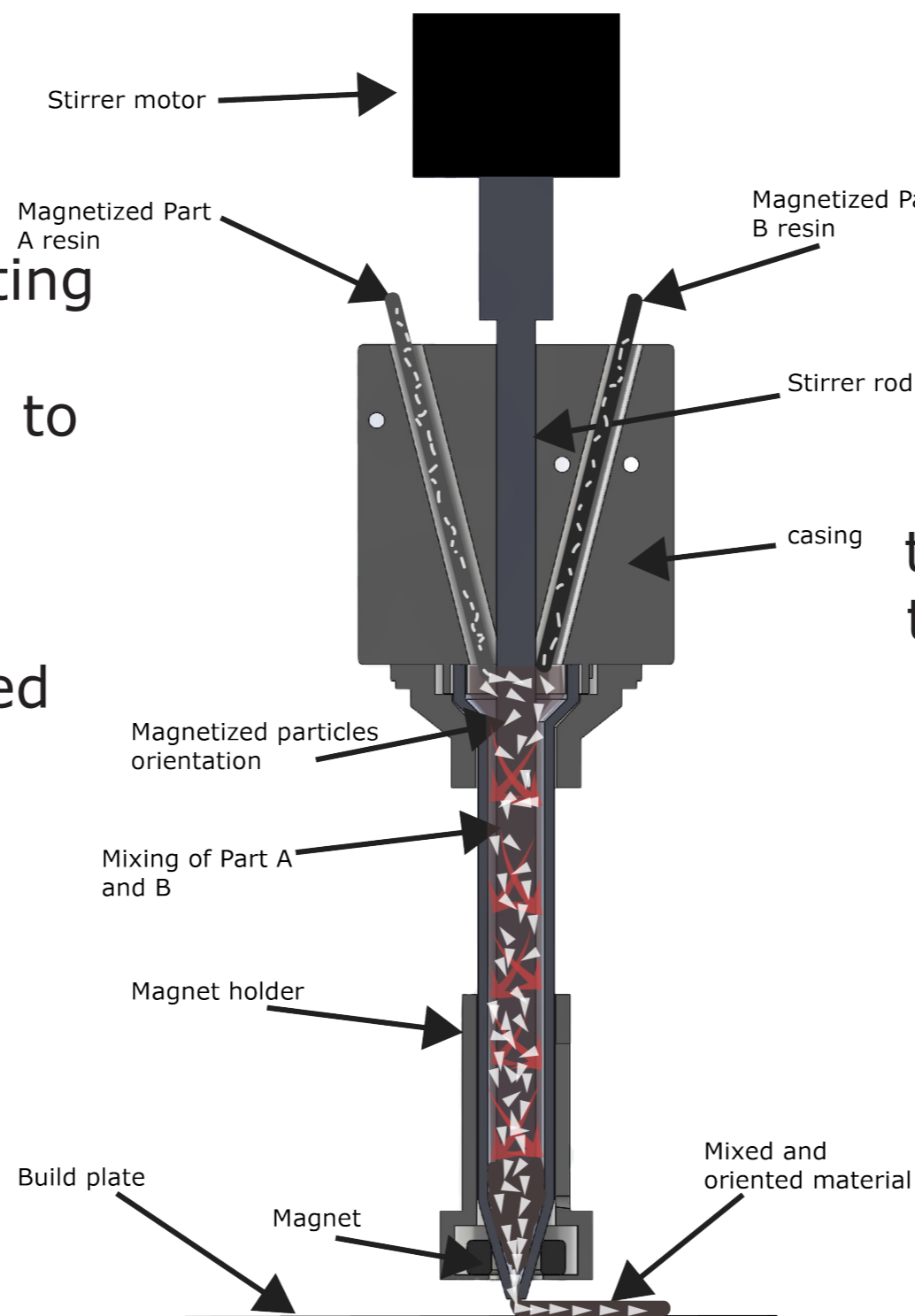
What is 4D printing magnetic materials?

4D printing is the addition of an extra dimension/property to a standard 3D printing setup, in this case, imparting directional magnetic behaviour (a magnetic moment) to the printed parts.

Soft Magnetic Materials are composite materials with a soft and flexible matrix in which magnetic particles (with programmed magnetic moments) are dissolved so that they change their shape when subjected to a magnetic field. In this project, a 2 part silicone resin is used with NdFeB microparticles. These resins are then exposed to high magnetic fields (3 tesla) which magnetizes the microparticles.

Inside the extruder

1. The two tubes containing the material end inside the dynamic mixing nozzle and keep extruding ink within it, the two parts are stirred together.
2. The ink is mixed well and makes its way down the nozzle, at which point it reaches the permanent magnet near the extrusion point.
3. The magnet aligns the moments of all the incorporated microparticles in the same direction.
4. Changing the direction of printing of the lines allows for different orientations which can be combined together to create compound motion.



Applications

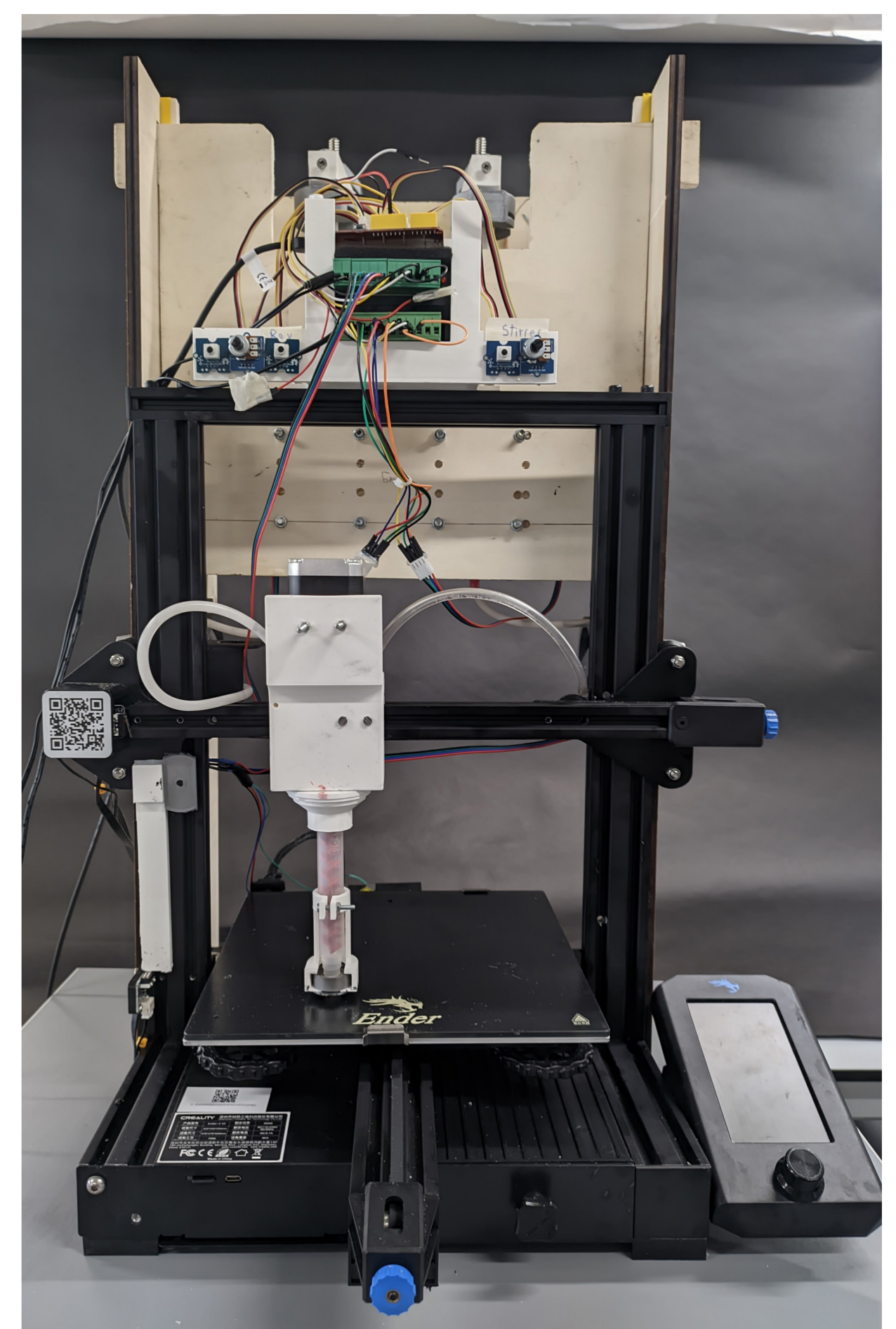
There are a lot of potential domains where this technology can be used, these include

- Haptics
- Soft robotics
- Bio-Mimicry
- remotely actuated structures
- Living hinges
- Jewelry and accessories

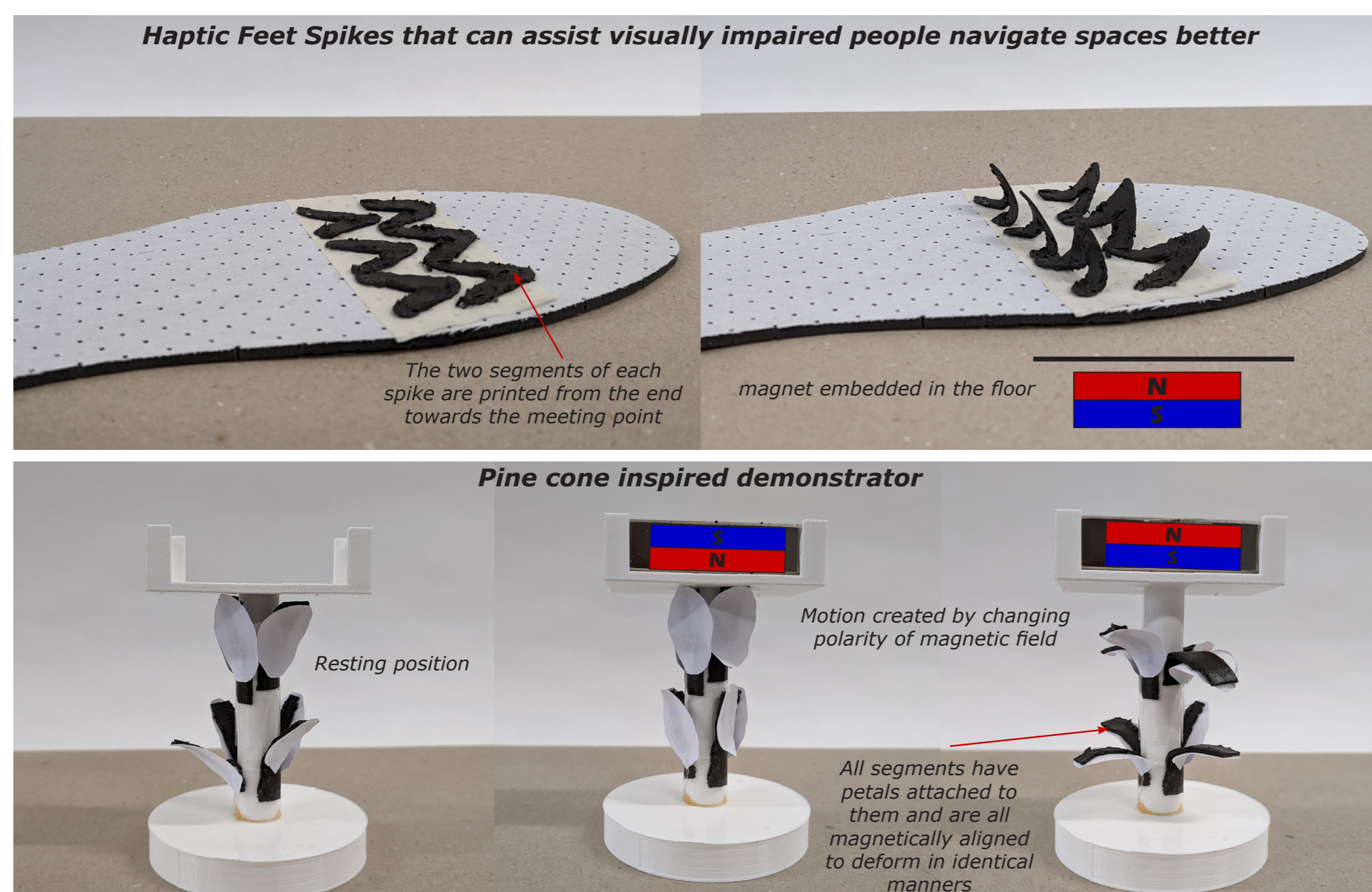
Below are examples of some potential applications are possible using the magnetic memory materials.

Important Printer modifications

Using an existing FDM 3D printer as base, a plywood super structure holds 3 key systems, the piston based extrusion system which actuates the 2 syringes containing the 2 parts of the ink, pushing them forward to the peristaltic pump system, which is needed to further assist the motion of the inks due to their high viscosity as well as serve to control the rate of flow of the materials. The third system is the electronics that controls the piston extrusion as well as the stirring of the nozzle.



Potential applications:



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