INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

This thesis addresses the stiction issue of magnetic nanoparticles (MNPs) in a targeted drug delivery system (TDDS). In a magnetically actuated TDDS, the MNPs are guided to the desired blood vessel by steering them from the bifurcation points, using an external electromagnetic actuation (EMA) system. Meanwhile, some MNPs get stuck to the vessel wall during the steering process. To overcome this problem, an EMA system is designed using four coils and the coil parameters are optimized for efficiently steering the MNPs in a Y-shaped microchannel. The system operates by applying a time-varying magnetic field (TVMF) to navigate the MNPs in the channel efficiently. The TVMF alternately switches between two modes of operation described as follows. The TVMF is applied for a specific duration to generate the magnetic force required to steer the MNPs to the desired outlet in the first mode of operation. The second mode of operation facilitates mitigation of the stiction and aggregation of MNPs by modulating the TVMF and time duration of operation to yield a lower magnetic force in the reverse direction to that in the first mode. The MNPs separated from the sidewalls move ahead with the fluid flow to the desired channel and this guidance mechanism is repeated until the MNPs reach the target point. Extensive simulations are performed to analyse the switching time for effective steering of the MNPs using COMSOL Multiphysics. Furthermore, the experimental validation of the proposed EMA system highlights its practical feasibility to mitigate the stiction issue. Results demonstrate that the magnetophoretic force produced to release the adhered particles in our system is around 99.5% lower than that of an existing EMA system, which aims to address the same issue. Moreover, the duration between the two modes of operation should be set using a ratio of 3:1 for effective guidance of the MNPs to the correct outlet. Thus, our system provides enhanced efficacy in mitigating the stiction issue by alleviating the detrimental effect of the MNPs getting steered to the undesired outlet.