[0071] Size sorting experiments were conducted be injecting a solution of 2.8 μm and 5 μm diameter iron and iron oxide embedded polystyrene particles suspended in water into the wells of the microfluidic magnetic trap platform so that the particles were. **FIG. 10A** depicts an initial random distribution of particles including transit particle **30** and held particles **31**, and **FIG. 10B** depicts the particles after being sorted as all being held. The tip provides the translatable magnetic field gradient while the Permalloy elements of the spin-valve elements are used to spatially confine the sorted particles. The particles are placed into each sorted position by approaching the surface of the membrane over where the particle to be moved is located. Since the tip field gradients die off as r^{-3}, it is necessary to bring the tip as close to the particle to be moved as possible. The minimum distance is limited by the thickness of the membrane which in one experiment was 200 nm; however, it is possible to decrease the thickness of the membrane to 100 nm without damaging the resilience of the membrane. Once the tip contacts the surface, the particle is moved to a predetermined trapping element. To release the particle from the tip field gradient, the tip is retracted from the surface to suitable distance, for example about 9 μm or greater. At this height, the tip then moves to the next particle to be sorted. **FIG. 11A** depicts how a particle can be moved into a desired portion using a magnetic tipped probe. In **FIG. 11A**, the particle **33** is moved from an initial position **34** to a new position **35** manipulating the tip **36** of the probe **37** as illustrated and discussed above. **FIG. 11B** depicts the magnetic tipped probe and microfluidic magnetic trap platform of **FIG. 11A** in perspective.

[0072] Once the particles are placed into desired positions in the array, each particle can be annotated for future manipulation and analysis. Sorting of various sized particles can be accomplished by tailoring of the tip geometry for specific size ranges.

[0073] In the case of a tip size of 800 nm, the geometry was optimized for 1 micrometer particles, although larger particles could also be sorted with less efficiency. The maximum velocity at which the particles are translated was measured by rastering the tip in incremental velocities and recording the point at which the magnetic microparticle no longer follows the tip. A maximum translation velocity of 2.2 mm/sec±0.1 mm/sec for a 1 μm particle was measured in this manner. To determine the maximum sorting rate, it was assumed that with an average translation distance of 20 μm, a tip repositioning time of 2 ms and a computer interface time of 1 ms. These approximations were used to calculate a maximum sorting rate of approximately 5500 individual particles can be sorted per minute.

[0074] The magnetic homogeneity and smaller size of the 1 micrometer magnetic particles made them a typical choice for magnetic tweezers experiments. To implement a magnetic tweezers platform, a comparison was needed between the forces acting on the particles to conventional tweezers instruments. To determine the force acting on the particles velocity was measured. However, since the particles are near the surface of the membrane, a simple treatment using the Stoke's Law for viscous drag is not appropriate in determining the force acting on the particle. Using the relationship for hydrodynamic drag on a particle positioned at a surface, the force is expressed as $F=1.7005\times6\pi\eta r^2G$, here η is the viscosity of the medium, which in this case is water, r the radius of the sphere and G the shear rate of the fluid flow. For this equation to be valid, it must be proven that the test system is under laminar flow conditions. For laminar flow the Reynold's number (Re) for the system must be less than 1, and for the present system Re was calculated as $Re=2.3\times10^{-6\pm0.1\times10^{-6}}$ from the velocity measurements made by scanning the tip. Therefore, the shear rate can be calculated under the condition of a uniform velocity gradient by using the velocity of at the center of the sphere, which, in this case, corresponds to the distance from the surface to the center of the sphere. Under these conditions, a shear rate of $4.6\pm0.1\times10^3$ sec^{-1} was calculated which corresponds to a force of 35.3±2.0 pN.

[0075] To confirm the experimental force measurements, micromagnetic simulations were used to calculate the total force acting on the particles. **FIG. 12** shows the force versus distance simulations for a conical and truncated tip with an 800 nm diameter and a 1 μm diameter magnetic particle. Simulations confirm that a truncated tip provides a stronger trapping force than a conical tip. For the truncated tip, the maximum lateral force acting on the particles is 45 pN. This value is slightly larger than the experimental value measured during the course of the present invention. Deviations from the experimental values obtained using hydrodynamic drag equation are most likely due to the frictional force resulting from the normal force, F_z, pulling the bead into the silicon nitride membrane surface. The force as a function of displacement from the center of the tip indicates that the size of the field gradient is comparable to the size of the particle, and the field outside the particle decreases rapidly. This localization of the magnetic trapping field allows for constant displacement measurements to be made, which is in contrast to typical magnetic tweezers that function as force clamps. While the set-up tested produced forces comparable to optical tweezers, it is possible to tailor the tip-particle geometry and magnetic material used to increase the force acting on the particle to forces typical of current magnetic tweezers apparatus (~10^2 pN).

[0076] The magnetic material coating the side walls of the cone comprising the tip produces sufficient magnetic field gradients to attract more than one particle at a time. This is an undesirable attribute that can be resolved by implementing the traps to separate the particles. Particles less than 5 μm in diameter that are stuck together may be split up by dragging the particles over the center of a Permalloy element, where the particle furthest away from the tip will remain with the Permalloy element, while the other continues to track the field gradient of the tip.

[0077] **FIG. 13** depicts a magnetic random access molecular manipulator according to one embodiment of the present invention (Note: will change description of **FIG. 13** on page **8** in same manner). In **FIG. 13 a** micro fluidic chamber **40** that includes an array of magnetic traps **1** according to the present invention is positioned on a magnetic random access memory chip **41** that can be used to individually switch the magnetic traps **1**"ON" and "OFF" by passing current pulses through the magnetic traps or through wires **43** that are configured to address each of the magnetic traps **1**. The micro fluidic chamber **40** includes a support **44** for the magnetic traps **1** which can be a fluid permeable support such as a membrane that provides a fluid barrier between the micro fluidic chamber **40** and the underlying electronics package. The micro fluidic chamber **40** can also include a