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Design of an Optical Image Stabilization Actuator for Mobile Phone Camera

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Optical image stabilization (OIS) is quickly becoming a standard feature in a high resolution mobile phone camera (MPC) over 3 mega pixels and MPC quantitywill rapidly exceed digital cameras over the next several years. OIS is an effective solution that addresses the quality of images. In general, human hands shake at the frequency of 10 to 20 Hz. Optical images projected upon the image sensor causes blurring when jittering is produced from motion of hands or environment in taking photos. Therefore, this work presents an OIS actuator utilized in a MPC mechanically to compensate jittering in taking photos.

Fig. 1 shows the experimential prototype and structure of the OIS actuator equipped with a stationary base and a movable part. To do so, four permanent magnets are assembled on the stationary base for generating magnetic flux. A movable part consists of an upper cover, a printed circuit board (PCB), a thrust ball bearing, and a lower base. Next, four coils are laid out on the PCB, and each two opposite coils are connected in series to be a set. Additionally, an OIS actuator composes of four coils and four magnets, and two Hall effect sensors are utilized to track and control the position of the movable part by measuring the magnetic field in a MPC accurately. The movement range required by an OIS actuator depends on the optics of the system, and the desired outcome is to move within 0.6 mm. Moreover, a thrust ball bearing is installed between the upper cover and lower base so that the movable part is allowed to move with respect to the stationary part without significant friction. Furthermore, a natural equilibrium system includes four balance balls inserted in PCB and four balance magnets fixed on a stationary base for maintaining the initial neutral position to ward off lock.

A compensating lens or a image sensor is placed on the upper cover of the movable part in a MPC. When a driving current is applied to coils in the PCB, the coils with the same set have two forces of different orthogonal directions. The dimensions of the OIS system are 23.1 mm long × 23.1 mm wide × 3.1 mm high, and the net weight of the movable part is 1.1 gw. The OIS actuator can fulfill low power consumption requirement, and this design is also possible to reduce dimensions for the application in a MPC.

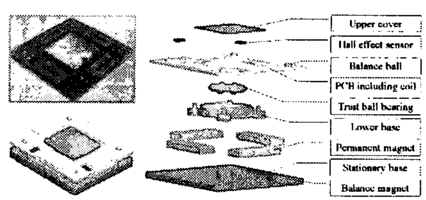

Fig. 1. Prototype and structure of OIS system.

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PMMA Coated Carbonyl Iron Microbeads and their Magnetic Characteristics

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Recently as one of the important applications of magnetic particles, extensive investigations have been putting in the area of magnetorheological (MR) materials, in which the MR fluids are suspensions of magnetic particles in a nonmagnetic fluid. MR fluids along with electrorheological (ER) fluids have been regarded as one of the smart materials with controllable properties by tuning external magnetic field strength. They can be reversibly transformed from a fluid-like to a solid-like state within milliseconds by showing dramatic transition in rheological properties. MR fluids generally show superior properties, including high yield stress of 10-100 kPa within a possible magnetic field strength range. These values are much higher than ER fluids. Furthermore, MR fluids can be relatively easy to commercialize as compared to ER fluids since magnetic field is more stable than electric field.

However, for engineering applications of the MR fluids, several problems have to be improved, since most of the magnetic particles used in MR fluids have serious sedimentation problem due to the high density as well as the abrasion of the equipment. In order to overcome these drawbacks, we prepared a magnetic composite with methacrylic acid (MAA) treated carbonyl iron (CI) as core and cross-linked poly (methyl methacrylate) (PMMA) as shellvia an in-situ dispersion polymerization. Ethylene glycol dimethacrylate was used as the cross-linking agent. It was confirmed by many researchers that the method of polymer coated magnetic particles is useful to mitigate several problems. Moreover, cross-linking of PMMA is also effective to improve the physical properties such as stiffness, surface hardness, resistance to temperature, and resistance to solvent attack.

Morphology and cross-sectional views of the CI/PMMA composite were investigated by scanning electron microscope (SEM) and transmission electron microscopy (TEM). Magnetization curves were measured by vibrating sample magnetometer (VSM). In addition, density of the PMMA-coated magnetic particles was measured by gas pycnometer. The characterization data shows that successful encapsulation of spherical iron-particle with cross-linked PMMA and the enhancement of dispersion stability of MR fluids. The synthesized magnetic particles were dispersed in mineral oil to prepare the MR fluid. MR properties ofthe MR fluids were analyzed by using a rotational rheometer equipped with a magnetic field supplier and parallel plate geometry.

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