iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** V **Month of publication:** May 2018

DOI: http://doi.org/10.22214/ijraset.2018.5397

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue V, May 2018- Available at www.ijraset.com

Image Stabilisation using Piezoelectric Effect

Anant Gavali[1], Shraddha Gupte[2], Prof. A. M. Chopde[3]
[1,2]*Vishwakarma Institute of Technology, Pune*
[3]*Prof, Vishwakarma Institute of Technology, Pune.*

Abstract: Image Stabilisation has been considered as essential in delivering an improved image quality in professional cameras, astronomical telescopes and mainly, in smart phones. Due to their high-response, high-precision and small size, piezoelectric micro electromechanical systems (MEMS) can be integrated in almost any device. The purpose of this paper is, to study the technique of image stabilisation and the principle of operation of the piezoelectric accelerometer. Also, the integration of these accelerometers in Image Stabilisation is studied.
Index Terms: OIS, MEMS, Accelerometer

I. INTRODUCTION

The mobile camera modules have shown a trend towards high resolutions, smaller sizes and lighter weight. The effect of blurring has been a great drawback. The addition of Image Stabilization has been a significant value-addition for photography. Also, separate accessory of a digital camera is being carried for photography is seen to fade out because of the availability of equivalent system in a more mobile friendly manner. As a result, the request for image stabilization is increasing in smart phones and Digital Security Systems (DSC).

There are two methods of image stabilization: Optical Stabilization and Electronic Stabilization. Optical Image Stabilization technology (OIS) is an effective solution for minimizing the effects of involuntary camera shake or vibration. The key element of all optical stabilization systems is that they stabilize the image projected on the sensor before the sensor converts the image into digital information [1]. It senses the vibration on the hosting system and compensates for these camera movements to reduce hand-jitter effects [2]. Also, handshake detection via integrated sensors, rapidly moving mechanical elements and digital signal processing with complex algorithms became state-of-the-art [3]. The purpose of this paper is to study the OIS system, MEMS accelerometer.

II. OPTICAL IMAGE STABILIZATION

Optical Image Stabilization (OIS), being one of the method to reduce the blurring effect due to vibrations, does not require any post-processing algorithms. Additional hardware is required to implement OIS. The key element of all optical stabilization systems is that they stabilize the image projected on the sensor before the sensor converts the image into digital information [2]. In this, the trajectory of light incident on the sensor is kept the same, even when there are jitters. These jitters are compensated by the movement of lens i.e. the lens moves in direction opposite to the camera shake. The figure below shows the compensation effect.

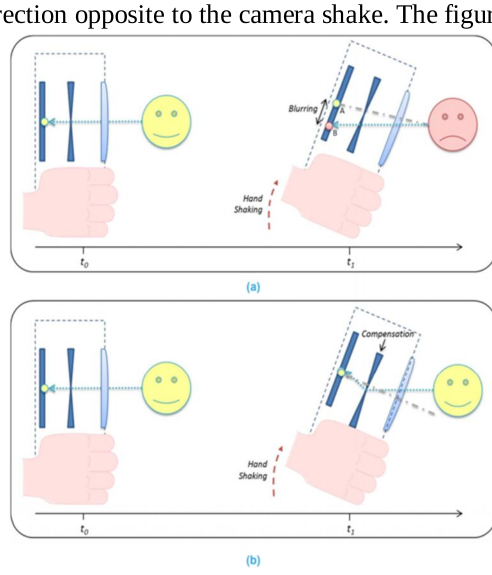

Fig. 1. Image trajectory without OIS (a) Image trajectory with OIS (b)

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue V, May 2018- Available at www.ijraset.com

III. CONTROL ALGORITHM

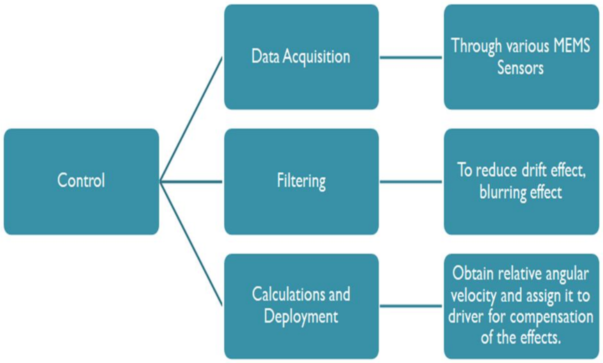

Fig. 2. Control Algorithm

To successfully implement OIS, its structure is split up into three stages as shown in the figure above. In the first stage, data is acquired and the lens position is obtained by the driver; the data is first filtered to reduce offset drift contribution. Then, in the second stage, the filtered data is integrated, obtaining the relative displacement caused by jitter. Finally, the OIS control function processes this displacement and the camera-module position data, elaborating the new set-point: this value is assigned to the driver to compensate for the jitter effect.

IV. ARCHITECTURE

Based on the structure used to build the camera module, OIS compensation can be done by using any of the two methods viz.Lens Shift where the image sensor is fixed to the bottom of the camera case and the lenses move with a translational movement[4]. Camera Tilt where the image sensor is integrated in the same body with the lenses, and both move angularly to compensate for involuntary shaking.[4 Another important part used in the hardware, is the position sensor, which is used to detect lens movement. The sensors used are of two types; Hall sensors, suitable for Lens Shift method and Photo sensors, suitable for Camera Tilt method. The detailed architecture is mentioned in the following sections.

A. Voice Coil Motor Driver and Hall Sensor

Specific drivers are usually used for piloting lens movement of the camera module and acquiring its relative positions thought the Hall sensors embedded in the camera [4].The structure of these devices can be divided into two stages: the driving stage and the acquiring stage. The driving stage consists of a Voice Coil Motor (VCM) and two Digital-to-Analog Converters (DACs), for producing a displacement of the lens. This stage has two operational modes: the PWM-mode driving, which manages the power efficiency and the Linear-mode driving, which reduces the noise. The VCM operates on the principle of Lorentz Force. Applying a voltage across the terminals of VCM causes the holder to move to one direction and applying a voltage of reverse polarity causes the holder to move in the opposite direction.

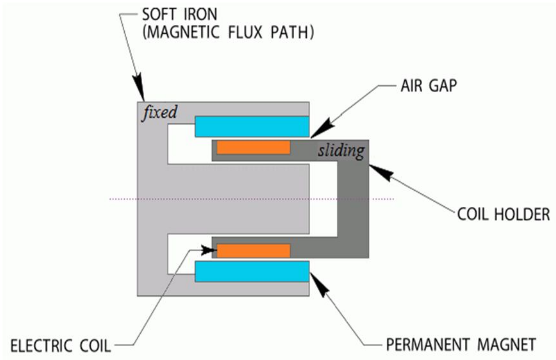

Fig. 3. Voice Coil Actuator

The acquisition stage manages the data acquired from the Hall sensor and provides the position of the camera module lens [4]. The Hall sensor must be accurate enough, to detect the slightest change in position of the lens.

B. Microcontroller

The microcontroller (MCU) are used to execute the Calculations and Deployment stage of the control algorithm. The main tasks that the MCU has to perform are

1) To manage the communication between the accelerometer and the driver.
2) To prepare and to elaborate all the incoming information to adapt to the same measurement unit.
3) To execute the main algorithm so as to control the entire system.
4) To tell the driver the new reference condition to be actuated on the camera module.

Computational power is one of the two main technical requirements of the MCU, as it has to perform all the routine tasks in fastest time possible. The other requirement of the MCU is Communication Capability, as it has to guarantee a stable link between the accelerometer and the driver.

IV. ACCELEROMETER

Accelerometers operate on the grounds of inertia which is subject to acceleration [1]. Piezoelectric accelerometer is a device which implements piezoelectric effect on certain materials to measure changes in the mechanical variables such as acceleration, vibration, mechanical shock, etc.

Accelerometer works on the principle of MEMS capacitor. Hence, in order to understand how a accelerometer works, we need to know how a MEMS capacitor functions.

Figure 4, shows the MEMS structure of a capacitor. The red arrows indicate the two plates of a capacitor. Of the plates, one is fixed and the other is movable. This model contains a comb like structure called combed finger arrangement. The two structures of the combed arrangement are very close to each other.

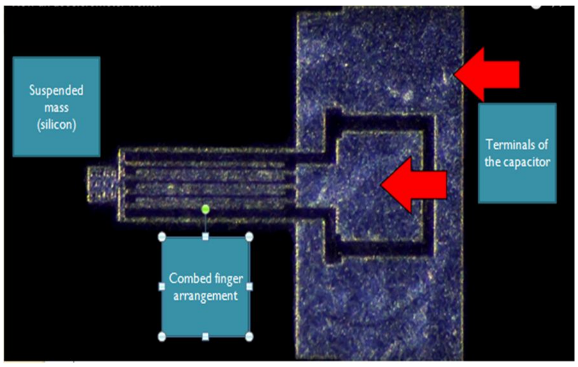

Fig. 4. MEMS structure of Capacitor

From figure 5, it is clear that the structures form parallel surfaces which forms a capacitor.

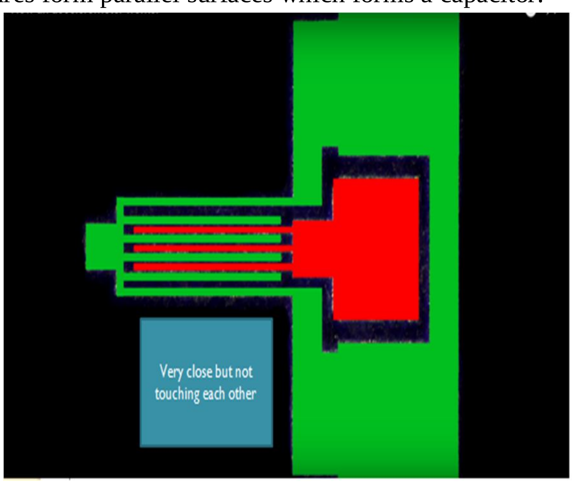

Fig. 5. MEMS structure of Capacitor showing two plates separated.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue V, May 2018- Available at www.ijraset.com

On the very left side is a tiny weight like structure. This is made of Silicon. Gravity, vibrations and movements can cause this little mass to move around.

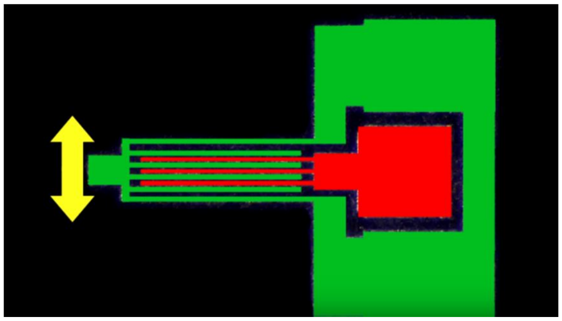

Fig. 4. MEMS structure of Capacitor showing Silicon weight movement.

When such movement occurs, it leads to shifting of the entire combed finger structure. When the fingers move the distance between the fingers changes. Hence, we get a change in capacitance. Thus, this is an electro-mechanical system that can sense a change in movement and convert it into equivalent capacitance value. These changing values can be converted into varying voltage or serial data which can be used for further processing.

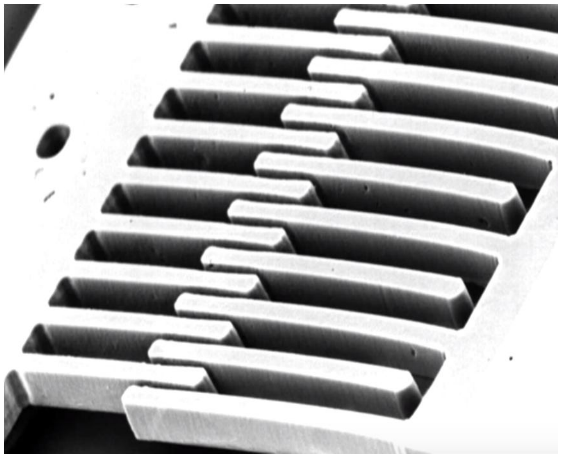

Fig. 5. MEMS accelerometer

A modern MEMS accelerometer will contain a structure similar to this. Although, it may contain more fingers to increase the surface area. This increases the capacitance, which in turn makes it easy to detect the change in capacitance. Hence, change in acceleration is noted easily.

V. CONCLUSION

Optical Image Stabilization is a technology that minimizes blurring effect caused by vibration. For a long time, it's been the essential feature of professional cameras and digital still cameras. Recently it has rapidly become an essential feature across various trendingsmartphones[7].

This paper describes the OIS system. We've also presented the OIS camera module technology that corrects the variation of the lens position to compensate for accidental movements that cause blurring. The OIS system has been described as the union of a MEMS accelerometer, a microcontroller executing a control algorithm that determines how much compensation is needed to correct the camera's shake, and a driver controlled by the MCU that retrieves the lens position information from the camera module's Hall sensors and sets the corrected position via the two voice coil motors embedded in it[8]. In this way, the system can compensate for the detected motion, moving the lens elements on the camera to produce quick actions to reduce blurring and obtain high-resolution images.

VI. ACKNOWLEDGEMENT

We would like express our heartfelt gratitude to our guide, Prof. Abhay Chopde for his vital guidance.

REFERENCES

[1] X.Zhou et al, Design and fabrication of a MEMS capacitive accelerometer with fully symmetrical double-sided H-shaped beam structure, Microelectronic Engineering 131:51–57, 201
[2] Zhang Yong-xiang, Zhang Wei-gong, Zhao Xiaoxu, and Yuan Hui-mei, Study on Electronic Image Stabilization System Based on MEMS Gyro, International Conference on Electronic Computer Technology, 2009
[3] Borys Golikand Dietmar Wueller, Measurement Method For Image Stabilizing Systems, Proc. SPIE 6502, Digital Photography III, 2007
[4] Fabrizio La Rosa, Maria Celvisia Virzì, Filippo Bonaccorso, Marco Branciforte, Optical Image Stabilization (OIS) White Paper
[5] Ramona Corman1, Oana Nedelcu, Dragoú Dobrescu, Design and simulation of a piezoelectric sensor with applications in
[6] Michael K. Masten, Inertially Stabilized Platforms For Optical Imaging Systems, IEEE Control Systems Magazine, 2008.
[7] Derek K. Shaeffer, InvenSense, Inc., MEMS Inertial sensors: A tutorial overview, IEEE Communications Magazine, Topics In Integrated Circuits For Communications, 2013.
[8] Torii · Michal Havlena · Tomáš Pajdla, Omnidirectional Image Stabilization for Visual Object Recognition, https://link.springer.com/article/10.1007%2Fs11263-010-0350-
[9] Y. Kagawa, T. Hatakeyma, Piezoelectric effect in liquid crystals, https://www.sciencedirect.com/science/article/pii/0022460X7790526
[10] G. Yugandhar, G. Ventakesware Rao, K. Srinivasa Rao, Modelling And Simulation Of Piezoelectric MEMS Sensor,
[11] https://www.sciencedirect.com/science/article/pii/S221478531500331
[12] S. Kavitha, R. Joseph Daniel, K. Sumangala, Design And Analysis of MEMS Comb Drive Capacitive Accelerometer For SHM And Seismic Applications, https://www.sciencedirect.com/science/article/pii/S026322411630389
[13] A. Albarbar, A. Badri, Jyoti K, Sinha, A. Starr, Performance Evaluation Of MEMS Accelerometers, https://www.sciencedirect.com/science/article/pii/S0263224108002091
[14] S-H. Yang, F.-M Jheng, Y.C. Cheng,Two Dimensional Adaptive Image Stabilisation, http://ieeexplore.ieee.org/document/4155591/?anchor=authors
[15] S. B. Rudraswamy, Ashwin Kumar, MEMS based Optical Image Stabilisation, http://ieeexplore.ieee.org/document/7498996/author
[16] Myeong-Gyu Song, Hyun- Woo Beak, No-Choel Park, Development of Small Sized Actuator with Compliant Mechanism for OIS http://ieeexplore.ieee.org/document/5467407/author
[17] B. Cardani, Optical Image Stabilisation for Digital Cameras http://ieeexplore.ieee.org/document/1615267/