Miniaturized 1inch Dual Servo Pick-up Actuator

D. W. Kang\textsuperscript{1}, K. H. Kim\textsuperscript{1}, J. H. Jeong\textsuperscript{1}, D. G. Gweon\textsuperscript{1}

\textsuperscript{1}Nano-Opto-Mechatronics Lab., Dept. of Mechanical Eng., KAIST
373-1 Gusseong-Dong, Yusung-Gu, Daejeon, 305-701, Korea

Introduction
Nowadays, the improvement and development of Multi-media and information & communication technology is rapidly processed. And many products, for example, digital camera, digital camcorder, and PDA, are used. They need large data storage capacity and small size, light storage system. Due to that, many studies and researches in data storage system have been carried out. Especially, 1inch HDD drive system was presented by IBM.[1] However, its system is expensive and uneasy to be portable. In ODD technologies, 1inch drive system is not yet or in processing status.[2] If possible and to be come up, it is cheaper than HDD system and easy to transfer information.

In this paper a miniaturized 1inch actuator is studied and designed for ODD system. In specifically, it is adapted in NFR (in using SIL(Solid Immersion Lens) system. It is a dual servo actuator, which consists of a Fine actuator and a Coarse actuator. Its actuating force generation method is VCM(Voice Coil Motor). The Fine actuator is composed of 4-wire suspensions and a bobbin wrapped by coils. The Coarse actuator has Cols and V-groove guide system.

Conceptual Design
For the embodiment in 1inch actuator of ODD system, new concepts should be adjusted to actuator system. The actuator is presented in Fig 1. The first idea is that fine and coarse actuator is located at one plane. Using one magnet circuit for fine and coarse actuator, this idea is realized such as Fig 2. This structure helps other benefits to 1inch system. Systems can be made thin and obtained required forces sufficiently in moving range. And then, total 1inch actuator system has symmetric and simple structure.[3] The second idea is that the shape of bobbin is a double-\(\Pi\) frame as Fig 3. Due to double-\(\Pi\) frame, the flexible mode frequency by bobbin structure is shifted to about tens-kHz frequency.[3] The third idea is that V-grooves, bars, and leaf spring are used as a guide mechanism in Fig 2.[4][5] Its good effect is to make pickup actuator very thin and simple.

Fig 1. The Conceptual Sketch of 1inch pickup actuator.

Fig 2. Single magnetic path for actuating forces and Guide mechanism

(a) Fine actuator and Bobbin shape

(b) Coarse actuator

Fig 3. Fine and Coarse Actuator
Design and Simulation Results
The 1inch dual servo pickup actuator consists of mechanical part and actuating force generation part. Mechanical part is composed of bobbin, moving body, 4-wire suspensions, and guide mechanism. And then, actuating force generation part is VCM. Bobbin is made of PC-GF20 similar to engineering plastic, moving body made of Al7076, and wire suspension made of Φ90μm copper. The height of Bobbin is 2.5mm and width 5mm, length 3.6mm and thickness 0.2~0.6mm. In Fig 4, the simulation result of moving body and bobbin is presented. Guide system is constituted by three V-grooves in moving body, a guide bar made of coated AL, and Leaf springs. Magnets in NdFe40 and yokes in SPCC are used in VCM. Mentioned parts is designed, produced, and assembled such as Fig 1.

This pickup actuator has required specifications that are 1st natural frequency of 56Hz, DC-gain of 64.4dB, and maximum acceleration of coarse actuator about 13m/sec^2 for a NFR system.

(a) Flexible mode frequency of Bobbin at 35.8kHz. 
(b) Moving part mode shape at 5.63kHz.

Fig. 4. Simulation result of Bobbin and Moving part

At the design of 1inch pickup actuator, some assumptions are adapted. One is that disk maximum deflection is several tens um. Other is that the disk diameter of 1inch ODD system is about 20~30mm. Due to assumptions, focusing and tracking range of 1inch pickup actuator is about ±100um, and coarse actuator range about 15mm.

Assembly and Experimental Results
In Fig 5, assembled 1inch dual servo pickup actuator is presented. And Table 1 presents characteristics of 1inch dual servo pickup actuator. Especially, by using LDV(Laser Doppler Vibro-meter) and sine swept signal, FRF of coarse actuator, focusing and tracking is carried out. So that, FRF of pickup actuator is obtained such like Fig 6.

Characteristics of Miniaturized 1inch Pick-up

<table>
<thead>
<tr>
<th>Size</th>
<th>28mm<em>25mm</em>3mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>B_ISC</td>
<td>0.22T</td>
</tr>
<tr>
<td>R_Focusing</td>
<td>2.2Ω</td>
</tr>
<tr>
<td>R_Tracking</td>
<td>6.2Ω</td>
</tr>
<tr>
<td>R_Coarse</td>
<td>12.2Ω</td>
</tr>
<tr>
<td>M_Isolated</td>
<td>0.08g</td>
</tr>
<tr>
<td>M_Total</td>
<td>0.47g</td>
</tr>
<tr>
<td>DC-gain</td>
<td></td>
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<tr>
<td>Focusing</td>
<td>89dB</td>
</tr>
<tr>
<td>Tracking</td>
<td>89dB</td>
</tr>
<tr>
<td>1st Frequency</td>
<td>100Hz</td>
</tr>
<tr>
<td>Coarse Actuator Force</td>
<td>73.8mN/A</td>
</tr>
</tbody>
</table>

Fig 5. Assembled 1inch dual servo pickup actuator

Table 1. Characteristics of 1inch dual servo pickup actuator

(a) FRF of Tracking Actuator

(b) FRF of Focusing Actuator
Conclusions
We proposed a miniaturized 1inch dual servo pickup actuator. This pickup actuator has some conceptual design ideas for slim, small size, and precision movement. One is that coarse and fine actuator is in an identical plane. Another is II-frame as a bobbin shape. The last is a guide system using V-grooves. Due to mentioned ideas, 1inch dual servo pickup actuator for a NFR system was made and fabricated.

References