

Plastic Chips by Hot Embossing Methods and Their Applications for DNA Separation and Detection

Gwobin Lee^{1,*}, Shu-Hui Chen², Guan-Ruey Huang¹, Wang-Chou Sung², Yen-Heng Lin¹

¹ Department of Engineering Science, ² Department of Chemistry, National Cheng Kung University, Tainan, Taiwan, 701

gwobin@mail.ncku.edu.tw

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Design and fabrication of microfluidic devices on polymethylmethacrylate (PMMA) substrates for analytical chemistry and biomedical-related applications using novel microfabrication methods are described. The image of microstructures is transferred from quartz master templates possessing the inverse image of the devices to plastic plates by using hot embossing methods. The micro channels on quartz master templates are formed by the combination of metal etch mask and wet chemical etching of a photomask blank. The micromachined quartz templates can be used repeatedly to replicate cheap and disposable plastic devices. The reproducibility of the hot embossing method is evaluated using 10 channels on different PMMA plastics (Fig. 1). The relative standard deviation of the channel profile on the plastic chips is less than 1 %. In this study, the PMMA microfluidic chips have been demonstrated as a micro capillary electrophoresis (μ -CE) device for DNA separation and detection. The capability of the fabricated chip for electrophoretic injection and separation is characterized *via* the analysis of DNA fragments Φ X-174-RF Hae III digest. Experimental results indicate that all of the 11 DNA fragments of the size marker could be identified in less than 2 minutes with relative standard deviations less than 0.4 % and 8 % for migration time and peak area, respectively. Moreover, with the use of a near IR dye, fluorescence signals of the higher molecular weight fragments (> 603 bp in length) could be detected at total DNA concentrations as low as 0.1 μ g/mL. In addition to DNA fragments Φ X174-RF Hae III digest, DNA sizing of hepatitis C viral (HCV) amplicon is also achieved using microchip electrophoresis on PMMA substrates.

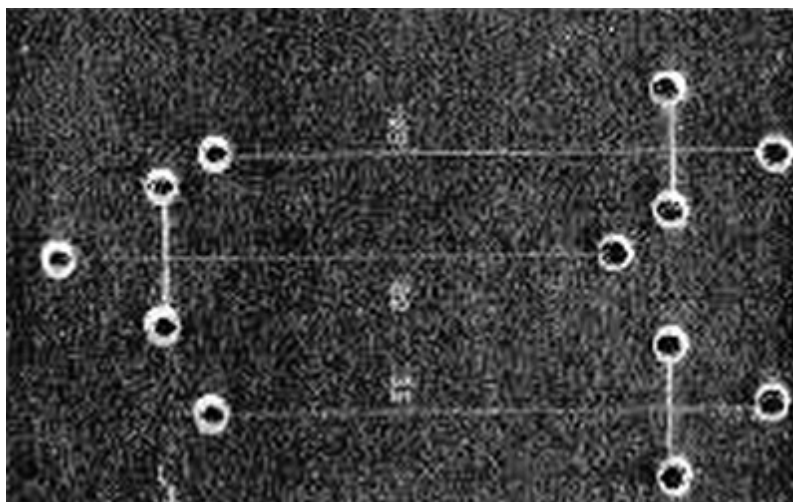


Fig. 1 Picture of a micro electrophoresis chip fabricated by the hot embossing method.

Design of Large Power Surface-Mounted Permanent-Magnet Motors Using Post-Assembly Magnetization

Min-Fu Hsieh*, You-Chiuan Hsu and David Dorrell

Department of System and Naval Mechatronic Engineering, College of Engineering, National Cheng Kung University

mfhsieh@mail.ncku.edu.tw

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Rare-earth permanent-magnet (PM) brushless motors possess the advantages of high efficiency, high torque/power density and low maintenance. They are usually assembled with the magnets pre-magnetized. However, as the motor size and output power increase, the handling of the pre-magnetized components can be difficult. These increase the manufacturing cost [1-2]. Hence, the “post-assembly magnetization” (PAM) represents a potential solution. Fig. 1(a) presents the conventional manufacture process for rare-earth PM motors while Fig. 1(b) illustrates the process with PAM. Problems occur in the steps of magnet insertion and rotor assembly (Fig. 1(a)), and this makes it difficult to produce large PM motors with high power. With PAM, the motor is fully assembled before the magnets are magnetized by applying a current pulse to the motor windings (this is commonly used for cheaper and smaller ferrite magnet machines). Fig. 1(b) shows that magnetization is performed in the last step and the assembly of the machine is more straightforward.

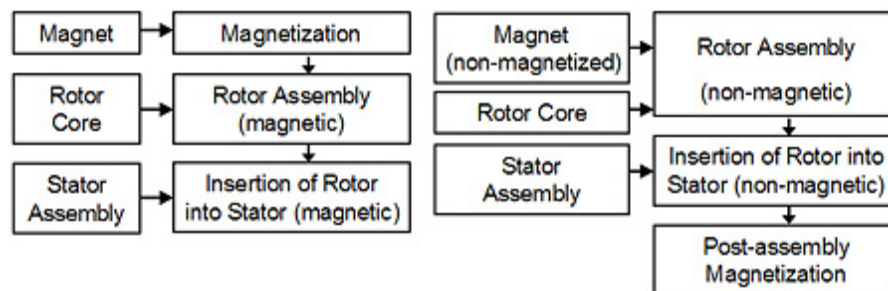


Fig. 1 Manufacturing processes for brushless PM machines (a) Conventional manufacture (b) Post-assembly magnetization

This paper presents the design of rare-earth surface-mounted PM (SPM) motors for manufacture with PAM. In the design procedure, magnetic circuit modeling is used in conjunction with a process for addressing the PAM. In this magnetization, a large current impulse is required to fully magnetize the magnets, and such current usually creates a large magnetic field that saturates the stator core material. The relative permeability becomes almost unity at the instant of magnetization. This paper makes use of this phenomenon in the design derivation for PAM. A 6 kW SPM motor was designed to demonstrate the proposed method. The design was then simulated using finite element analysis. To experimentally verify the proposed process, a 400 W SPM prototype was designed and magnetized.

Derivation of Design Process

Post-assembly or *in-situ* magnetization techniques have been investigated [1-6] but no systematic design so far is proposed. The process derived in this paper is detailed in the following.

Material Permeability at Large Magnetizing Currents

The magnetizing current required for full PAM is approximately 3-4 times the coercivity current for NdFeB magnet material [5], although [4] find that 2-2.5 times is sufficient.

Design Process

The design process considers both the “parameter design for motor operation” and the “magnetizing current for PAM”. As can be seen in Fig. 2, at Point A of the machine geometry, there is a filamentary conductor with the same number of turns as the belt of magnetizing coil sides (distributed over several slots) so that it represents the MMF center for the magnetization. The winding layout for one phase and the connection of the two phases for magnetization are shown in Fig. 3. The magnetizing terminal current or phase current I_{ph} is $2I_{mag}$ because there are two parallel connections in a phase winding.

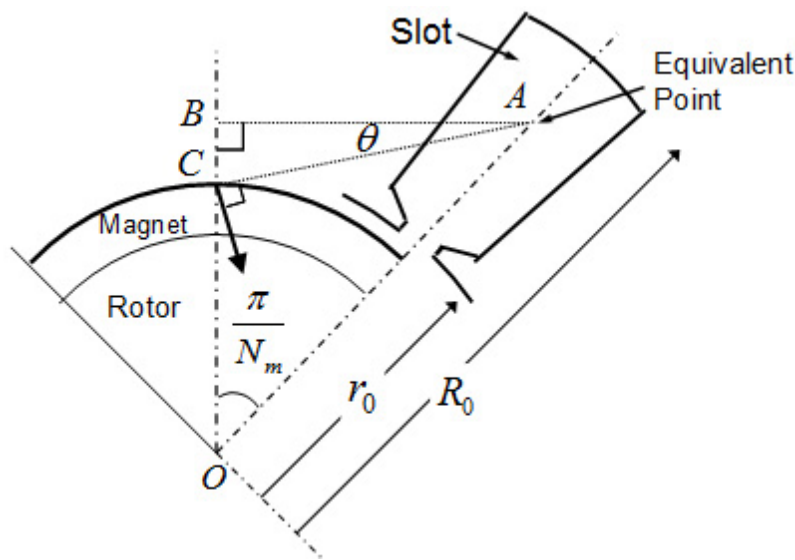


Fig. 2 MMF center and flux density for magnetization.

The relationship between I_{mag} , R_o and r_o for the required magnetizing flux density can be used to calculate the required current for magnetization. The slot-fill factor is a critical factor for design with PAM. This is because the conditions for both magnetization and motoring operation should both be satisfied.

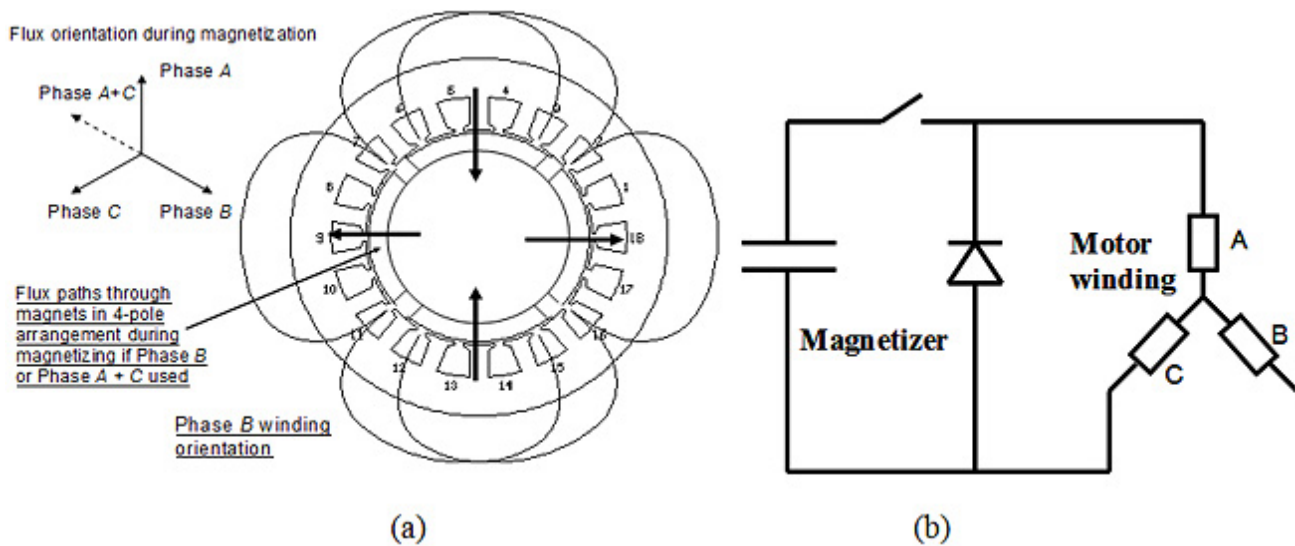


Fig. 3. Coil arrangement and orientation of one phase (2 parallel paths formed from 2 series coils) and magnetization connections. Phase *B* could be used, or Phases *A* and *C*, as used in the simulation and experimental work.

To summarize, in the proposed design process, R_o and r_o are first calculated from the motor specification (e.g., the slot-fill factor and back EMF constant). For a calculated R_o and r_o combination, the magnetizing current can be determined to satisfy the design. A computer program has been developed using this method to calculate the magnetizing current.

Design Results and Simulation

Initial Design Specification

A 4-pole 18-slot 6 kW machine is studied. The curves in Fig. 4 show the relationships between r_o and R_o for the defined back EMF constant. The solid curves represent I_{mag} from 500 A to 2 kA for various r_o and R_o combinations under the prescribed field intensity at Point C of Fig. 2. In Fig. 4, at the design point, 1.8 kA should be sufficient to produce the magnetic field (2.5 times the magnet coercivity) required to fully magnetize the motor. This can be considered as the lower bound.

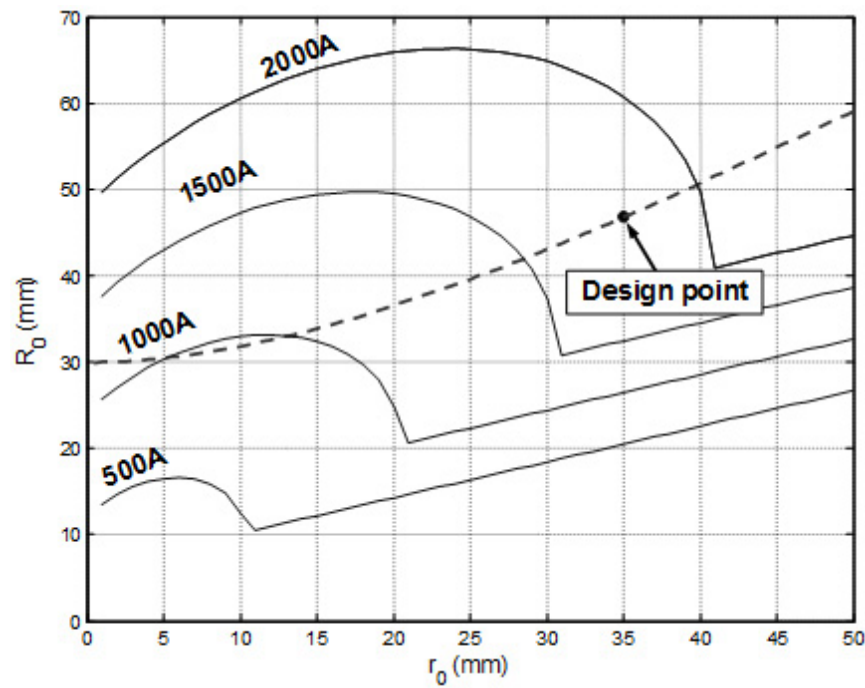


Fig. 4. Relationship of I_{mag} , r_o and R_o . 1800 A is sufficient to supply 2.5 times the magnet coercivity at the design point for full magnetization.

Magnetization Validation

Fig. 5(a) shows a flux plot for an applied magnetizing pulse on the designed SPM motor. The winding layout of one phase is shown in Fig. 3. This simulation was carried out using ANSOFT finite element software. The winding current generates a magnetic flux which correctly magnetizes the four-pole rotor. The flux pattern illustrates that there is high saturation since there appears to be only little material boundary. Also, the field intensities in different locations shown in Fig. 5(b) are sufficient to magnetize the magnets.

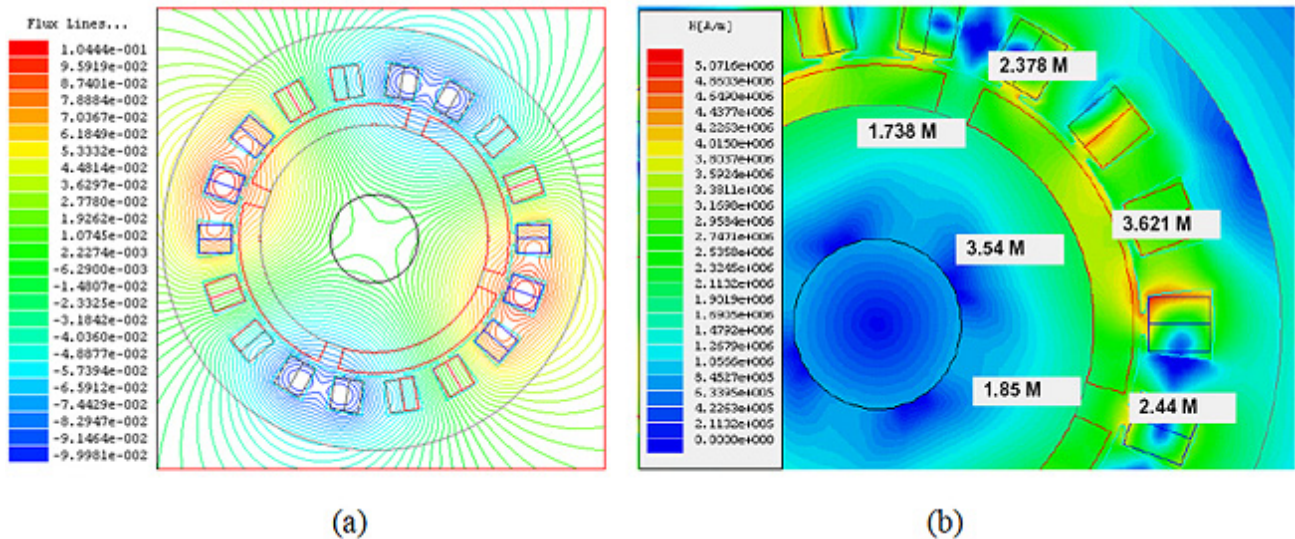
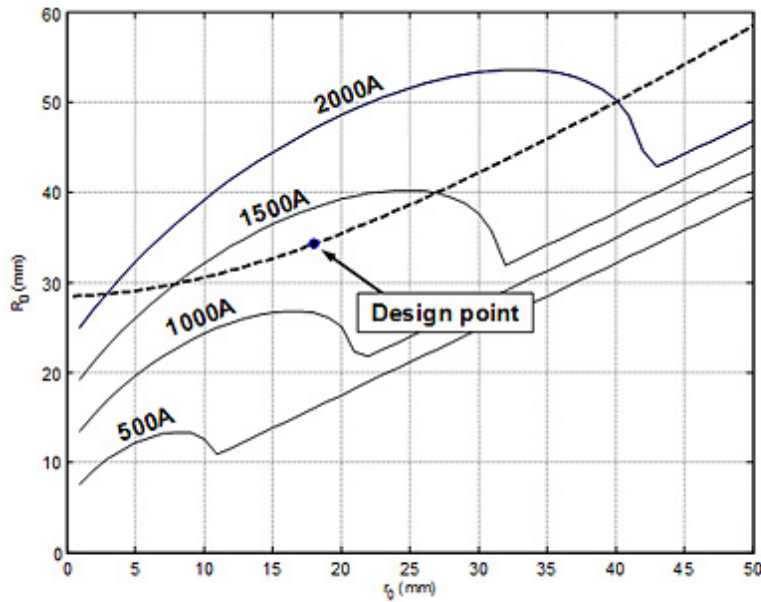


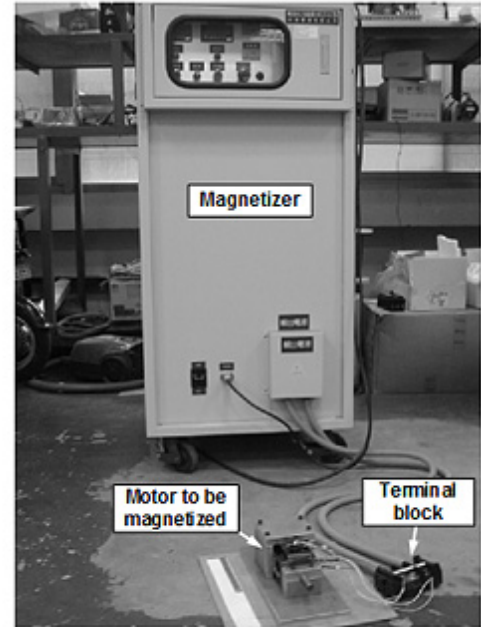
Fig. 5. Simulation results: (a) SPM motor with magnetization flux (2 kA coil current) and (b) Magnet field intensities at different parts of the magnet during magnetization (with 2 kA coil current) - sufficient to magnetize the motor. The unit of M is 10^6 A/m.

Experimental Study

A 400 W 6-pole, 9-slot prototype machine is designed with the proposed approach and tested to verify the required magnetization current calculated. By following the process previously described, the required magnetization current and the motor size are obtained, as shown in Fig. 6(a). In the experiment, a current of around 1.1 kA is applied to magnetize the magnets. The magnetizer used for the test is shown in Fig. 6(b). The comparison of back-EMF waveforms is presented in Fig. 7(a), and the two back-EMF waveforms agree well, which indicates that the applied PAM current is sufficient. The proposed approach towards the estimation of the required magnetization current has been shown to be validated. The copper temperature rise was measured on the surface of the machine windings during the PAM process. As shown in Fig. 7(b), the maximum temperature rise recorded was around 2.9 °C for a series of current injection tests, which is insignificant.

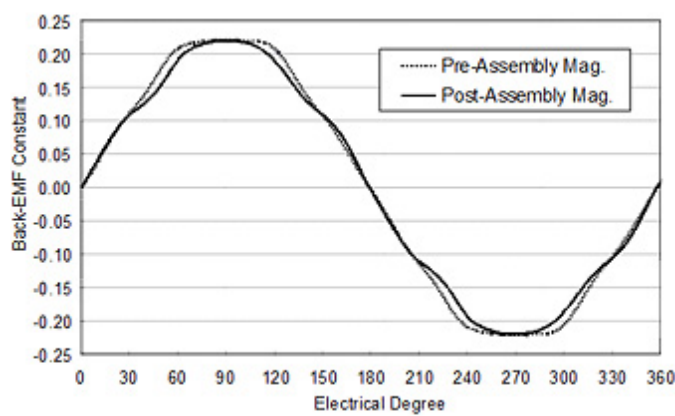


(a)

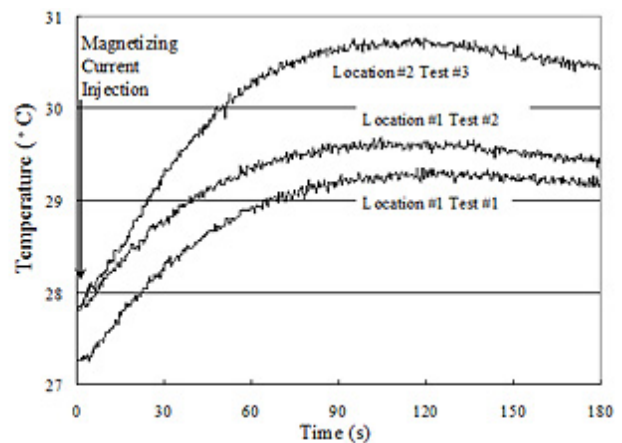


(b)

Fig. 6. Experiment studies: (a) calculation of the required magnetization currents in the 9-slot 6-pole motor: 2.5 times coercivity; (b) the experiment setup.



(a)



(b)

Fig. 7. Experimental results: (a) Back-EMF constant waveforms. Both machines are tested at 1000 rpm; (b) Measured temperature rise from three tests (Test 1 and Test 2 are measured at the same thermocouple location while Test 3 is measured at another location nearby).

Conclusion

A method for designing a rare-earth surface PM motor which is magnetized after assembly has been put forward and verified using finite element analysis and experiments. It is first used on an example 4-pole 18-slot 6 kW motor. The magnetization was investigated. The predicted magnetizing current of 2 kA was sufficient to produce full magnetization. The performance was tested which met the specification. Further investigation of a small prototype was performed, and the experimental results verify the developed approach. The thermal limit was also not exceeded.

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Leveraging Tenant-Incubator Social Capital for Organizational Learning and Performance in Incubation Program

Shih-Chieh Fang^{1,*}, Fu-Sheng Tsai², Julia L. Lin.³

¹ Department of Business Administration, College of Management, National Cheng Kung University

² Department of Business Administration, Cheng Shiu University

³ Department of International Business, Dean of the School of Management, I-Shou University

fangsc@mail.ncku.edu.tw

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In a business age emphasizing organizational capabilities, companies need to constantly absorb and utilize knowledge resources from internal and external environments. Companies need both independent and collaborative learning (i.e. inter-organizational learning). Taiwan is an economy where there are intensive entrepreneurial and innovative activities. The learning and capability development of new ventures become critical factors, not only for the survival and success for themselves, but also for the performance of the economy as a whole. Thus, we investigate the inter-organizational learning among business incubators (as a platform for knowledge resource identification and exchange) and tenants. With analyses of a sample of 101 tenants in incubation programs, we found that (see figure 1 for the conceptual framework), by leveraging the social capital (relationship quality, incubator referral, shared cognition and symbol system) between the tenants and their incubator, high-quality inter-organizational learning mechanisms (knowledge sharing, participation) can be stimulated to enable tenants to gain better performance (technological, managerial and satisfaction). Theoretically, the paper contributes by integrating the inter-organizational networks perspective with the inter-organizational relations perspective. For practitioners, we explicate the importance of social capital practices in incubation programs – treating the incubation relationship more strategically but not just operationally for contractual purpose. Inter-organizational communities, informal gathering of multi-parties, participative consensus development between incubator and tenants, expert yellow-page databases, among others, were suggested to facilitate the development of social capital and inter-organizational learning in incubation context.



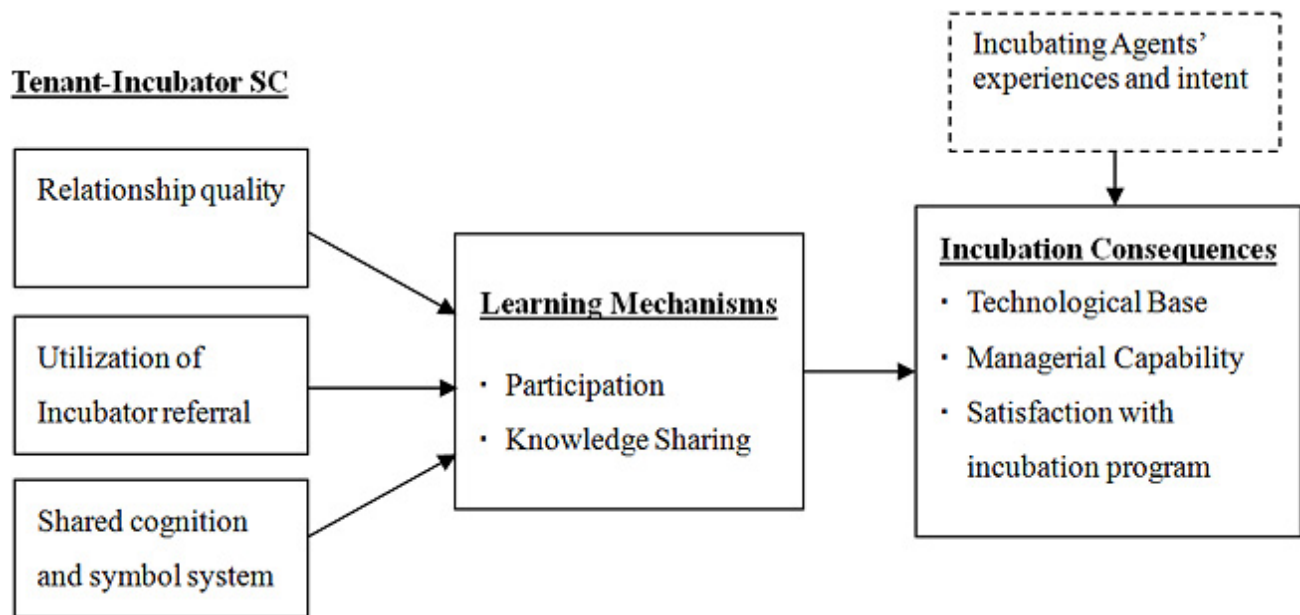


Figure 1 Conceptual framework: Tenants' learning by leveraging tenant-incubator social capital

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Motion-Aware Temporal Coherence for Video Resizing

Yu-Shuen Wang¹, Hongbo Fu², Olga Sorkine³, Tong-Yee Lee^{1,*}, Hans-Peter Seidel⁴

¹ Department of Computer Science and Information Engineering, College of Electrical Engineering and Computer Science, National Cheng Kung University

² Department of Computer Science and Engineering, City University of Hong Kong

³ Department of Computer Science, New York University

⁴ Max Planck Institute Informatik

tonylee@mail.ncku.edu.tw

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Project Web Site: <http://graphics.csie.ncku.edu.tw/VideoResizing/>

Research on automatic resizing of media is becoming ever more important with the proliferation of display units, such as television, notebooks, PDAs and cell phones, which all come in different aspect ratios and resolutions. In this paper, we introduce a content aware technique (see figure 1) which considers the interior contents while resizing the videos. Specifically, we represent an image/frame with a grid mesh and then warp the mesh based on the saliency measure. Unlike the previous methods [1, 2, 3], which strove to preserve the prominent objects untouched, our method [3][4] allows them to be scaled uniformly, enabling the distortion propagation in multiple directions. In addition to the resizing of static images, we extend our resizing technique to videos [4]. The most important issue on this extension is the temporal coherence since the interior contents keep changing when the video is played. Due to the camera and object motions, simply preserving consistent resizing of temporally adjacent pixels cannot achieve temporal coherence and thus, resulting in flickering or waving artifacts. To solve this problem, we detect the camera motion based on the SIFT features and then decompose the scene into foreground and background regions. Obviously, the background motions depend on the camera while the foreground motions are arbitrary. We introduce different constraints to preserve their temporal coherences due to their different natures. All the criteria are formulated into energy terms and we solve for the resized videos by minimizing the objective function. Experimental results show our method outperforms previous methods for a variety of images (see figure 2). More results and our paper can be found in <http://graphics.csie.ncku.edu.tw/VideoResizing/>

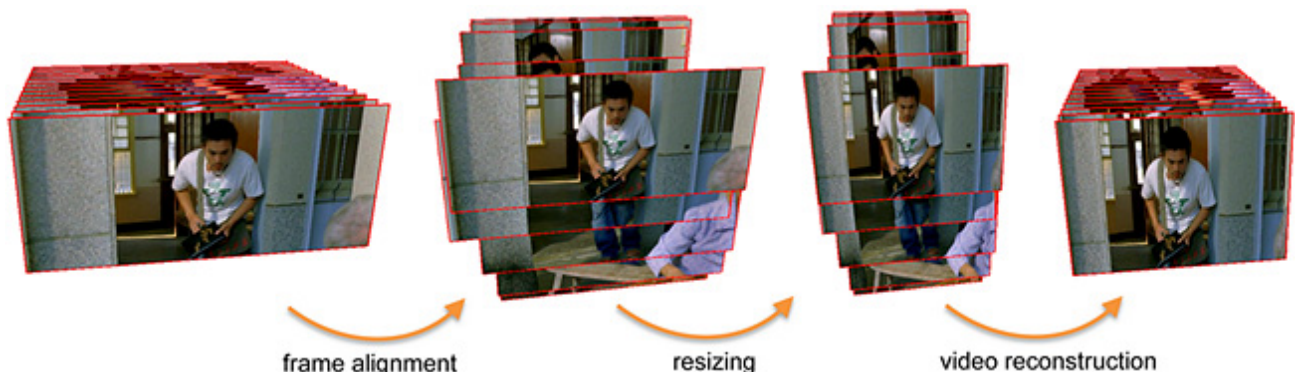


Figure 1: Overview of our automatic content-aware video resizing framework. We align the original frames of a video clip to a common coordinate system by estimating interframe camera motion, so that corresponding components have roughly the same spatial coordinates. We achieve spatially and temporally coherent resizing of

the aligned frames by preserving the relative positions of corresponding components within a grid-based optimization framework. The final resized video is reconstructed by transforming every video frame back to the original coordinate system.

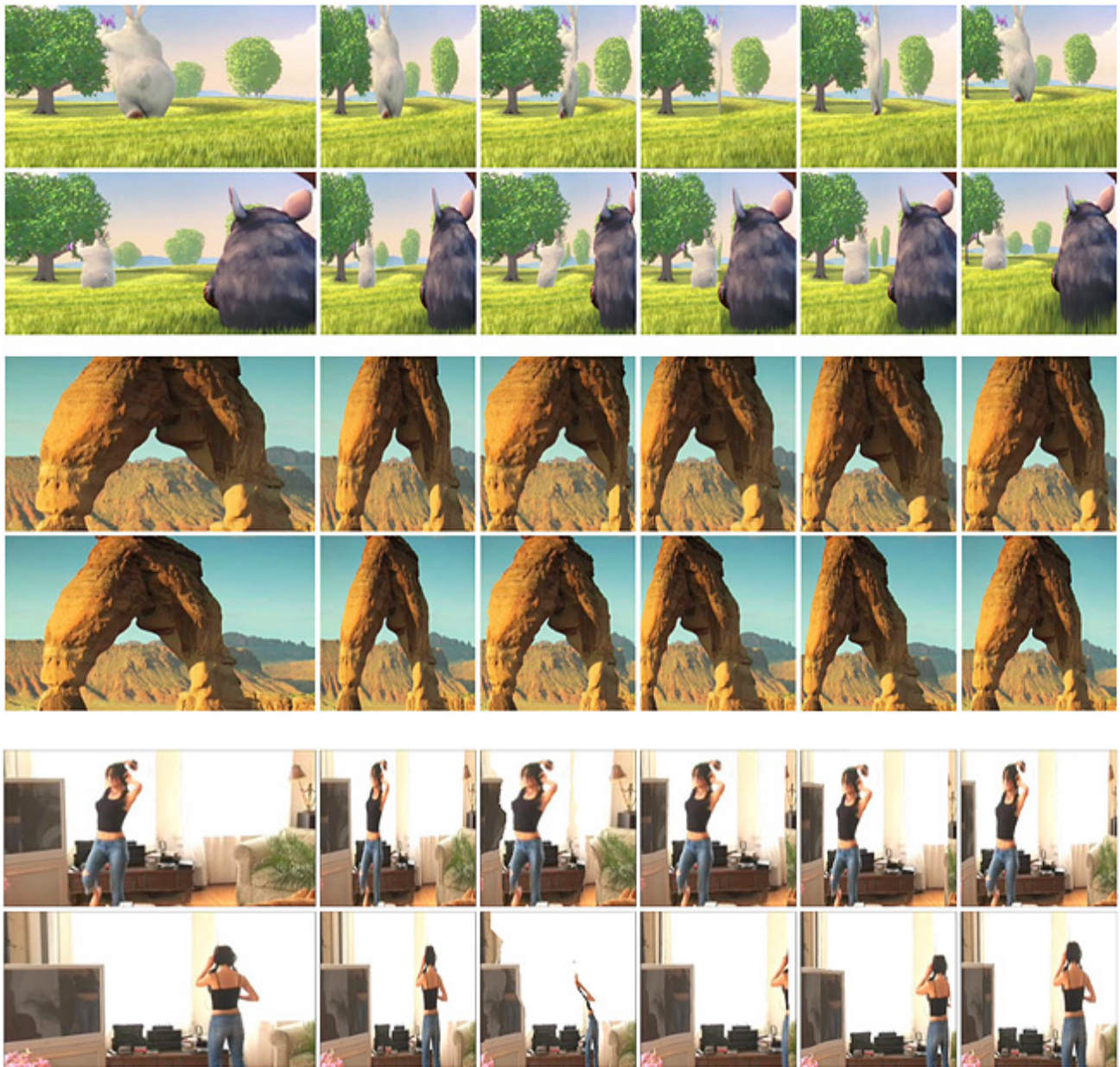


Figure 2: From left to right columns: the original frame images, resizing results with homogeneous resizing, [1], [2], the naive extension of [3], and our method. Clearly, only our method can well preserve the visually prominent features while successfully retaining temporal coherence. Due to the motion-oblivious temporal coherence constraints, the previous content-aware resizing methods often cause inconsistent alteration of corresponding features across frames, e.g., the white bunny in the first example, the arch in the second example and the woman's body in the third example.

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