Optically-induced Flow Cytometry for Continuous Microparticle Counting and Sorting
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This paper reports a new microfluidic device, optically-induced flow cytometry, capable of continuously counting and sorting microparticles based on optically-induced dielectrophoretic forces. Microparticles can be first successfully focused into a narrow line by using “virtual electrodes” generated by digital projectors. 9.7- and 20.9- μm microparticles can be then distinguished by embedded optical fibers. Finally, an optically-induced dynamic switch can sort microparticles with different sizes continuously. The development of the microfluidic chip may provide a useful platform for microparticle counting and sorting.

Typically, microparticles can be focused and sorted by neighboring sheath flows or negative dielectrophoresis (DEP) forces induced by metal electrodes in micromachined flow cytometry. However, not only may the sheath flows cause the contamination of the sample stream but they also increase the risk of breaking affinity binding between biosamples and microparticles. The metal electrodes have to be fabricated through relatively complex metal deposition and patterning processes. In this study, we report a new device by integrating the optically-induced dielectrophoresis (ODEP) and buried optical fiber detection in one chip. No complicate metal patterning process was needed to fabricate the DEP microelectrodes. Successful particle counting and sorting can be achieved using the developed chip.

Figure 1 shows a schematic illustration of the optically-induced flow cytometry. First, the microparticles pass through symmetric virtual electrodes to focus the microparticles in a narrow line. Then the focused microparticles pass through a pair of buried optical fibers to count the number and analyze the diameter of the particles. Finally, an oblique virtual electrode is used to direct the particles with different sizes to different direction. Figure 2 shows the principle of inducing the ODEP force. When projecting light patterns on the amorphous silicon layer, electron-hole pairs are excited. Then AC voltage can drop across the liquid layer inside the illuminated area, thus inducing non-uniform electric field and DEP forces. To bury optical fibers and provide a gap for particle manipulation, a SU-8 structure was fabricated by standard lithography processes.
Figures 3 shows that microparticles can be successfully focused into a straight line by using the ODEP force. The particle velocity inside the channel was estimated to range from 400 to 800 μm/s. Small and large microparticles can be then sorted into the upper and the lower virtual channel by switching the direction of the ODEP switch. The operating condition of the ODEP force is 15 Vpp at 100 kHz to generate a negative DEP force. One of the major advantages for ODEP operation is it can dynamically change the pattern of virtual electrodes. The dynamic patterns are drawn by Microsoft Power Point software and projected onto the chip by a commercial projector. Therefore, particles with different sizes can be switched continuously.

Figure 3. (a) Smaller microparticles were switched upwards (b) Larger microparticles were switched downwards.

A pair of optical fibers were inserted into the optically-induced flow cytometer chip (Fig. 4) for the purpose of counting and analyzing microparticles. Figure 5 shows the detected signals of the mixture with 9.7 and 20.9 μm microparticles. The 9.7- and 20.9-μm microparticles can be successfully distinguished from each other by the embedded optical fiber detection. The signal for the 20.9-μm microparticles is about 7 times larger than the signal for 9.7-μm microparticles. For 20.9 μm microparticles, a total count of 83 particles without any missing was achieved. For 9.7 μm microparticles, it was a total count of 77 particles with 3 missing.
Another type of particle sorting is also demonstrated (Figure 6). It is composed of two virtual electrodes with different inclinations projected on the pathway of the focused microparticles. The first electrode generates a weaker ODEP force and the second one produces a stronger force. When focused microparticles pass through the sorter, larger particles will be first deflected downwards by the weaker ODEP force and smaller particles will penetrate this virtual electrode and finally be deflected upwards by stronger force. As shown in Figure 6(b), microparticles with different sizes can be sorted successfully. Note that different ODEP force can be induced by different power intensity or line width of the illuminated light.

Figure 6. (a) Schematic illustration of the continuous microparticles separation (b) Microparticles are continuously separated by weaker and stronger virtual electrodes induced by different intensity of illumination.

Instead of using syringe pumps, gravity was used to drive the sample. Arrays of the symmetric virtual electrodes were used to focus the microparticles in a straight line. No photolithography and metal patterning processes were used. A pair of buried optical fibers was embedded in the chip to count and analyze the microparticles. A continuous microparticle separator was also demonstrated. The developed chip is capable of focusing, counting and sorting microparticles and has potential for use in future cell-based analysis techniques.
Adenosine Modulates Cardiovascular Functions Through Activation of Extracellular Signal-Regulated Kinases 1 and 2 and Endothelial Nitric Oxide Synthase in the Nucleus Tractus Solitarii of Rats

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Nucleus tractus solitarii (NTS) locates in the brain stem which is the central cardiovascular control center and have been demonstrated to play an important role in the cardiovascular regulation. Our previous study also demonstrated that the cardiovascular regulatory effects of insulin in the NTS were accomplished through activating PI3K-PKB/Akt-NO signaling pathways. Adenosine has been shown to play an important role in central cardiovascular control that microinjection of adenosine into NTS produces slowly developed long-lasting (minutes) and dose-related decreases in blood pressure (BP) and heart rate (HR). The molecular mechanism however remained to be clarified. In this study, we performed intra-NTS microinjection of adenosine and examined its effect in blood pressure (BP) and heart rate (HR). Moreover, we examined the downstream signal molecules involved in the adenosine mediated cardiovascular regulation by immunohistochemistry and immunobloting analyses. Two conclusions can be drawn from this study. First, Adenosine-ERK-eNOS signaling was confirmed in neuronal cells of NTS. Second, Adenosine induced the phosphorylation and activation of ERK and eNOS can cause the increase the NO amount in NTS that consequently affect the blood pressure (BP) and heart rate (HR). The following two figures are selected from the original article. Figure 1A showed microinjection of adenosine in NTS can slowly induce decreases in both blood pressure (BP) and heart rate (HR) that can be blocked by specific MEK inhibitor PD98059 that indicated the ERK is a downstream signal molecule in Adenosine mediated cardiovascular regulatory effects. The similar result was shown in Figure 1B and indicated that eNOS a downstream signal molecule in Adenosine mediated cardiovascular effects. We also
demonstrated the ERK can phosphorylate and activate eNOS and regulated NO production in NTS (figure 5 in the article). Figure 2A and 2B showed the results of western blot and immunohistochemistry that ERK-eNOS signaling indeed was activated in NTS upon adenosine stimulation.
Optimized Scale-and-Stretch for Image Resizing
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Recently, content aware image resizing is becoming important, since current display devices, such as television, notebooks, PDAs and cell phones, all come in different aspect ratios and resolutions. Traditional methods perform homogeneous resizing without considering the image content, equally propagating the distortion over the entire image and noticeably squeezing prominent objects. To achieve resizing without distortion, many approaches attempt to remove the unimportant information from the image periphery. For example, based on a face detection technique and a saliency measure, the image is cropped to fit the target aspect ratio and then uniformly resized by traditional interpolation. However, cropping methods may potentially remove prominent objects close to the image boundary. Another clear drawback of cropping methods is that important regions may lie at opposite edges of the image—a common problem in real images.

Recently proposed retargeting methods try to retain prominent objects while reducing or removing other image content. Seam carving methods [1,2] reduce the image size in a certain direction by removing monotonic 1D seams of pixels that run roughly in the orthogonal direction (image expansion is achieved by duplicating such seams instead). To reduce artifacts, they search for minimal-cost seams that pass through homogeneous regions by computing their forward [2] or backward energy [1]. These methods produce very impressive results, but their discrete nature may cause noticeable jags in structural objects. Moreover, these two methods only propagate distortion along the resizing direction. So, if the homogeneous information in the required spatial direction runs out, removing seams in that direction to change the aspect ratio would inevitably generate significant distortion.

In this paper [4](see Figure 1), we present a “scale-and-stretch” warping method that allows resizing
images into arbitrary aspect ratios while preserving visually prominent features. The method operates by iteratively computing optimal local scaling factors for each local region and updating a warped image that matches these scaling factors as closely as possible. The amount of deformation of the image content is guided by a significance map (see Figure 2) that characterizes the visual attractiveness of each pixel; this significance map is computed automatically using a novel combination of gradient and salience-based measures. Our technique allows diverting the distortion due to resizing to image regions with homogeneous content, such that the impact on perceptually important features is minimized. Unlike previous approaches, our method distributes the distortion in all spatial directions, even when the resizing operation is only applied horizontally or vertically, thus fully utilizing the available homogeneous regions to absorb the distortion. We develop an efficient formulation for the nonlinear optimization involved in the warping function computation, allowing interactive image resizing. Experimental results show our method outperforms previous methods for a variety of images (see Figure 3). More results can be found in http://graphics.csie.ncku.edu.tw/Image_Resizing/

Figure 1: We partition the original image (left) into a grid mesh and deform it to fit the new desired dimensions (right), such that the quad faces covering important image regions are optimized to scale uniformly while regions with homogeneous content are allowed to be distorted. The scaling and stretching of the image content is guided by a significance map which combines the gradient and the saliency maps.

Figure 2: We define the significance map as the product of the gradient magnitude and the saliency measure. Compared with the gradient map, the significance map is less sensitive to the disturbance of trees and leaves, focusing on the old man and the little girl. We compare the results of narrowing the original image using the gradient map and our significance map. The shapes of the old man and little girl are preserved better with our significance map.
Figure 3: Comparison of our results with those of improved seam carving [2], i.e., by Rubinstein et al. 2008, and the warping method of [3], i.e., by Wolf et al. 2007. The results of [3] and our method tend to be smoother than those of seam carving. Notice the discontinuities in the people, San Francisco Heart and the house roof, which are due to the pixels being directly removed. Compared with [3], our method can preserve the aspect ratios of prominent features better.

Reference:


Utilization of Fuel and Development of Fuel Industry in Qing Taiwan
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As fuel is an important material in daily life, its acquirement and utilization is thus a significant subject of research in life history, economic history as well as in environmental history. Historians Braudel and Pomeranz have both pointed out that one important reason contributing to the prosperity of modern Europe is its advantage of forest resources, which could not only benefit important industries like shipbuilding and steelmaking, but also provide civilians sufficient fuels for cooking and warming. To ensure the fuel supplement, governments of European countries, China and Japan had taken various measures since the 16th century, including protecting forests from illegal logging, seeking new lands providing woods, afforesting on a large scale, and developing alternative fuels such as coal. Ensuring provision of energy had become a crucial condition for development of modern civilization.

The demand for fuel in modern world not only changed people's attitudes toward fuel resources but also changed the structure of fuel industry. Forests and the later-developed fossil fuels had become state-owned or private property but not public goods. Fuels were commercial products that could be sold to make profits, and thus it could be the investment goal of capitalists. Under such circumstances, the producing and processing of timber, charcoal and fossil fuels was not individual work but on a large-scale with the investment of capitalists. With the expansion of scale and soar of production efficiency, fuel industry was gradually dominated by capitalists and moving toward capitalization.

While much academic attention has been paid on the history of fuel and energy in Europe and China, there are few studies exploring the acquirement and utilization of fuel in Taiwan. In particular, the fuel industry during Ming-Cheng period and Qing Dynasty were often neglected due to the limitation of historical data. To overcome the research restriction, this paper explores various resources to examine how fuel was consumed and traded in Qing Taiwan, and then traces the development of fuel industry. These resources include: family account books recorded by Suzhou code which was exclusively used by the Chinese merchants during the Qing Dynasty, "Dan-Xin Archives," which is the official archives of Danshui and Xinzhu in Qing Taiwan, and surveys on consumption of Han people conducted during the early period of Japanese rule as supplement.
Four major types of fuel, namely straw, timber, charcoal and coal, were used in Qing Taiwan. Among them, straw, including bean rattan and cane exaction, were used mainly by people engaged in agricultural production, who could provide themselves fuel from farms. With the rest of the population having to buy timber and charcoal, the consumption demand for timber and charcoal thus constituted the main market of fuel in Qing Taiwan. Furthermore, the market of fuel shows obvious differences between southern and northern Taiwan. While the inhabitants in northern Taiwan mainly used straw and charcoal made of Taiwan acacia, and coal was used in some urban areas of Keelung and Taipei, cane exaction played an important role as fuel in southern Taiwan. In addition, the types of charcoal also varied between the north and south.

During the late Qing, the expenses of fuel per capita was $4-5$, and the consumption of timber per capita was around $0.9-1.0$ ton. The amount was similar to the consumption in Pearl River Delta but much lower than that of late-18th-century France, which was more than two ton. Even so, fuel was still a crucial expense in Han families, occupying 8% of the living expenditure of a worker family. When accounting the fuel expenses of all non-agricultural population in Taiwan and the industrial expenses of fuel together, it could be estimated that the value of fuel market was more than $3,100,000$ dollars in 1893, and the industrial expenses of fuel was mainly used in roasting tea leaves.

Since the mid-Qing Dynasty, increase in population led to further growth in the market of fuel, but the natural forests decreased with the expansion of farmland. While cutting and selling timber was mainly engaged in by the lower class of Taiwanese society, including the unemployed and women, coal business was a new venture attracting opportunists. On the one hand, timber industry was restricted to shallow mountain areas whereas deep mountain areas were hardly explored because of its long distance, ban of Qing government and the threaten of "head-hunting" of the aborigines. On the other hand, the engagement of coal business ran high risk in deep mountainous areas but enjoyed high profits, thus some opportunists devoted to the business, and some of them emerged as rich merchants in Qing Taiwan.

After opening the ports, the demand of fuel increased rapidly because of the growing needs for roasting tea leaves, opium, and business of craftsman. However, the forests in shallow mountains in northern Taiwan decreased due to the development of camphor and tea planting. The shortage of timber resulted in the spread of coal in northern Taiwan. Simultaneously, some businessmen actively joined the afforestation industry, including Lin family at Banqiao, Lin

**Figure:** Planting of Taiwan acacia

**Source:** National Taiwan University Library, Danshui Archives, No. TH33902-010.

**Notes:** In a legal case at Danshui County during late Qing Dynasty, the prosecutor who accused of illegal logging of Taiwan acacia provided this figure. The figure shows that Taiwan acacia were often planted around gardens on hills to prevent from wind or serve as a boundary mark. The farmers could also gain profits from logging and making charcoal at that time.
family at Wufeng, Cheng and Lin families at Xinzhu. By contrast, in southern Taiwan, although there were plenty of natural forests, rich merchants largely subscribed coal from workers, intending to control the circulation channel of coal. Such involvement in fuel industry was the first sigh of state or capitalists monopolization in energy industry. The monopolization was formally operated during the later colonial period, when the Japanese government controlled mountainous regions and Japanese entrepreneurs occupied the power to exploit fossil fuels.