出國報告（出國類別：考察）

斯里蘭卡考察之出國報告書

服務機關：中央大學資訊工程學系
姓名職稱：施國琛教授
派赴國家：斯里蘭卡(Sri Lanka)
出國期間：2013/12/11至
2013/12/17
報告日期：2014/05/14

摘要

施國琛教授由會議主席應邀為 ICTer 2013 研討會之主題演講嘉賓，並於此訪會議中探討未來可能的合作。在這短短的五天拜訪中，施教授除了主題演講外: 出席關於人機互動與數位學習議題的報告會場並擔任主持人、領導 “視頻偽造及動量編輯” 議題之研討會 (workshop)、會見數位高水平學者與會議管理者。此外，教授於此會議發表一篇之論於發布會中得到最佳論文獎。基與此次拜訪的具體經驗，斯里蘭卡籍的學生有一定的學術水平，考量未來能在學術上之合作。

目錄

關於 ICTer 2013 研討會

國際會議信息和通信技術的進步為新興地區（ICTer）的前身是 1998 年以來它提供了在那裡的研究信息和通訊技術所做的是由本地和外國的計算機科學家提出了一個平台，在斯里蘭卡舉行的開創性國際信息技術會議（IITC）和 IT 專業人員。今年我們有來自德國，澳大利亞，瑞典，日本，新西蘭，台灣，英國，新加坡和印度的參與者。

為了獲得更廣泛的國際參與和推動計算技術的研究，在世界上特別是在亞太地區的迅速崛起的地區，它決定與電氣學院和電子工程師協會（IEEE）的合作夥伴。本次會議的程序都在印刷和電子形式分發。該文章發表 IEEE 資源管理器並連接到谷歌的學者和入選論文都發表在 ICTer 雜誌特別版與全球觀眾。

ICTer2013 年除了 112 提交文件的方式，組委會已選擇 18 作為正式提交論文，24 篇短和 18 篇張貼論文。有來自美國，日本，台灣，瑞典，澳大利亞和印度的資深教授 8 主題演講。將有大約 8 個生產車間和教程將舉行會前會後的活動。

目的

- 赴(ICTer) 2013 研討會主題演講 (Keynote speaker)
    - 演講主題為: 影片偽造及動量編輯
- 至科倫玻之 UCSC 大學參與研討會 (Workshop)
- 與院長及其他 UCSC 大學之教授會面
- 至論文報告會場擔任主席

參與之行程

- 2014/12/11: 抵達斯里蘭卡
- 2014/12/13-14: 出席研討會並演講、擔任研討會相論文發表會場之主席
- 2014/12/14: 全天參與研討會 (workshop)
- 2014/12/16: 參與院長與 UCSC 大學的數位資深教授
- 2014/12/17: 離開斯里蘭卡飛往孟加拉

施國琛教授專題演講 Keynote 的內容

- 影像偽造
    - 視頻造假/偽造文件是通過改變，合併，或創建新的視頻內容產生假視頻的技術。
- 動量編輯
- 物件追蹤
- 視頻修補
- 動量的插值 (Motion Interpolation)
- 視頻策劃和特效製作
- 影像的區域分割
- 影像修補
- 視頻物件的移除

出國之過程與心得

- 此趟五天之行與各國家之高水平研究學者即會議管理者討論許多研究上或其他相關議題，得到許多關於學術上的許多未來合作機會與想法:
    - 澳大利亞西悉尼大學之教授　Althula
    - 日本島根大學之教授　Musahito Hirakawa
    - 印度統計學院之教授　Umapada Pal
    - 瑞典斯德哥爾摩大學之教授　Robert Ramberg
    - 印度孟買大學博士　Sushil Kuilkarni
    - 新加坡南洋理工大學之教授　May Oo Lwin
    - 英國南安普敦大學之教授　Mahesan Niranjan
- 聯合國開發計劃署 2013 年人類發展報告中指出，斯里蘭卡擁有全球教育第 92 位支排屏，而其中排名最高的是南亞。教育在斯里蘭卡的所有層面中亦包括完全免費 學士學位課程，有 15 所大學和 17 所學院政府和私營部門擁有的資機構現在也越來越多。教育系統是由英國標準演變而來，由小學（1-5 年級），中學（6-11 年級），三級（12-13 級），這是 5 級獎學金考試，劍橋（O/ L）

的結束和 GC E（A/L），其中 GCE（A/L）是作為高考的公立大學。2012 年教資會報告中，58.98%的學生有資格進入院校，但只有 20.40%的收到錄取。

- 到由於現有職位大學並於此行找到未來可能合作之相關部門:
  - o 計算科倫坡學院大學
  - o 佩拉德尼亞大學
  - o 莫勒圖沃大學 o Ruhuna 大學

  斯里蘭卡 Rajarata 大學

建議

- 建議開始與斯里蘭卡大學相關單位進行系對系層級的雙方會談
- 建議開始雙方研究合作
- 目前斯里蘭卡政府相當鼓勵與他國進行教育合作，校級積極的合作與獎勵能吸引更多優秀學生入學

相片

研討會開幕儀式

研討會主席 Hewagamage 教授與施國琛教授點亮油燈 (斯里蘭卡的傳統)

大會主席 Epasinghe 教授的開場

施國琛教授的 Keynote (主題演講)

主題: “Video Forgery and Motion Editing” (影像偽造及動量編輯)

首席嘉賓賦予施國琛教授講牌來感謝施教授這次研討會給予的協助

施國琛教授與另外一位日籍教授 Hirakawa 參加 Keynote

施國琛教授與博士班學生 Chinthaka 於此研討會獲得最佳論文獎

相關資訊

- http://www.ugc.ac.lk/downloads/statistics/stat_2012/chapter1.pdf
- https://data.undp.org/dataset/Table-8-Education/mvtz-nsye
- http://www.ugc.ac.lk/downloads/statistics/stat_2012/chapter1.pdf
- http://www.icter.org/conference/icter2013

附件 A: 研討會行程表

Time Schedule : ***Day 1 (12-Dec-13)***						
08:30-09:00	Registration					
09:00-09:45	Inauguration Opening Ceremony					
09:45-10:25	Keynote 1: **Video Forgery and Motion Editing** *by Professor Timothy K. Shih, National Central University, Taiwan.*					
10:25-10:55	**TEA Break**					
10:55-11:30	Keynote 2: **Enhancing Health Communication using Digital Media: Trends and Experiences** *by Professor May Oo Lwin, Nanyang Technological University,* Singapore.					
11:30-11:35	**Q & A**					
11:35-12:10	Keynote 3: **Document Image Analysis: Past, Present and Future** *by Professor Umapada Pal, Indian Statistical Institute, India.*					
12:10-12:15	**Q & A**					
12:15-13:15	**LUNCH Break**					
Split into 3 Parallel Tracks						
	Track 1	**Image Processing and Computer Graphics**	**Track 2**	**Software Engineering and Mobile Software Development**	**Track 3**	**Machine Learning**
13:15- Start	13:15-13:30	**Automatic Panorama Generation from a Video with Dynamic Background** *by Kumara W. G. C. W., National Central University, Taiwan., Shih-Ming Chang, Tamkang University, Taiwan and Timothy K. Shih, National Central University, Taiwan.*	13:15-13:30	**Impact of Refactoring on External Code Quality Improvement: An Empirical Evaluation** *by S.H. Kannangara and W.M.J.I. Wijayanayake, University of Kelaniya, Sri Lanka*	13:15-13:30	**Ontology Based Annotation Mechanism for Financial Documents** *by Perera, K, Lanka Software Foundation, Sri Lanka, Karunarathne, D.D.,University of Colombo School of Computing, Sri Lanka, Siriwardena, A.,Lanka Software Foundation, Sri Lanka and Balaretnaraja, D.,Lanka Software Foundation, Sri Lanka*
	13:30-13:45	**Active Contour-based Segmentation and Removal of Optic Disk from Retinal Images** *by M.H.S.P. Kumara and R.G.N. Meegama, University of Sri Jayewardenepura, Sri Lanka*	13:30-13:45	**Location Based Advertising Framework for Mobile and Web Application Developers in Sri Lanka** *by E. A. T. D. Edirisinghe, G. Guruparan, R. A. S. M. Rupasinghe, N. J. A. H. S. Perera, P. S. Haddela and A. Kirupananda, Sri Lanka Institute of Information Technology, Sri Lanka*	13:30-13:45	**Prediction of Horizontal Gene Transfer in Escherichia coli using Machine Learning** *by P. G Sudasinghe, C. R Wijesinghe and A. R. Weerasinghe, University of Colombo School of Computing, Sri Lanka*
	13:45-13:50	**Q & A**	13:45-13:50	**Q & A**	13:45-13:50	**Q & A**
	13:50-14:05	**Computational Cell Classification Methodology for Hepatocellular Carcinoma** *by Chamidu Atupelage, Tokyo Institute of Technology, Japan, Hiroshi Nagahashi, Tokyo Institute of Technology, Japan, Fumikazu Kimura, Tokyo Institute of Technology, Japan, Masahiro Yamaguchi, Tokyo Institute of Technology, Japan, Tokiya Abe, Keio University, Japan., Akinori Hashiguchi, Keio University, Japan. and Michiie Sakamoto, Keio University, Japan.*	13:50-14:00	**Web Browsers on Smart Mobile Devices: A Gap Analysis on the State of the Art** *by hinthaka Dharmasiri, Rythmal Jayendranath, Amila .L. Ariyarathna, Pahan .M. Pereraand Shahani M. Weerawarana, University of Moratuwa, Sri Lanka*	13:50-14:05	**Semi-Supervised Algorithm for Concept Ontology Based Word Set Expansion** *by N. H. N. D. de Silva,University of Moratuwa, Sri Lanka., A. S. Perera,University of Moratuwa, Sri Lanka.and M. K. D. T. Maldeniy, Codegen International (Pvt) Ltd,Sri Lanka.*
			14:00-14:10	**Extensive Compression of Text Messages in Interactive Mobile Communication** *by H.K. Salinda Premadasa, Sabaragamuwa University of Sri Lanka, Sri Lanka and R.G.N. Meegama,University of Sri Jayewardenepura, Sri Lanka*	14:05-14:15	**Short-term Forecasting of Electricity Consumption in Maputo** *by Constantino Sotomane,Stockholm University,Sweden and Ministry Of Science and Technology, Mozambique, Lars Asker,Stockholm University,Sweden, Henrik Boström,Stockholm University,Sweden and Venâncio Massingue, Eduardo Mondlane University, Mozambique.*

	14:05-14:20	**A Novel Approach to Simulate Wind-driven Waves in the Deep Ocean** *by Maheshya Weerasinghe, Damitha Sandaruwan, Chamath Keppitiyagama, Nihal Kodikara, University of Colombo School of Computing, Sri Lanka*	14:10-14:15	**Q & A**	14:15-14:20	**Q & A**
	14:20-14:30	**DILVI - A Platform to build Language Training Simulations** *by Dilunika J. K. and Wimalarathne S. P. , University of Colombo School of Computing, Sri Lanka*		**ICT4D & Information Systems**		**Language Processing**
			14:15-14:30	**Impact of the Information Systems service quality on performance of IT sector organizations in Sri Lanka** *by Weerakoon W.M.L.P, Wijayanayake W.M.J.I, University of Kelaniya, Sri Lanka.*	14:20-14:35	**A Stochastic Part of Speech Tagger for Sinhala** *by M. Jayasuriya,Virtusa (Pvt) Ltd, Sri Lanka and A. R. Weerasinghe, University of Colombo School of Computing, Sri Lanka*
	14:30-14:35	**Q & A**	14:30-14:40	**Techno-economical optimization of a municipal solid waste management system using evolutionary algorithms** *by A.T.D. Perera,University of Moratuwa, Sri Lanka., A.N. Madusanka,Sri Lanka Institute of Nanotechnology, Sri Lanka. and A.A.P. de Alwis, University of Moratuwa, Sri Lanka.*	14:35-14:45	**A Comparative Analysis of Opinion Mining and Sentiment Classification in non-English Languages** by *Nishantha Medagoda, Subana Shanmuganathan and Jacqueline Whalley,Auckland University of Technology*
	14:35-14:50	**Facial Image Classification Based on Age and Gender** *by Thakshila R. Kalansuriya and Anuja T. Dharmaratne, University of Colombo School of Computing, Sri Lanka*	14:40-14:45	**Q & A**	14:45-14:50	**Q & A**
	14:50-15:00	**Facial Expression Recognition using Active Shape Models and Support Vector Machines** *by K. Samarawickrame and S. Mindya, Informatics Institute of Technology, Sri Lanka*	14:45-14:55	**Recommender Systems Approach to Optimizing Career Pathways Development for Youth in Emerging Knowledge Economies** *by K. Dharini Amitha Peiris and Ivan Gan,University of Auckland,New Zealand.*	14:50-15:00	**Speech Recognition for Low Resourced Languages: Efficient Use of Training Data for Sinhala Speech Recognition by Active Learning** *by Thilini Nadungodage,University of Colombo School of Computing, Sri Lanka., Ruvan WeerasingheUniversity of Colombo School of Computing, Sri Lanka. and Mahesan Niranjan,University of Southampton,UK*
	15:00-15:10	**Video Steganography** *by A. Munasinghe, Anuja Dharmaratne and Kasun De Zoysa, University of Colombo School of Computing, Sri Lanka*	14:55-15:05	**Going Global – Lessons learned from developing an online Master's in ICT4D** *by Ulrika Drougge, Sirkku Männikkö Barbutiu and Peter Mozelius, Stockholm University, Sweden*	15:00-15:10	**Document Analysis Based Automatic Concept Map Generation for Enterprises** *by E.L.Karannagoda, H.M.T.C.Herath, K.N.J.Fernando, M.W.I.D.Karunarathne, N.H.N.D.de Silva andA.S. Perera, University of Moratuwa, Sri Lanka*
	15:10-15:15	**Q & A**	15:05-15:15	**Q & A**	15:10-15:15	**Q & A**
Parallel Tracks Over						
15:45-16:20	Keynote 4 :**From Bioinformatics to Systems Biology** *by Professor Mahesan Niranjan, University of Southampton, United Kingdom.*					
16:20-16:30	**Q & A and 1st Day Panel Discussion**					
19:00-22:00	Conference Dinner at Global Tower Hotel, Wellawatta.					

Time Schedule : ***Day 2 (13-Dec-13)***						
08:30-09:00	Registration and Day 2 opening					
09:00-09:35	Keynote 5: **Multimodality + Multimedia + Sensors = Pleasant Interfaces** *by Professor Masahito Hirakawa, Shimane University, Japan.*					
09:35-09:40	Q & A					
09:40-10:15	Keynote 6: **Design-based Mobile Learning Research: Results and reflections on communication and sustainability** *by Professor Robert Ramberg, Stockholm University, Sweden.*					
10:15-10:20	Q & A					
10:20-10:50	**TEA Break & Poster visit**					
Split into 3 parallel Tracks						
	Track 1	**Networking and Algorithms**	**Track 2**	**Data Base & Data Mining 1**	**Track 3**	**Human Computer Interaction**
10:50- Start	10:50-11:05	**ISP Friendly Peer Selection in Bit Torrent** *by Tharidu Fernando and Chamath Keppetiyagama, University of Colombo School of Computing, Sri Lanka*	10:50-11:05	**Hybrid Framework for Privacy Preserving Data Sharing** *by Ruvan Kumara Abeysekara and Weishi Zhang, Dalian Maritime University*	10:50-11:05	**Non Invasive Human Stress Detection Using Key Stroke Dynamics and Key Stroke Pattern Variations** *by Suranga D.W. Gunawardhane, Pasan M. De Silva, Dayan S.B. Kulathunga and Shiromi M.K.D. Arunatileka, University of Colombo School of Computing, Sri Lanka*
	11:05-11:15	**KAnt: Leveraging ant colony optimization for automatic knowledge acquisition from web documents** *by Rivindu Perera, 99X Technology, Sri Lanka and Udayangi Perera, Informatics Institute of Technology, Sri Lanka*	11:05-11:15	**Big Data solution for Sri Lankan development: A case study from Travel and Tourism** *by Rinusha Irudeen and Sanjeeva Samaraweera, Database Competency Excellence Group,Virtusa (Pvt) Ltd, Sri Lanka*	11:05-11:15	**V-Touch: MarkerlessLaser-Based Interactive Surface** *by C.R. Dikovita and D.P. Abeysooriya, International College of Business and Technology, Sri Lanka*
	11:15-11:25	**Churn prediction methodologies in the telecommunications sector: A survey** *by W.M.C. Bandara,University of Moratuwa, Sri Lanka, A.S. Perera,University of Moratuwa, Sri Lanka and D. Alahakoon,Deakin University, Australia*	11:15-11:25	**Comparing Support Vector Regression and Random Forests Modeling for Predicting Malaria Incidence in Mozambique** *by Orlando P. Zacarias, Stockholm University, Sweden and Eduardo Mondlane University, Mozambique and Henrik Boström, Stockholm University , Sweden*	11:15-11:20	**Q & A**
	11:25-11:30	**Q & A**	11:25-11:30	**Q & A**		
		Wireless and Sensor Networks		**Data Base & Data Mining 2**		**e-Learning**
	11:30-11:45	**Energy-Efficient Communication with Wake-Up Receiver Technologies and an Optimized Protocol Stack** *by Matthias Vode, Mirko Lippmann, and Wolfram Hardt, Chemnitz University of Technology,*	11:30-11:45	**Spatial data mining technique to evaluate forest extent changes using GIS and Remote Sensing** *by P.K.S.C.Jayasinghe, Sri Lanka Institute of Information Technology,Sri Lanka, Masao Yoshida, Ibaraki University, , Japan*	11:20-11:35	**Analysis of the awareness of Collaborative e-Learning (CeL) in Sri Lankan university education** *by Ilhavanchi Kanaganayagam and Shantha Fernando University of Moratuwa, Sri Lanka*

		Germany			11:35-11:45	**A Framework for Adaptive Learning Management Systems using Learning Styles** *by M. Prabhani Pitigala Liyanage, K. S. Lasith Gunawardena, Masahito Hirakawa, Shimane University, Japan*
	11:45-11:55	**My Sensors: A System for Secure Sensor Data Sharing over Internet** *by E.M.D. Siriwardane, Asanka Sayakkara, E.M.W.V.Ekanayake, Kasun De Zoyza, University of Colombo School of Computing, Sri Lanka*	11:45-11:55	**Dynamic Partitional Clustering Using Multi Agent Technology** *by D.M.M.B. Dehideniya, A.S. Karunananda, University of Moratuwa, Sri Lanka*	11:45-11:55	**Affective E-Learning Model for Recognizing Learner Emotions in Online Learning Environment** *by T.C.Sandanayake, University of Moratuwa,Sri Lanka, A.P.Madurapperuma, Open University of Sri Lanka, Sri Lanka*
	11:55-12:05	**Reconfigurable Universal Sensor Interface for Distributed Wireless Sensor Nodes** *by Anuradha C. Ranasinghe, Lahiru K. Rasnayake, M. Kalyanapala, Sri Lanka Institute of Information Technology, Sri Lanka*	11:55-12:05	**A Federated Approach on Heterogeneous NoSQL Data Stores** by H. M. L. Dharmasiri and M. D. J. S. Goonetillake, University of ColomboSchool of Computing, Sri Lanka	11:55-12:00	**Q & A**
	12:05-12:15	**An Investigation into Dynamic TLPs for Smartphone Communication to Facilitate Timed Response in Way Finding for Vision Impaired People** *by Dhammika H. De Silva, Curtin University, Western Australia and Sri Lanka Institute of Information Technology, Sri Lanka and Iain Murray, Curtin University, Western Australia.*	12:05-12:10	**Q & A**		
12:20- End	12:15-12:20	**Q & A**				
Parallel Tracks Over						
12:20-13:30	**LUNCH Break and Poster visit**					
13:30-14:05	Keynote 7: **Statistical Relational Learning - Different formalisms and representations** *by Dr. Sushil Kulkani, University Of Mumbai, India.*					
14:05-14:10	Q & A					
14:10-14:30	Invited Speech : **CodeGen**					
14:30-14:40	Invited Speech : **Cambio**					
14:40-14:50	Invited Speech : **IFS**					
14:50-15:00	**Q & A**					
15:00-15:30	**TEA Break & Closing Ceremony**					
15:30-16:05	Keynote 8 : **Architecture for Digital Knowledge Ecosystems** *by Professor Athula Ginige, University of Western Sydney, Australia*					
16:05-16:10	**Q & A**					
16:10-16:45	**Panel Discussion, Best Paper Award, Closing Ceremony**					

附件 B: 研討會海報

Call for Participation

ICTer2013

International Conference on Advances in ICT for Emerging Regions (ICTer2013) on 12th & 13th December at BMICH, Colombo, Sri Lanka

KEYNOTE SPEAKERS

Video Forgery and Motion Editing
Prof. Timothy K. Shih
National Central University, Taiwan.

Architecture for Digital Knowledge Ecosystems
Prof. Athula Ginige
University of Western Sydney, Australia.

Multimodality + Multimedia + Sensors = Pleasant Interfaces
Prof. Masahito Hirakawa
Shimane University, Japan.

Document Image Analysis: Past, Present and Future
Prof. Umapada Pal
Indian Statistical Institute, India.

Design-based Mobile Learning Research
Prof. Robert Ramberg
Stockholm University, Sweden.

Statistical Relational Learning-Diff. formalisms & representations
Dr. Sushil Kulkarni,
University of Mumbai, India.

Enhancing Health Communication using Digital Media, Prof. May Oo Lwin, Nanyang Technological University, Singapore.

From Bioinformatics to Systems Biology
Prof. Mahesan Niranjan, University of Southampton, United Kingdom.

Further Details: *http://www.icter.org/conference/keynote_speeches*

PAPER AND POSTER PRESENTATIONS

* All papers reviewed by experts in the domain
* 40 papers accepted out of 112 submissions (acceptance rate 27%)
* 18 full papers, 22 short papers and 15 poster presentations in 3 parallel tracks
* 9 papers and 1 poster accepted out of 17 submissions from foreign unversities
* Copies of proceedings available at the conference
* All acepted papers together with author details are listed at - *http://www.icter.org/conference/accepted_papers*
* 5 pre-conference wokshops on 11-Dec-2013
* 3 post-conference tutorials and 2 workshops on 14-Dec-2013

Further Details: *http://www.icter.org/conference/workshops-tutorials*

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FOR REGISTRATION

Full conference fee Rs. 15,000 (US$150) and workshop fee Rs. 5,000 (US$50)
Register Online at *http://www.icter.org/conference/register*

FOR MORE DETAILS

ICTer 2013 Conference Chair: Dr. K. P. Hewagamage (conf-chair@icter.org)
Conference Secretariat: Mr. S. Prasanna Herath (+94 71 833 9979)
Further information: Ms. Renuka Matiwalakumbura (+94 11 258 1248)
University of Colombo School of Computing, No. 35, Reid Avenue, Colombo 07, Sri Lanka

Upto date details: *http://www.icter.org/conference*

Call for Participation

ICTer2013

International Conference on Advances in ICT for Emerging Regions (ICTer2013) on 12th & 13th December at BMICH, Colombo, Sri Lanka

WORKSHOPS 11-Dec-2013

W1. Medical Informatics
Dr. C. Atupelage, Dr. R. Ranaweera, Dr. M. Jayathilake, Dr. R. Yapa, Dr. A. Pinidiyaarachchi and Dr. A. Dharmarathne
Tokyo Institute of Technology, University of Peradeniya, UCSC
Full day (09.00 to 16.30)

W2. e-Waste & Green Computing
Mr. H. Wijewardana, Mr. A.M.S.C.M.B. Attanayake, Mr. Kuganathan and Mr. F. Hudah
UCSC, HNB and ICTA Agency
Full day (09.00 to 16.30)

W3. Cloud Computing in Software Development
Mr. S. Kanankearachchi, Mr. C. De Silva, Mr. G. Amarasinghe, Mr. C. Bandara and Mr. K. Mannapperuma
Conducted by 99x Technologies
Full day (09.00 to 16.30)

W4. Low Cost Immersive VR Simulations for Industrial Applications and Serious Games
Prof. N. D. Kodikara, Mr. D. Sandaruwan and Mr. Y.P Samarasinghe UCSC
Full day (09.00 to 16.30)

W5. Building Future Proof ERP
Mr. A. Kumarasinghe, Mr. B. Hiripitiyage and Mr. S. Magallege
Conducted by IFS
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5

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1

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2

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3

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4

Automatic Panorama Generation from a Video with Dynamic Background

Kumara W. G. C. W.[#1], Shih-Ming Chang[*2], Timothy K. Shih[#3]
[#]*Department of Computer Science and Information Engineering, National Central University*
No.300, Jhongda Rd., Jhongli City, Taoyuan County 32001, Taiwan (R.O.C.)
[*]*Department of Computer Science and Information Engineering, Tamkang University*
No. 151, Yīngzhuān Rd, Danshui District, New Taipei City, 25137, Taiwan (R.O.C.)

[1]chinthakawk@gmail.com, [2]rest306@hotmail.com, [3]timothykshih@gmail.com

***Abstract*— Panorama photos are very useful when capturing large scenic backgrounds like famous constructions or eye catching landscapes. Users normally prefer capturing such backgrounds with them or friends as the foreground, but the moving people in such popular locations always obstruct the iconic structure in the background. In this paper a solution for automatic panorama generation is presented which is capable of removing moving objects in the background. First user captures a short video starting from the centre of the focus area and then following a clockwise circular path. Then, proposed application generates the panorama based on input video following the steps: segmentation of human object, removal of moving human objects, and generation of panorama. Experimental output panorama photos show that the proposed system is very usable and results are satisfactory.**

***Keywords*— Automatic Panorama Creation, Image Inpainting**

I. INTRODUCTION

Generation of the panorama from set of photos is being a useful and attractive research topic within the researches in the domain for several years. Kekre, H. *et al*. [1] presented a panorama generation approach to nullify effect of rotation of partial images on process of vista creation. Their method is capable of resolving the missing region in the vista caused due to the rotation of partial image parts used during the vista creation. Image inpainting has been used during the process to fill the missing region. That missing view regeneration method was also able to overcome the problem of missing view in vista due to cropping, irregular boundaries of partial image parts and errors in digitization. Meng Wang [2] presented an approach to create a single view point full view panorama photograph from a set of image sequence. Individual ordered frames extracted from a panning video sequence have used as the input making it simple for both shooting and stitching.

Going forward another step of panorama generation Wagner, Daniel *et al*. [3] presented a method for the real-time creation and tracking of panoramic maps on mobile phones. Specially, the maps generated are accurate and allow drift-free rotation tracking. Song, Baosen *et al*. [4] then presented another panorama generation based research to enlarge the horizontal and vertical angles of view for an image. Camera calibration, image feature extraction, image registration, bundle adjustment, photometric optimization, image fusion and output panorama projection has been used during the design. They presented that their application can stitch together multi-row images automatically into a panorama. A smoothly varying affine stitching field which is flexible enough to handle parallax while retaining the good extrapolation and occlusion handling properties of parametric transforms was presented by Lin, Wen-Yan *et al*. in [5]. Their algorithm which jointly estimates both the stitching field and correspondence permits the stitching of general motion source images, provided the scenes do not contain abrupt protrusions.

However, all the recent researches on panorama generation focused only on the generation of the panorama images using the set of input images. But users' real needs on panorama generation are more complex. Generally panorama images are very useful to capture scenic locations or large buildings, where naturally crowded with moving people and other objects. Even though users like taking panorama images while they are in the foreground and such scenes as background, those moving objects obstruct the panorama. Hence, in this paper we present a novel method of panorama generation which is capable of avoiding the moving objects from the panorama.

First, user captures a short video of the intended focus area starting from the centre of the expected panorama image, then following a clockwise circular path as shown in Fig. 1.

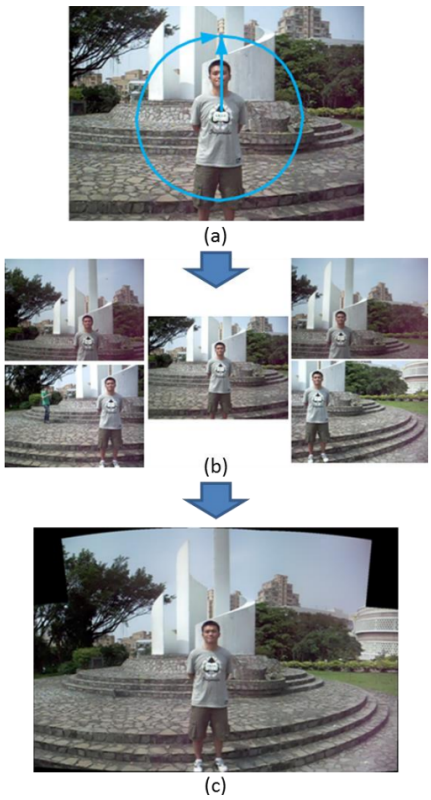


Fig. 1 Flowchart of the system use (a) video direction (b) selected frame set (c) generated panorama

Internal operational steps of the proposed solution are shown in Fig. 2. First, a set of five frames is selected from the source video with equal inter frame distance. Then, there are three main phases as segmentation of human object, removal of moving human objects, and generation of panorama.

The rest of the paper is organized as follows. Section II presents the system architecture details while section III is focused on the experimental results. Finally the presented work is concluded in the section IV with the possible future research directions on the topic.

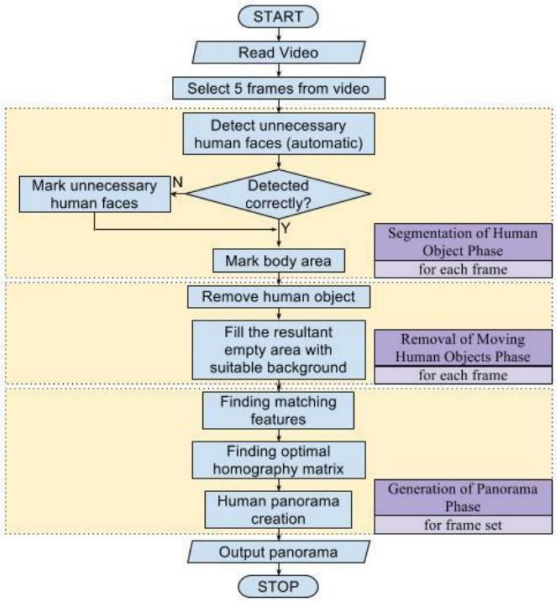


Fig. 2 Operational steps of panorama generation

II. System Architecture

This section presents the internal architectural details of the proposed system and the operational steps segmentation of human objects phase, removal of moving human objects phase and generation of panorama phase.

A. Segmentation of Human Objects Phase

Detection of the faces of the humans appear in the image set of the video is carried out here. Human faces are automatically detected based on the *Haar-Features* [11, 23] and skin color mechanisms of face detection. In the case of failure in detecting faces automatically user can manually mark the face area. Fig. 3 shows one example of face detection of the proposed system.

Fig. 3 Face detection example

Then based on the detected face region human body area is marked except for the main human object. Proposed solution is still limited only to standing adults. Static ratios are used during the marking of body area as, $height_{face:body}$ = 6.0 and $width_{face:body}$ = 2.5. An example result is shown in Fig. 4.

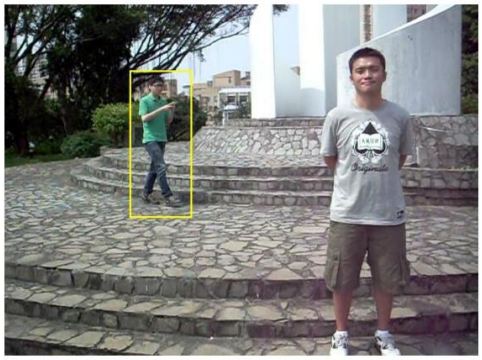


Fig. 4 An example of marked human body area

Next from that marked human body area, only the human object data is extracted to be used in the next phases. A graph-cut based algorithm named Automatic GrabCut (Auto-GrabCut) is used here for the segmentation of the objects [10, 20, 21, 26]. Algorithm 1 presents the steps of segmentation of human object using Auto-GrabCut in detail. One example of the segmented human object is shown in Fig. 5.

Algorithm 1: Segmentation of human object

Input: Each frame of the source frame set
Output: Detected human body
begin

1. Convert RGB to grayscale format
2. Find edges using Sobel operator
3. Change the color of the corresponding pixels in the original RGB image (conspicuous points) based on the Sobel values in the grayscale image as follows,
   If (Sobel value of the pixel < 180)
      New color = black
   Else
      New color = Red
4. Tag conspicuous points as foreground pixels based on the new pixel values
   Equally divide the definition area (the box around the human body) into two vertically and use *GrabCut* algorithm in each part
   If (result area of *GrabCut*) < (40% of definition area)
      Set a sample model based on human body structure in the definition area. Sizes of each human body part are calculated based on the size of face area as $width_{face:hand:leg}$ = 1:2:2.5 and $height_{face:hand:leg}$ = 1:2.5:3.5.
      Cluster color in each part of definition area into two parts which covered with sample model using mean-shift algorithm and mark the small color cluster as white (background) and large color cluster as red (foreground).
      Use *GrabCut* algorithm again with the new background and foreground values
   Else
      Go to step 5
5. Use the erosion and dilation method in the *GrabCut* result.

B. Removal of Moving Human Objects Phase

In the step A the human objects to be removed were identified. Now those detected human objects should be removed from the image. The vacant region caused by the removal of the human object should be properly covered. The concept called video inpainting [16, 24] can be used to fill the empty area with suitable background. Video inpainting works

well for the regular videos, because the background information required appears in the previous or next frames of the original video. But in here video was captured following a circular path which makes it difficult to find the relevant background information in the same location of the previous or next frame as the background as well changes when camera moves. Cross Diamond Hexagonal Search (CDHS) algorithm from Cheung *et al*. [9] is used to find the similar structural properties of two consecutive frames, then the relevant background to be used can be found. Fig. 6 shows the schematic diagram of filling the empty area caused by removal of moving human object. A basic box shape is used to demonstrate the concept, even though the human object in the real application is much complex shape. Algorithm 2 presents the steps of removing the moving human object and filling the background area. A completed result is shown in Fig. 7.

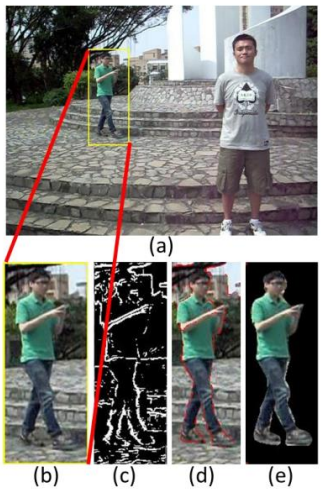


Fig. 5 An example of human object segmentation (a) human body area marked original frame (b) human body area (c) detected edges with Sobel (d) conspicuous points marked (e) Auto-GrabCut result

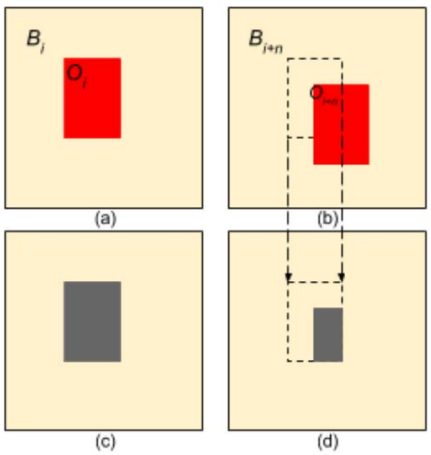


Fig. 6 Background filling procedure (a) original $frame_i$ (b) original $frame_{i+n}$ (c) after human object removal (d) after background fill

C. Generation of Panorama Phase

The final panorama generation is discussed in this section. In the section II-B moving human objects have been removed from the selected frames. In this section the procedure of generation of the panorama using those five frames are discussed. The most important thing here is matching the same features from the frames and merging them together to generate the panorama without any recognizable defects.

Algorithm 2: Removal of Moving Human Objects and refilling the background

Data: Detected human body area information and source frame set
Result: Background refilled image
begin

1. Find the covering region by the object O_i in $frame_i$ and $frame_{i+n}$ using *Auto-GrabCut*.
2. Find the movement direction of boundary of O_i using CDHS algorithm. The used block search area is 15×15 pixels. The block matching of direction detection in CDHS algorithm is uses the Sum of Squared Differences (SSD) method.

$$SSD\ value = \sum_{i=0}^{n} (R - R')^2 + (G - G')^2 + (B - B')^2 \quad (1)$$

   where, R, G, B, R', G' and B' are Red, Blue, Green values in $frame_i$ and $frame_{i+n}$ respectively.
3. Create the mark map to tag the state of background B_i and O_i in consecutive frames. The relative position can be extracted with the block matching in step 2.

$$mark\ map = \begin{cases} 1, & background\ \ B_i \\ 2, & co\ vering\ region\ \ O_i\ and\ O_{i+n} \end{cases} \quad (2)$$

4. If the mark value is changed due to movement of O_i,
   a) Change the value of mark map accordingly.
   b) Calculate the similarity between O_i and B_i with Sum of Absolute Difference (SAD) method [19]. Repair O_i with the background information in B_i.

$$SAD\ value = \sum_{i=0}^{n} (R - R') + (G - G') + (B - B') \quad (3)$$

   Repeat for all the frames
   c) Load the next frame and repeat from step 1.

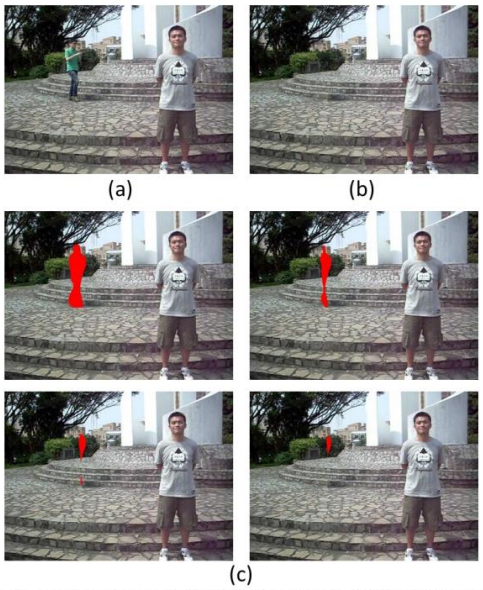
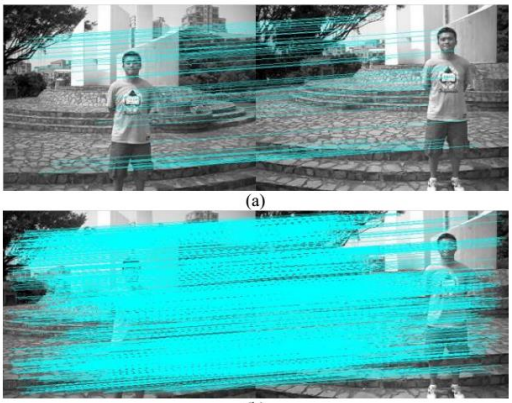


Fig. 7 An example of removal of moving human objects (a) before removal of moving human object (b) after removal of moving human object (c) several selected intermediate steps

Generation of panorama is carried out in three steps as given in Algorithm 3. In first step it is required to find out matching features of the five selected frames in order to merge them together to generate the panorama. Affine-SHIFT (ASHIFT) proposed by Morel [12] is used as the tool to find the matching features from two frames taken in different shooting angles and positions. As the comparing two frames are captured in only

two different angles all the matching features should follow the same angle between them. This concept is used to filter out any false matches by the ASHIFT. An example of matched features using the SHIFT [15, 17, 22, 25] and ASHIFT algorithms using four parameters [12, 13] is shown in Fig. 8.



(a) (b)

Fig. 8 An example of matched features (a) using SHIFT algorithm (b) using ASHIFT algorithm

Then the source frame set can be merged together to generate the panorama based on the matching feature set. Traditionally average color value of the pixels were used as the new color value in the overlapping regions, which then resulted a ghost effect in the overlapping regions. In this paper seam carving [18] based image stitching method [15] is used to generate the panorama from the source frame set. Seam carving is used to divide the overlapping area of the panorama in to two parts, then left and right of it is filled by using the relevant patches from the originals as shown in Fig. 9.

But as the properties of the images like exposure may slightly differ from each other as in Fig. 10, it is first required to calibre the image set with each other using a homography matrix [8]. In the step 2 homography matrix is found and finally in the third step panorama is generated [14, 15]. In camera calibration the homography [6] is also used to ensure all source images can be projected in the same plane. Therefore it is required to calculate the homography matrix via features that can be extracted by ASIFT algorithm. Hence from [6],

$$s * m' = H * m \tag{4}$$

where, s is the scale matrix, H is the homography matrix, $m = (x, y, 1)$ and $m' = (x', y', 1)$ is a pair of corresponding points matrix in the original image and in panorama plane.

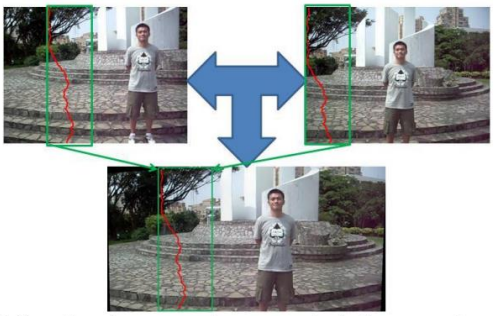


Fig. 9 Generation of panorama using seam carving (optimum seam is marked in red) top: original images, bottom: combined image with overlapping region is marked in green

Algorithm 3: Generation of panorama

Step 1: Finding matching features

Data: Source frame set

Result: Coordinates of the matching feature points

begin

1. Find the matching feature points between two frames with ASIFT algorithm.
2. Calculate the gradient M_F of matching feature points in frames A and B as,

$$M_F = \frac{\Delta Y}{\Delta X} = \frac{Y_B - Y_A}{X_B - X_A} \tag{5}$$

where (X_A, Y_A) and (X_B, Y_B) are the coordinates of the matching points.

3. If $M_F \neq 0$, find the number of high similarity feature matching using SAD method in a small range bounded by 3×3 pixels.
4. Find the maximum number of M_F and compute calibration parameters matrix using coordinates of matching features.
5. Repeat for all frames.

Step 2: Finding optimal homography matrix

Data: Source frame set and coordinates of matching feature points

Result: Homography matrix

begin

1. Cluster matching feature points according to color features using the mean-shift algorithm
   - Convert the color space into CIELuv
   - Copy the L and U dimension parameters of CIELuv into a 2D array *arrayLU*
   - According to the *arrayLU* perform the clustering process
   - Eliminate small regions by merging with neighbor regions
2. For each group calculate the homography matrix by using the matching feature points within the group. Solve at least four pair of corresponding points. If there is no sufficient number of points the group is neglected (see Appendix A for more details).
3. The homography matrix of each group is fed into Eq. 6 to calculate the value of $(H*m)$ and compare the deviation d between the actual m' and the calculated $(H*m)$ where n is the number of matching feature pairs.

$$d = \frac{\sum_{i=0}^{n} (m'_i - H * m_i)}{n} \tag{6}$$

4. The optimal homography matrix is the one with the minimum deviation that is the one with the smallest d.

Step 3: Human panorama creation

Data: Homography matrix and the source frame set without moving human objects

Result: Final panorama

begin

1. Registration: Image registration involves matching features in a set of images or using direct alignment methods to search for image alignments that minimize the SAD method between overlapping region because the overlapping region is relatively similar than the other regions between two image. In some methods of image stitching the registration is done manually because this may need less processing time and let the stages become faster.
2. Calibration: Image calibration [7] aims to minimize differences between an ideal lens models and the camera-lens combination that was used optical defects such as distortions. If feature detection methods were used to register images and absolute positions of the features were recorded and saved, that data can be used for geometric optimization of the images. In the proposed system the feature detection methods use ASIFT algorithm to find feature matching in the set of source image.
3. Blending: Image blending involves executing the adjustments of source images resulted in the calibration stage and combine with remapping of the images to an output projection. Colors are adjusted between images to compensate for exposure differences. In this part color obtained also can use the averaging method and interpolation to compute the value of pixel.

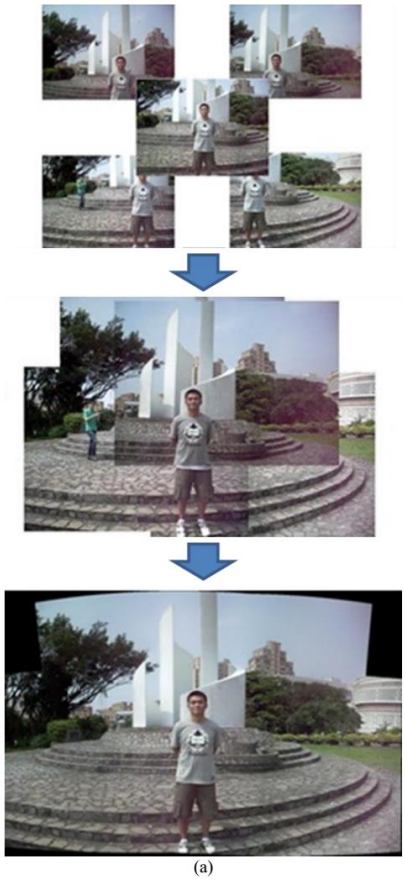
III. Experimental Results

Here the results of the experiment are discussed. Without using any supporting device for the camera (like tripod) input videos were captured to simulate a regular user who uses a regular camera. Selected set of frames and the generated output panorama for three videos are shown in Fig. 10.

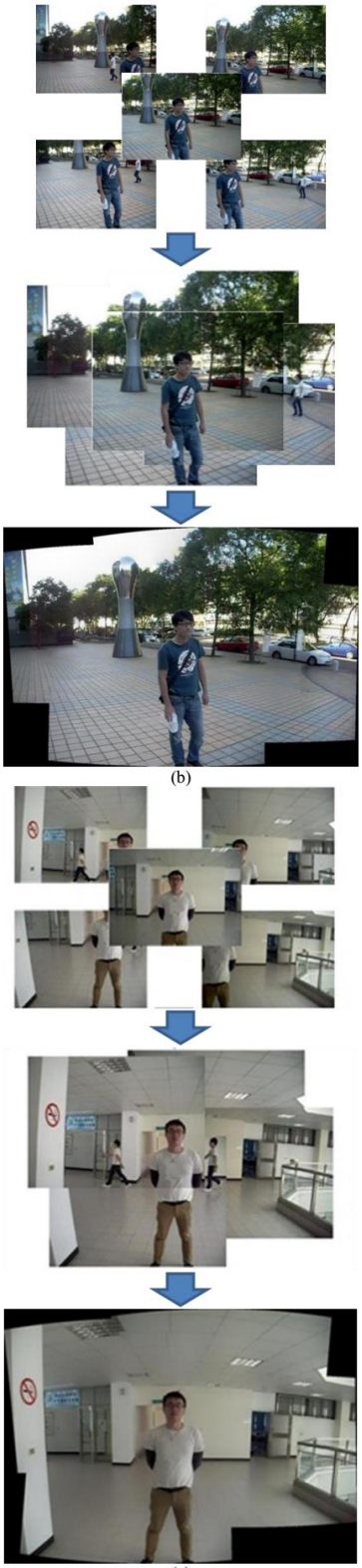
A PC with 1.8 GHz CPU and 2 GB RAM is used for the processing of the results. Time taken in each phase of the process for the three videos was measured and displayed in Table I and Fig. 11. As can be seen in the Table 1 and Fig. 11 time taken in the segmentation of human objects and removal of moving human objects phases is almost similar for all three source videos. However time taken in the generation of panorama phase for three source videos is largely different. The reason for this probably is the color complexity and structural complexity of the input frame set. As an example Fig. 10-(c) video which was captured indoor required a comparatively less processing time due to the fact that it is less complex in color and structure comparing to Fig. 10-(b) and (c).

TABLE I
Time Taken to Generate the Panorama

Experime--nt video	Segmenta--tion of human object (s)	Removal of moving human objects (s)	Generati--on of panorama (s)	Total (s)
(a)	27.31	27.84	485.27	540.42
(b)	25.52	24.17	402.80	452.48
(c)	25.41	25.76	100.81	151.98



(a)



(b) (c)

Fig. 10 Experimental results (a) and (b) are outdoor, (c) is indoor, for each set upper frame set is the selected input frame set from the input video, second is merged results without camera calibrations, and below photo is the generated panorama. Note that moving human objects are removed from the panorama

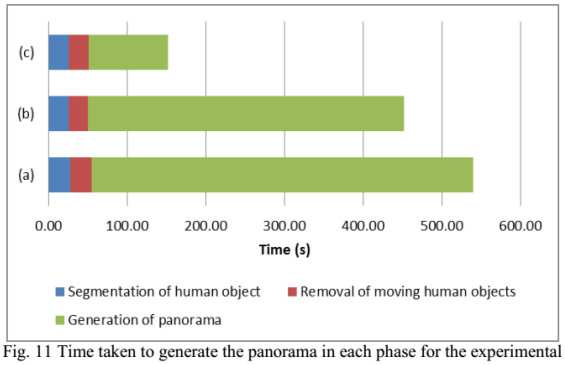


Fig. 11 Time taken to generate the panorama in each phase for the experimental results given in Fig. 10

IV. Conclusions

A novel method for generation of panorama image from a video captured from a simple digital camera by a novice user is presented in this paper. Users prefer panorama photos of famous buildings or large structures with main human objects as the foreground. But normally such locations are crowded with moving human objects in the background. Most important contribution of the presented method is that it is capable of removing such moving human objects from the background. User first captures a short video starting from the center of the main human object and follows a clockwise circular path covering the required background area. After the video is fed to the system, it generates the panorama image following three main phases as segmentation of human objects, removal of moving human objects, and generation of panorama. Presented results show that application generates good quality panorama images.

Authors are further investigating the ways to improve the application. Target future directions are implementation of the application for mobile platforms and automatically frame the generated panorama without current empty regions around.

Acknowledgment

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Appendix A

Eq. 1 can be expanded as,

$$s\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} \quad (7)$$

where, h_{ij} represents each element of the homography matrix.

Eq. 7 can be further simplified as follows,

$$\begin{bmatrix} sx' \\ sy' \\ s \end{bmatrix} = \begin{bmatrix} h_{11}x + h_{12}y + h_{13} \\ h_{21}x + h_{22}y + h_{23} \\ h_{31}x + h_{32}y + h_{33} \end{bmatrix} \quad (8)$$

Then value of s can be found as follows,

$$s = h_{31}x + h_{32}y + h_{33} \quad (9)$$

By applying s in first two rows of Eq. 8,

$$(h_{31}x + h_{32}y + h_{33})x' = h_{11}x + h_{12}y + h_{13}$$
$$(h_{31}x + h_{32}y + h_{33})y' = h_{21}x + h_{22}y + h_{23} \quad (10)$$

Scale of H is a variable and h_{33} is usually normalized to 1 [6]. Therefore to solve the eight parameters at least four pairs of corresponding points are required. As an example for point pair (x_1, y_1) and (x'_1, y'_1) equation can be rewritten as,

$$(h_{31}x_1 + h_{32}y_1 + 1)x'_1 = h_{11}x_1 + h_{12}y_1 + h_{13}$$
$$(h_{31}x_1 + h_{32}y_1 + 1)y'_1 = h_{21}x_1 + h_{22}y_1 + h_{23} \quad (11)$$

By taking x'_1 and y'_1 to the right of equation,

$$h_{11}x_1 + h_{12}y_1 + h_{13} - h_{31}x_1 - h_{32}y_1 = x'_1$$
$$h_{21}x_1 + h_{22}y_1 + h_{23} - h_{31}x_1 - h_{32}y_1 = y'_1 \quad (12)$$

Repeat the same for all four point pairs and the following equation can be obtained. Then by solving this homography matrix can be found.

$$\begin{bmatrix} x_1 & y_1 & 1 & 0 & 0 & 0 & -x'_1 x_1 & -x'_1 y_1 \\ 0 & 0 & 0 & x_1 & y_1 & 1 & -y'_1 x_1 & -y'_1 y_1 \\ x_2 & y_2 & 1 & 0 & 0 & 0 & -x'_2 x_2 & -x'_2 y_2 \\ 0 & 0 & 0 & x_2 & y_2 & 1 & -y'_2 x_2 & -y'_2 y_2 \\ x_3 & y_3 & 1 & 0 & 0 & 0 & -x'_3 x_3 & -x'_3 y_3 \\ 0 & 0 & 0 & x_3 & y_3 & 1 & -y'_3 x_3 & -y'_3 y_3 \\ x_4 & y_4 & 1 & 0 & 0 & 0 & -x'_4 x_4 & -x'_4 y_4 \\ 0 & 0 & 0 & x_4 & y_4 & 1 & -y'_4 x_4 & -y'_4 y_4 \end{bmatrix} \begin{bmatrix} h_{11} \\ h_{12} \\ h_{13} \\ h_{21} \\ h_{22} \\ h_{23} \\ h_{31} \\ h_{32} \end{bmatrix} = \begin{bmatrix} x'_1 \\ y'_1 \\ x'_2 \\ y'_2 \\ x'_3 \\ y'_3 \\ x'_4 \\ y'_4 \end{bmatrix} \quad (13)$$