Topics in CGIV

Computer Graphics, Image processing and computer Vision
Division of Computer Information Engineering

Lee Byung Gook, Dongseo Univ., Busan, Korea
lbg@dongseo.ac.kr

2009.8.20~21

The JSPS/KOSEF Core University Program Seminar
on Next Generation Internet
TEMF Hotel, Gyongju, Korea

Ubiquitous Frontier
Digital
DSU
Dongseo University

Topics in CGIV

Computer Graphics, Image processing and computer Vision
Division of Computer Information Engineering

Lee Byung Gook, Dongseo Univ., Busan, Korea
lbg@dongseo.ac.kr

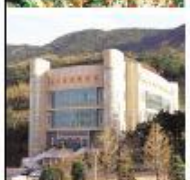
2009.8.20~21

The JSPS/KOSEF Core University Program Seminar
on Next Generation Internet
TEMF Hotel, Gyongju, Korea

Ubiquitous Frontier
Digital
DSU
Dongseo University

Ubiquitous Frontier
Digital
DSU
Dongseo University

Top Ten & To the World
너의 가슴에 세계를 담아라 !



1992~2001

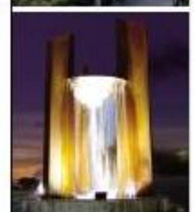
1965. 3 동서학원 설립
1992. 3 개교(설립자 장성만 박사) 및 제1회 입학식(8개 학과 400명)
1996. 2 제1회 학위수여식
1996. 3 동서공과대학교에서 동서대학교로 교명 변경
1996. 6 C.T. VISION 2000 선포
1996. 7 동아일보 주관 대학 정보화 랭킹 우수대학으로 선정
국제기술봉사단(Tech. Corps) 창단
1996. 10 독일베를린공대와 공동학위과정(석 · 박사) 합의 / 교육부평가 "세계화 · 정보화 부문 우수대학"으로 선정
1997. 2 교육의 세계화 선언 및 상징물 건립
1997. 5 낙동강 환경봉사단 창단
1997. 11 한 · 독 공동연구센터 개소
1998. 5 독일 루켄발데 현지 공동연구센터 개소 / 썬공인 자바센터 개소
1998. 9 교육부평가 교육개혁 "대학과 지역사회의 연계 분야" 우수대학으로 선정
1999. 2 제4대 朴東順 총장 취임
1999. 9 민석스포츠센터 개관
1999.10 디지털디자인대학원 석 · 박사과정 인가
1999. 11 Dream Engineering Valley 개관
2000. 3 종합정보시스템(DAKOTAS)개통식 / 학생문화관 준공 / 대학종합평가 "교육영역, 사회봉사영역, 대학원영역" 우수대학 선정
2000. 7 산업자원부 주관 "영남권 디지털디자인 거점대학" 선정(DDIC)
2000. 8 산업자원부 주관 "신발산업 고급인력 및 기술전문가양성 기관" 선정 / 교육부평가 "이공계 연구소 기자재 첨단화 지원사업" 선정
2000. 9 교육부평가 "대학별 자체 교육개혁 실천 분야" 우수대학 선정
2001. 6 교육부평가 "이공계연구소 기자재 첨단화지원 사업" 선정
2001. 7 소프트웨어전문대학원 설립인가
2001. 8 교육인적자원부 평가 "대학별 자체교육개혁 실천분야" 우수대학선정
2001. 11 Mobile Campus 구축

Mar. 1965 Dongseo Academic Institute Founded
Mar. 1992 Dongseo College of Technology was established (8 majors with 400 students).
Feb. 1996 The first commencement ceremony.
Mar. 1996 Dongseo University of Technology was renamed Dongseo University.
Jun. 1996 C.T. VISION 2000 was declared.
Jul. 1996 Chosen as the Best Information University by Donga Daily Newspaper / International Technology Corps was organized.
Oct. 1996 Dual degree program with Technical University of Berlin (MA and Ph.D.) began. / Chosen as the Best Information and Globalized University by the Ministry of Education
Feb. 1997 Declared "Globalization" of Education and built a memorial sculpture.
May.1997 Nak-dong River Environment Protection Corps was organized.
Nov. 1997 Korea-Germany Joint Research Center opened.
May.1998 The Joint Research Center at Lukenwalde, Germany opened. / Java Center authorized by Sun opened.
Sep. 1998 Chosen as the Best Educational. University by the Ministry of Education.
Feb. 1999 President Park Dong Soon was inaugurated.
Sep. 1999 Minseok Sports Center opened.
Oct. 1999 Approval of MA and Ph.D. programs at the graduate school of Digital Design
Nov. 1999 Dream E. Valley opened.
Mar. 2000 The unified information system, DAKOTAS, opened. / Student Union completed / Chosen as the Best University in the fields of education, social services, and graduate school by the Ministry of Education.
Jul. 2000 Chosen as the base university for digital design in Youngnam Province.
Aug. 2000 Chosen as the institute for fostering high-class manpower and technical experts in the footwear field by the Ministry of Commerce, Industry and Energy. / Support received for advancement of apparatus and materials in the science and engineering field by the Ministry of Education and Human Resources.
Sep. 2000 Chosen as the best university in the field of "self-practice of the university reform plans" by the Ministry of Education and Human Resources.
Jun. 2001 Support received for advancement of apparatus and materials in the science and engineering field by the Ministry of Education and Human Resources.
Jul. 2001 Approval of opening of the Graduate School of Software.
Aug. 2001 Chosen as the best university in the field of "self-practice of the university reform plans" by the Ministry of Education and Human Resources.
Nov. 2001 Establishment of the Mobile Campus.

2002~2005

2002. 2 한국대학교육협의회 주관 '교양교육'과 '디자인학문' 평가에서 전국 최우수대학에 선정
2002. 9 한국산업인력공단 일본취업연계 IT 연수기관 선정
2002. 11 교육인적자원부 지방대학 육성지원대학 선정
2003. 2 제5대 朴東順 총장 취임
2003. 3 정보통신부 'IT 학과 교과과정개편지원사업' 선정
2003. 3 뉴밀레니엄관 완공, 개교 10주년 기념식
2003. 7 교육인적자원부 지방대학 육성지원대학 선정
2003. 8 산업자원부 지역기술혁신센터(TIC) 선정
2003. 9 Japan Center 개소
2004. 6 교육인적자원부 지방대학혁신역량강화사업(NURI) 5개 사업단 선정
2004. 7 교육인적자원부 학교기업지원대상대학 선정
2004. 8 산업자원부 지역혁신특성화시범사업대학 선정
2005. 2 대학종합평가 "발전전략 및 비전" 분야 전국 1위
2005. 5 u-Campus 구축 및 Ubiquitous 체험관 개관식
2005. 5 한국문화콘텐츠진흥원 문화콘텐츠 특성화 교육기관 선정
2005. 6 정보통신연구진흥원 IT분야 해외교수 초빙지원사업(우수대학) 선정
2005. 6 독일 에어랑엔대학과 공동학위과정 협정
2005. 6 삼성경제연구소 주관 "대학혁신과 경쟁력" 대학우수 사례 발표(제목: 동서대학교 특성화프로그램)
2005. 7 동서대, 북경이공대, 고베예술대학 공동연구 실시에 대한 협정서 조인
2005. 8 핀란드 오울루대학 공동학위프로그램 개설
2005. 10 중국 심천대 공동학위프로그램 협정 체결
2005. 10 중국 중산대 학술교류 협정 체결

Feb. 2002 Selected as one of the best universities in the fields of Liberal Arts and Design Education by the Korea Council for University Education.
Sep. 2002 Chosen as the IT Training Institute for employment in Japan by the Korea Industrial Human Resources Cooperation.
Nov. 2002 Financial support received for the development of regional universities by the Ministry of Education and Human Resources.
Feb. 2003 President Park Dong Soon was inaugurated.
Mar. 2003 Support received for curriculum development for IT majors by the Ministry of Information and Communication
Mar. 2003 New Millenium Building opened.
Jul. 2003 Financial support received for the development of regional universities by the Ministry of Education and Human Resources.
Aug. 2003 Selected as a Technology Innovation Center(TIC) by the Ministry of the Commerce, Industry and Energy.
Sep. 2003 Japan Center opened.
Jun. 2004 Won five business proposals for the New University for Regional Innovation (NURI) offered by the Ministry of Education and Human Resources.
Jul. 2004 Support received for University Business Development from the Ministry of Education and Human Resources.
Aug. 2004 Selected as the University for Regional Innovation System by the Ministry of Commerce, Industry and Energy.
Feb. 2005 Ranked first in "Development Strategy and Vision" in the Comprehensive University Evaluation.
May. 2005 Built U-Campus and had an opening ceremony of The Ubiquitous Experience Hall.
May. 2005 Selected as an educational institute specialized in cultural content production by Korea Culture & Content Agency.
Jun. 2005 Selected for Overseas Professor Invitation Project in IT (Best Practice) by Institute of Information Technology /Assessment.
Jun. 2005 Signed a dual degree program with Erlangen University of Germany.
Jun. 2005 Presented a case study on "University Innovation and Competitiveness" organized by Samsung Economic Research Institute.
Jul. 2005 Signed joint research & development projects with Beijing Institute of Technology, Kobe College of Liberal Arts.
Aug. 2005 Opened dual degree program with University of Oulu in Finland.
Oct. 2005 Signed a dual degree program with Shenzhen University in China.
Oct. 2005 Academic exchange agreement with Sun Yat-Sen University in China.



2006~2007

2006. 1 미국 조지워싱턴대학과 학술교류협정 체결
2006. 2 해외인턴사원 취업지원사업에 선정(2004년,2005년 이어 3년 연속)
2006. 2 호주 선샤인코스트대학과 학술교류협정 체결
2006. 4 교육인적자원부 '2단계 BK21 사업'에 3개 팀 선정
2006. 5 스웨덴 룰레아 공과대학과 학술교류협정 체결
2006. 6 인도네시아 페트라크리스찬대학과 Tech. Corps 관련 협정 체결
2006. 6 2006 세계 대학 총장 회의 개최
2006. 6 개교 15주년 기념식
2006. 6 중국 중산대학과 학술교류협정 체결
2006. 6 일본 리츠메이칸대학과 학술교류협정 체결
2006. 6 미국 호프국제대학과 학술교류협정 체결
2006. 6 동서대 일본연구센터와 세종연구소 학술교류협정 체결
2006. 7 중국 노팅험대학과의 학술교류협정 체결
2006. 7 독일 바이센제예술대학과 디자인학부, 교환학생관련 협정 체결
2006. 9 한 일 6개 대학 공동세미나 개최
2006. 10 미국 호프국제대학과 교환학생관련 협정 체결
2006. 10 중국 중남재경정법대학 학술교류 협정
2006. 11 부산시와 독일 'NI 그래픽스넷'과 공동으로 유비쿼터스와 VR,CG 기술개발 연구소인 IA를 우리 대학에 설립
2006. 12 부산, 경남 최초의 IPv6 기반의 와이브로 기지국 개통
2007. 2 제6대 박동순 총장 취임
2007. 2 제12회 학위수여식
2007. 2 2007학년도 입학식
2007. 4 동서대 공자 아카데미 개원
2007. 6 중국 중남재경정법대학 항목 합작대학 설립
중국 웨이팡과학기술대에 '한중 국제유학원' 개원
2007. 7 임권택영화예술대학 설립
2007. 8 국제생활관 개관
2007. 9 민석도서관 개관
2007. 10 임권택영화 연구소 개소

Jan. 2006. Academic Exchange Agreement with University of George Washington in the US
Feb. 2006 Selected for Overseas Internship Support (consecutive 3years, 2004-6)
Feb. 2006 Academic Exchange Agreement with University of Sunshine Coast in Australia
Apr. 2006 3 Teams were selected for "Phase 2 BK21" by Ministry of Education & Human Resources Development
May. 2006 Academic Exchange Agreement with Lulea University of Technology in Sweden
Jun. 2006 Academic Exchange Agreement on Tech. Corps related Fields with Petra Christian University in Indonesia
Jun. 2006 Held World University Presidents Forum 2006
Jun. 2006 Celebration of the 15th Anniversary of the University Foundation
Jun. 2006 Academic Exchange Agreement with Sun Yat-Sen University in China
Jun. 2006 Academic Exchange Agreement with Ritsumeikan University in Japan
Jun. 2006 Academic Exchange Agreement with Hope International University in the US
Jun. 2006 Academic Exchange Agreement between Dongseo University Japan Center and Sejong Institute
Jul. 2006 Academic Exchange Agreement with Nottingham University in China
Jul. 2006 Agreement on Exchange Students of Division of Digital Design with Kunsthochschule Berlin-Weißensee in Germany
Sep. 2006 Held 6 Universities Joint Seminar of Korea-Japan
Oct. 2006 Agreement on Exchange Students with Hope International University in the US
Oct. 2006 Academic Exchange Agreement with Zhongnan University of Economics and Law in China
Nov. 2006 Establishment of IA(The Institute for Ambient Intelligence) jointly with Busan Metropolitan City and 'NI Graphics' in Germany
Dec. 2006 Opened IPv6 based WiBRO Radio Access Station firstly in the area of Busan City and Kyungnam Province
Feb. 2007 Inauguration of the 6th President, Dong-Soon Park
Feb. 2007 The 12th Laureation
Feb. 2007 2007 Entrance Ceremony
Apr. 2007 Opened Dongseo University Confucius Institute
Jun. 2007 Establishment of Joint College with Zhongnan University of Economics and Law in China
Opened 'Korea-China Overseas Education Center' at Weifang Science & Technology Vocational College in China
Jul. 2007 Establishment of Im Kwon Taek College of Film & Performing Arts
Aug. 2007 Opened International House
Sep. 2007 Opened Minseok Library
Oct. 2007 Opened Im Kwontaek's Film Research Center

Divisions : 16
Students : 14,845
Graduate Students : 359
Professors : 293
Lectures : 474
Employees : 307

Academic Divisions

경영학부
Division of Business Administration

외국어계열
Division of Foreign Languages

국제학부
Division of International Studies

국제학과
Department of International Studies

영상매스컴학부
Division of Visual Communication

관광학부
Division of Tourism

사회복지학부
Division of Social Welfare

보건의료계열
Division of Health Science

정보시스템공학계열
Division of Information Systems Engineering

컴퓨터정보공학부
Division of Computer & Information Engineering

건축토목공학부
Division of Architecture & Civil Engineering

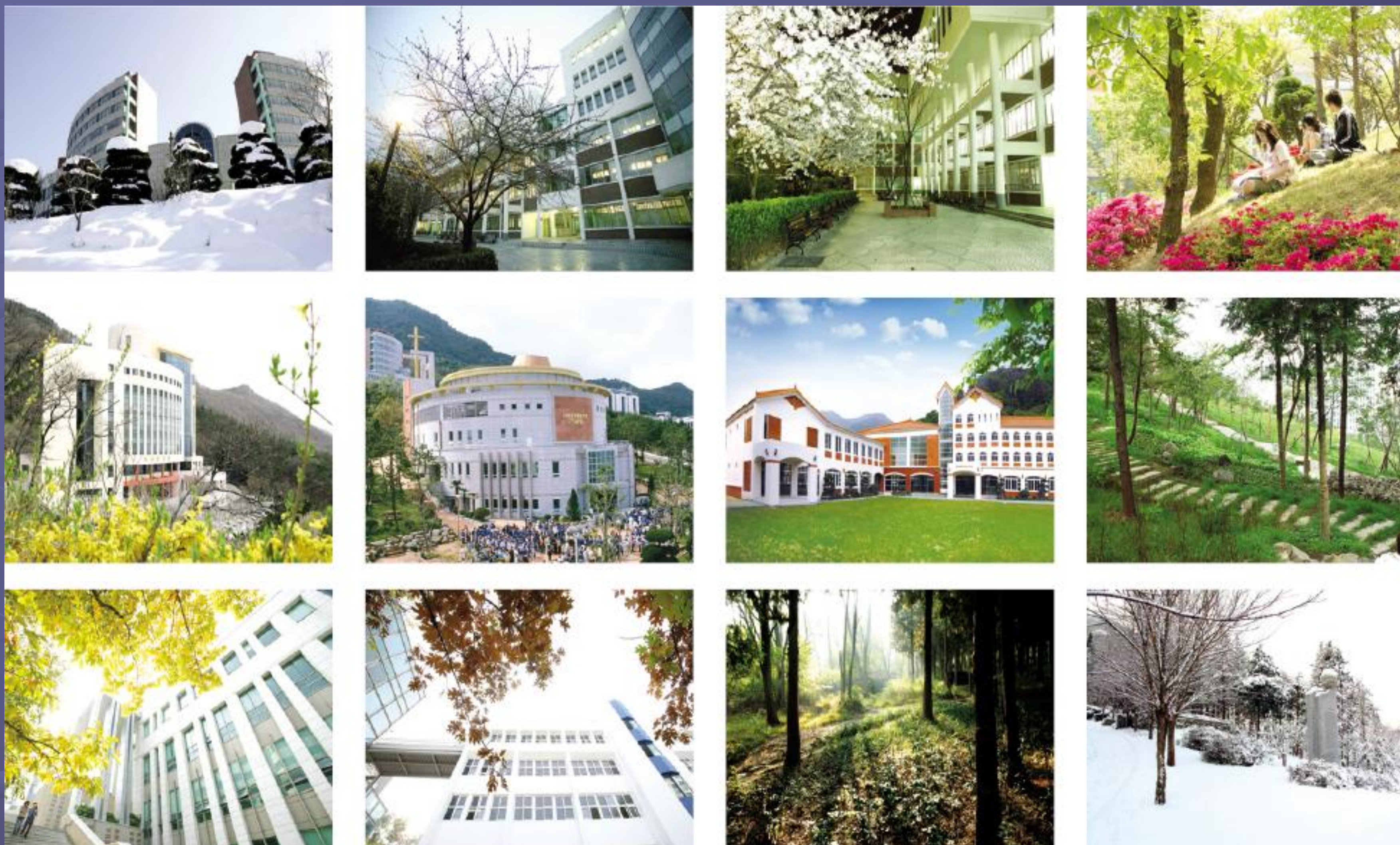
응용생명공학부
Division of Applied Bio-Engineering

디지털콘텐츠학부
Division of Digital Contents

디자인학부
Division of Design

레포츠과학부
Division of Leisure & Sports Science

임권택영화예술대학
Im Kwon Taek College of Film & Performing Arts



Topics in CGIV

Computer Graphics, Image processing and computer Vision

Division of Computer Information Engineering

Lee Byung Gook, Dongseo Univ., Busan, Korea
lbg@dongseo.ac.kr

2009.8.20~21

The JSPS/KOSEF Core University Program Seminar
on Next Generation Internet
TEMF Hotel, Gyongju, Korea

Computer Graphics, Image Processing and Computer Vision Research Group (CGIV)

Members

- Professor : byung-gook lee, joon-jae lee, hwang-kyu yang, jaechil yoo, kwan-pyo ko, hoon yoo, kwang-min jeong, dong-hak shin
- Ph.D. Students : nam-woo kim
- M.S. Students : nam-seok choi, yong-hyeon hwang, seung-jae lee, du-cheol gang, neeraj sharma, seung-il han, yeong-mi jeon, jung-hye kwon, kyeong-ran kim, tan chun wei, chow hoo mun, teresa liew bao yng, liliana
- Internship Students : diong wei liam(Malaysia Multimedia Univ., 07.7~), mur liyana binti mohd marizd(Malaysia Multimedia Univ., 06.6~06.9), tee cheau mei(Malaysia Multimedia Univ., 06.6~06.9), thomas ebner(Tech. Univ. of Dresden, 05.10~06.6), andre bugay(Tech. Univ. of Dresden, 05.10~06.6), eileen(Malaysia Multimedia Univ., 05.6~05.10)
- B.S. Students : dong-hun choi, jung-woo lee, jong-hyun baek, sung-hyun kim, cho-hee jin
- Alumni : sang-jun cha(07.8), myoung-su yun(07.2), sang-ji kim(07.2), rae-won kang(07.2), lye wei shi(07.2), raghubansh bahadur gupta(07.2), kishore kunal(sona)(06.8), sang-jun lee(06.2), jee-hoon jung(06.2), woo-jong lim(05.2), hyo-min ahn (05.2), hong-ju cho(05.2), you-chun tang(05.2), woo-jin jung(05.2), in-ho baik (05.2), jae-sik kang(05.2), yun-li lee(04.8), seow-hui saw(04.8), hyun-woo park (04.8), seung-mok lee(04.8)

Research Fields - Schedule.

- Subdivision : kwan-pyo ko, yeong-mi jeon, jung-hye kwon, chow hoo mun
- E-spline : du-cheol gang, nam-woo kim, yeong-mi jeon
- Image Processing & Deinteracing : du-cheol gang, kyeong-ran kim, cho-hee jin
- Fingerprint Pattern Matching : nam-seok choi, neeraj sharma,
- Level Set : teresa liew bao yng, nam-woo kim
- Integral Image : dong-hak shin, yong-hyun hwang, tan chun wei
- Image Deformation : nam-seok choi, nam-woo kim
- Multi Touch Screen : nam-seok choi, yeong-mi jeon

- Laser Pointer Interaction : seung-jae lee, jung-woo lee
- PTZ Camera Control : seung-il han, jong-hyun baek
- Mobile Phone Keypad : seung-il han, du-cheol gang
- U-Frame Interaction : nam-woo kim, sung-hyun kim
- IS communication : dong-hun choi, jong-hyun baek
- USB Camera Hand Tracking : seung-il han, jung-hye kwon, jong-hyun baek

- Parametrization : nam-woo kim
- Polygonal Simplification : nam-woo kim
- FPD Mura Detection : yong-hyun hwang, tan chun wei
- Etc : yong-hyeon hwang

lbg@dongseo.ac.kr

Korea Mathematical Methods for Curves and Surfaces
Dongseo 2007 Level Set and Its Applications

July 4~6, 2007, Dongseo Univ., u-IT관 702호, Busan, Korea
Dongseo Univ. supported by
KOSEF : 3D Range Image Processing and Semiconductor Package Inspection Based on Optimal Approximation Functions,
KOTEF07 : Multi-User Interaction Technology for Ubiquitous Smart Space.

Schedule(tentative)

July 4. Sectio
- 09:00-12:00
- 14:00-16:00

July 5. Sectio
- 14:00-16:00
- 16:00-17:00

July 6. Sectio
- 10:00-12:00
- 14:00-16:00
- 16:00-18:00
- 18:00-20:00

Korea Mathematical Methods for Curves and Surfaces
Ewha 2006

August 25~26, 2006, Ewha Univ., 이화-신세계관 (map) 213호, Seoul, Korea
with financial support from Ewha Univ. 수리과학연구소
Dongseo Univ. KOTEF06:유비쿼터스 스마트 공간 개발을 위한 멀티유저 인터랙션 기술 개발
*이화-신세계관은 map에서 삼성교육문화관 앞 건물

Program(tentativ

August 25.
- 14:00-14:3 Ewha Univ.
- 14:30-15:0 Dongseo U
- 15:00-15:3 Chosun Un
- 15:30-16:0
- 16:00-16:3 Hoon Yoo,
- 16:30-17:0 Dongseo U
- 18:00-20:0

August 26.
- 09:00-09:3 Univ.
- 09:30-10:0 Wavelets E
- 10:00-11:3

Korea Mathematical Methods for Curves and Surfaces
Dongseo 2006

January 9~11, 2006, Dongseo Univ. Graduate School of Software,
u-IT 6th floor, International Conference Room, 702, Korea
supported by Information Center for Mathematical Sciences, KAIST

Internatioal Workshps Organizing Committee :
Byung-Gook Lee, Joon-Jae Lee, KwanPyo Ko, Dongseo Univ.
Jungho Yoon, Ewha W. Univ.
Jaechil Yoo, Dongeui Univ.
Choi, U Jin, KAIST.

Gangahn Bridge, Busan, Korea

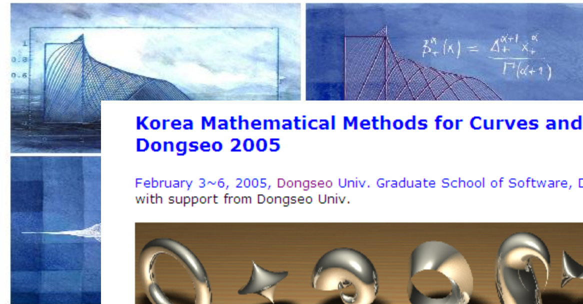
Program(tentative):

January 9 Section 1 : u-IT 6th floor : ByungGook Lee
- 10:00-10:50 Tutorial-Subdivision:from Stationary to Non-stationary scheme, Jungho Yoon, Ewha Univ.
- 11:10-12:00 Invited-Nonuniform and local variational subdivision, Scott N. Kersey, Georgia Southern Univ.
- 12:00-14:00 break
- 14:00-14:50 Invited-Bivariate orthogonal polynomials on triangular domains, Abedallah Rababah, Jordan Univ.
- 15:10-16:00 Invited-Fast Multipole Method for Global Illumination, Sharat Chandran, Indian Institute of Technology-Bombay.
- 18:00-20:00 reception : 대도 buffet

January 10 Section 2 : u-IT 702 : Jungho Yoon
- 10:00-10:50 Tutorial-Subdivision Zoo, KwanPyo Ko, Dongseo Univ.
- 11:00-11:30 Introduction to Lifting Scheme, yoo hoon, Dongseo Univ.
- 11:30-12:00 Wavelets, Sangsu Park, Ewha Univ.
- 12:00-14:00 break
- 14:00-15:00 New Year's Concert

Korea Mathematical Methods for Curves and Surfaces
Dongseo 2005

June 23~25, 2005, Dongseo Univ. Graduate School of Software, Design Hall, Korea



The figures a... Biomedical Im...

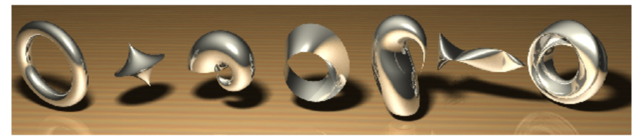
June 23
- 09:00-1
- 13:00-1
- 14:30-1
- 16:00-1

June 24
- 10:00-1
- 11:00-1
- 15:00-1 Dongse
- 15:40-1
- 16:20-1 Univ.

June 25
- 09:00-1
- 13:00-1 Dongse

Korea Mathematical Methods for Curves and Surfaces
Dongseo 2005

February 3~6, 2005, Dongseo Univ. Graduate School of Software, Design Hall, Korea
with support from Dongseo Univ.



The figures are from the Exact Reconstruction of Arbitrary Surfaces by Interpolatory Subdivision, lee r

February 3
- 14:00-15:0
- 15:00-16:0
- 16:00-17:0

February 4
- 10:00-10:3
- 10:30-11:0 Univ.
- 11:00-12:0
- 13:30-14:0
- 14:00-14:3
- 14:30-15:3
- 15:30-16:3
- 16:30-16:4

February 5
- 10:00-11:0

List of Participan
Dongseo Univ. :
Ewha Univ. : jun
Konkuk Univ. : ha
Kyungwon Univ.
Sogang Univ. : m
Dongeui Univ. : j
KIAS : sung-woo

Korea Mathematical Methods for Curves and Surfaces
Dongseo 2004

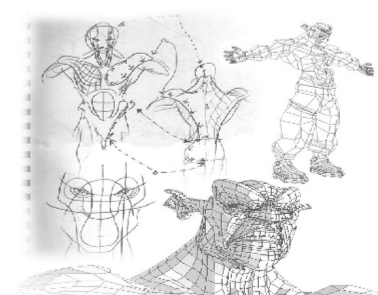
August 9~13, 2004, Dongseo Univ. Graduate School of Software, Design Hall, Korea

August 9
- 10:00-12:00 Polygonal Simplification Methods, byung gook lee, Dongseo Univ.
- 14:00-16:00 D-D:10 years after, jungho yoon, Ewha Univ.
- 16:00-18:00 Error estimates for the web-spline method, chang-ho kim, Konkuk Univ.

August 10
- 10:00-11:00 Polynomial generation and quasi-interpolation in stationary non-uniform subdivision, yeon ju lee, Ewha Univ.
- 11:00-12:00 Analysis of non-uniform subdivision scheme, sung-woo choi, KIAS
- 14:00-16:00 Point-wise convergence of polynomials, gang jun yoon, KAIST
- 16:00-18:00 LCD Blemish Detection, joon jae lee, Dongseo Univ.

August 12
- 10:00-12:00 Analysis of non-uniform subdivision scheme, sung-woo choi, KIAS
- 14:00-17:00 Web-spline methods, jaechil yoo, Dongeui Univ.

August 13
- 10:00-12:00 Multilevel B-spline approximation, byung gook lee, Dongseo Univ.
- 14:00-17:00 Polynomial Fitting for Edge Detection in Irregularly Samples Signals and Images, jungho yoon, Ewha Univ.

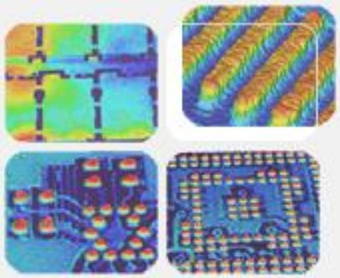


COMPANY PRODUCTS SUPPORT English / Korean

PARMI

The Leader of
3D Solder Paste Inspection

Parmi is a world leader in 3 dimensional inspection for printed solder paste on PCB.
We provides a series of products to meet various customer needs. Top level quality and surprisingly high inspection speed of our machines are based on the unique 3D RSC (Range scan camera) sensor.



HOME

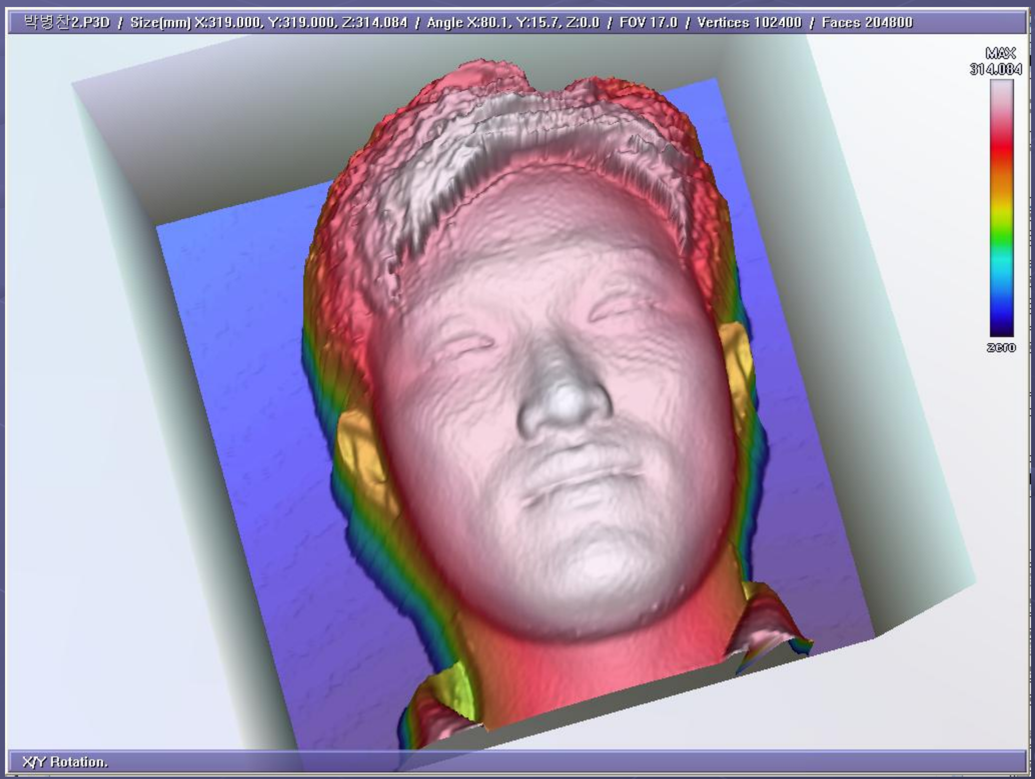
PARMI

4DCULTURE

lbg@dongseo.ac.kr

PARMI

4DCULTURE



lbg@dongseo.ac.kr

An Efficient Scattered Data Approximation Using Multilevel B-splines Based on Quasi-Interpolants

The 5th International Conference on 3-D Digital Imaging and Modeling
Byung-Gook Lee, Joon Jae Lee, Jaechil Yoo
lbg,jjlee@dongseo.ac.kr,yoo@deu.ac.kr

3DIM 2005

PARMI

DONG-EUI UNIVERSITY

Digital DSU Dongseo University

B-spline approximation

- Global approximation
- Quasi-interpolants

Multilevel B-spline approximation

Applications

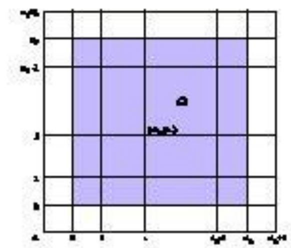
- Surface approximation with scattered data
- Image representation and compression
- Filling holes in Range data

B-spline approximation

$$f(x,y) = \sum_{i=1}^{m+d+1} \sum_{j=1}^{n+d+1} c_{ij} B_{i,d}(x) B_{j,d}(y)$$

Given a set of scattered points $P = \{P_i\}$, $P_i = (x_i, y_i, z_i) \in R^3$ and let $\Omega = \{(x, y) \mid 0 \le x < m, 0 \le y < n\}$ be a rectangular domain in the xy-plane such that (x_i, y_i) is a point in Ω. Let Φ be a control lattice overlaid on a domain Ω. The control lattice Φ is an uniform tensor product grids over Ω. The knot intervals are uniform interval defined as h_x in x-axis and h_y in y-axis. So, for uniform cubic B-spline case, degree d=3 and the set of knot vectors are defined as below.

$$x_i = \{-dh_x, \dots, 0, h_x, \dots, m h_x, \dots, (m+d)h_x\}$$
$$y_j = \{-dh_y, \dots, 0, h_y, \dots, n h_y, \dots, (n+d)h_y\}$$



Let Φ be a control lattice overlaid on a domain Ω.

Multilevel B-spline approximation

The algorithm run in a multiresolutional setting over uniform partitions such that the final surface f is composed of a sequence of surfaces at dyadic scales.

$$f = f_0 + f_1 + \dots + f_k$$

where $f_i \in S_i$, $i = 0, 1, \dots, k$ and $S_0, S_1, \dots, S_k$ is a nested sequence of subspaces of S_k.

$$S_0 \subset S_1 \subset \dots \subset S_k$$

The MBA algorithm serves result as smooth initial approximation f_0 to $\Delta^0 P = P$ defined on the coarsest control lattice $\Phi_0 = \Phi$, by applying the BA algorithm. To continue to the finer levels, below explanation are quoted from [7]. The first approximation possibly leaves large discrepancies at the data points in P. In particular, f_0 leaves a deviation

$$\Delta^1 z_i = z_i - f_0(x_i, y_i) \text{ for } i = 0, \dots, n.$$

The next finer control lattice Φ_1 is then used to obtain function f_1 that approximates the difference $\Delta^1 P = \{(x_i, y_i, \Delta^1 z_i)\}$. Then, the sum of $f_0 + f_1$ yields a smaller deviation for each (x_i, y_i) in Ω.

$$\Delta^2 z_i = z_i - f_0(x_i, y_i) - f_1(x_i, y_i) \text{ for } i = 0, \dots, n$$

In general, for each level k in the hierarchy, the point set $\Delta^k P = \{(x_i, y_i, \Delta^k z_i)\}$ is approximated by a function f_k defined over the control lattice Φ_k, where

$$\Delta^k z_i = z_i - \sum_{l=0}^{k-1} f_l(x_i, y_i) = \Delta^{k-1} z_i - f_{k-1}(x_i, y_i)$$

Quasi-interpolants

Given a function f, the basic problem of spline approximation is to determine B-spline coefficients $\{c_i\}$ such that

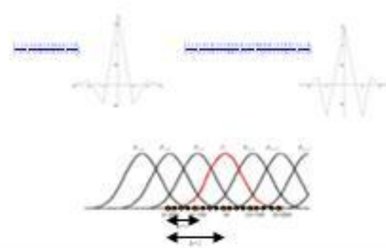
$$Pf = \sum_{i=1}^{n} c_i B_{i,d}$$

is a reasonable approximation to f.

We fix k and propose the following procedure for determining c_k:

(i) Choose a local interval $I = [t_\mu, t_\nu)$ with the property that I intersects the interior of the support of $B_{k,d}$: $I \cap (t_k, t_{k+d+1}) \neq \emptyset$. Denote the restriction of the space $S_{d,t}$ to the interval I by $S_{d,I}$, i.e. $S_{d,I} = \text{span}\{B_{\mu-d,d}, \dots, B_{\nu-1,d}\}$.
(ii) Choose some local approximation method P_I with the property that $P_I g = g$ for all $g \in S_{d,I}$.
(iii) Let f_I denote the restriction of f to the interval I. Then there exist B-spline coefficients $\{b_i\}_{i=\mu-d}^{\nu-1}$ such that $P_I f_I = \sum_{i=\mu-d}^{\nu-1} b_i B_{i,d}$.
Note that $\mu - d \le k \le \nu - 1$ since $\text{supp} B_{k,d}$ intersects I.
(iv) Set $c_k = b_k$.

Weights : uniform data case



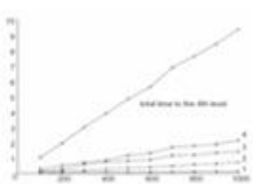
Applications

$$g_1(x) = |x|\sin(x)$$
$$g_2(x) = x^2 \sin(7x^2)$$
$$g_3(x) = |\sin(x)|$$
$$g_4(x) = \begin{cases} 0 & \text{if } x \le 0.5, \\ 1 & \text{if } x > 0.5. \end{cases}$$

Given a test function $g_k(x)$, we first sampled data points from it and applied to the algorithm to obtain an approximation function f. The difference between g_k and f is then measured by computing the normalized RMS(root mean square) error which is divided the RMS error by the difference of maximum and minimum values of g_k between the function values on a dense grid.

$$RMS = \sqrt{\frac{\sum_{i=1}^{N} (g_k(x_i) - f(x_i))^2}{(N+1)}}$$

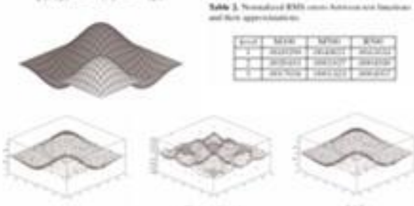
Table 1. Normalized RMS errors.



To demonstrate the time efficiency of the proposed method, we calculate time as the sample points increase from 100 to 1000 by 100 steps where the number of control points at initial level is 7×7 and four levels are performed. Fig. 4 plots the relative time value to 100 sample points according to the sample size. From this result, we can see it linearly increases with sample size. The space complexity is $O(n + (2^{k+2} - 1)(n_x n_y))$ because we have to store all the control lattices in the hierarchy. But if an adaptive control lattice hierarchy is used, a control lattice can be reduced by a simple set of necessary control points.

$$g(x, y) = \sin(x) + \sin(y)$$

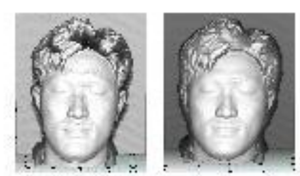
Table 2. Normalized RMS errors between test functions and their approximations.



We used three data sets of M100, M500 and R500, where M100 and M500 are small and large data sets, which consist of 100 and 500 points, respectively. We uniformly sampled 7×7 and 15×15 data points, respectively, while the others was randomly sampled. And R500 points were totally randomly sampled.

A) Original image B) Level=1 C) Level=3 D) Level=5

The experiment is also performed for large number of uniform data such as flower image with size of 512 by 512. PSNR(20 log(255/RMS)) is used as a error metric for image compression. High quality reconstructed image of 31.933dB is obtained with 18.24:1 of compression ratio at the level 5 in Fig. 11.



A) Original range data B) Multilevel B-spline approximation : A real range data acquired from 3D scanner is used to prove the efficiency of the proposed algorithm. Fig 9 shows a head data with many holes in hair region due to low reflection of laser where the size of data is 320x320 and the pixel intensities depict depth values. The undesired hole or missing points are usually case when the data come from laser scanner 3D acquisitions or if they represent damaged objects to be restored. An attractive field of research focuses on situations in which these holes are too geometrically and topologically complex to fill and entirely scattered data set exist. As shown in Fig. 10, the method generates good approximation and smooth surface, filling missing data points by interpolation property where the algorithm generated five level with initial 8x8 control points.

Work flow

FPD Data → Preprocess → Feature extraction → Postprocess

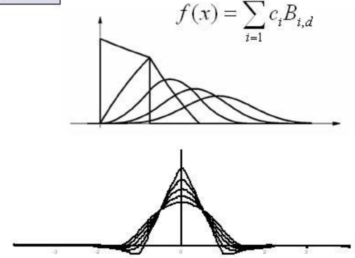
Feature extraction:
- 3D Surface Approximation
- Wavelet Transform

3D Surface Approximation

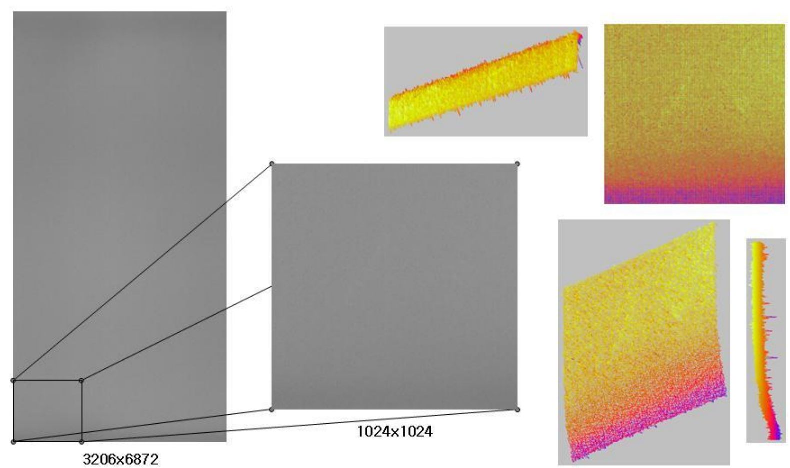
- Polynomial
- B-spline
- Psi basis(edge enhancement, CAGD2005 yoon)
- Exponential spline

- Global vs Local
- Cross Validation
- Thresholding(height vs area)

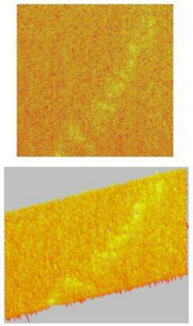
$$f(x)=\sum_{i=1}^{m} c_i B_{i,d}$$



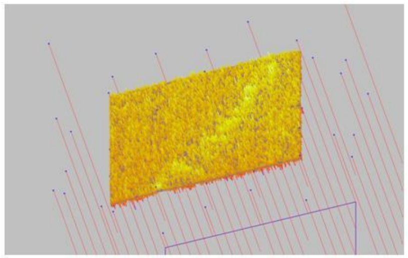
BLU 얼룩불량 377_6317.bmp



Cubic B-spline approximation

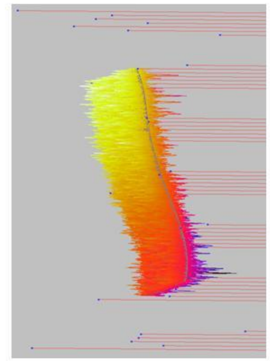


256x256 bmp image

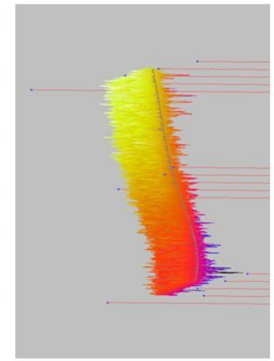


Cubic B-spline approximation with 7x7 control points

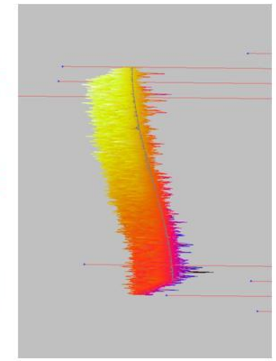
Number of control points



7x7 control points

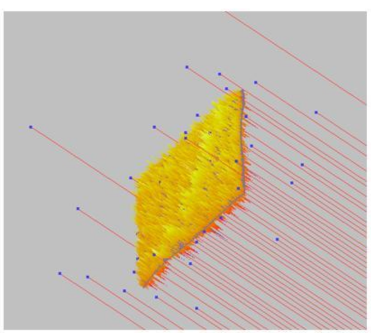


5x5 control points

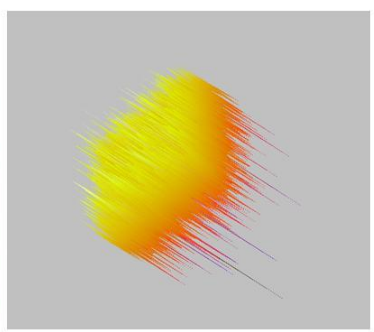


4x4 control points

Difference image

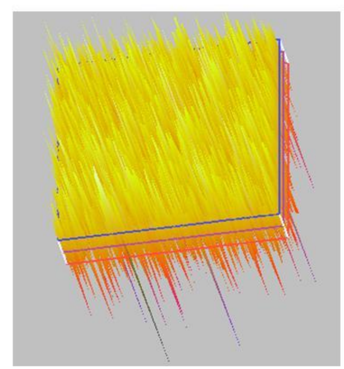


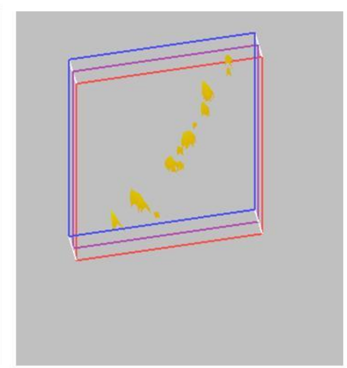
Cubic B-spline approximation with 7x7 control points



Difference bitmap image data

Mura detection filter





with mura detection filter

A WAVELET BASED FLAT PANEL DISPLAY DEFECT DETECTION

WavE 2006, July 10-14, 2006, EPFL Lausanne, Swiss

Byung-Gook Lee, Joon Jae Lee, Hoon Yoo, Yeon Ju Lee, Jungho Yoon
lbg@dongseo.ac.kr http://kowon.dongseo.ac.kr/~lbg/

Objectives

- Defect Detection of Plat Panel Display

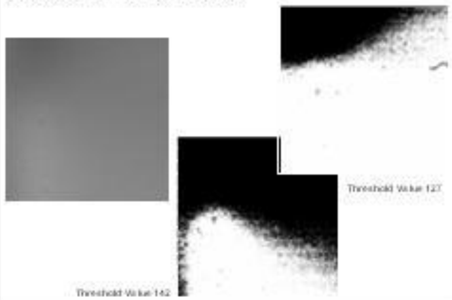
Problems

- Uneven illumination due to self radiation
- High frequency noise inherent in images

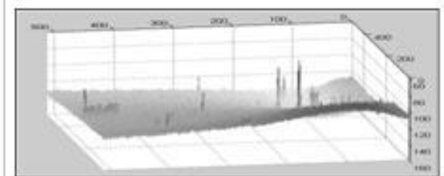
The Proposed Method

- Surface approximation based approach using wavelet multiresolution

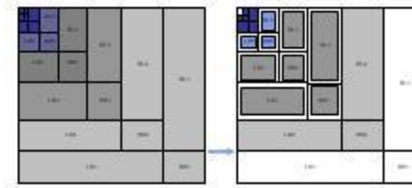
Uneven illumination



Idea for uneven illumination compensation

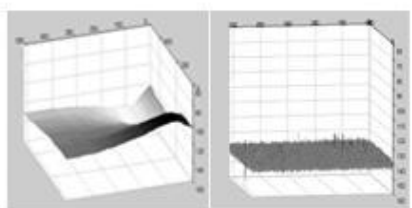


Wavelet Representation



- Field of automatic inspection and FPD products
  Why do we need the automatic inspection of FPD
  What is the FPD products?
- Approaching points and Algorithms
  Analyze the defects in FPD
  How can we solve the problems?
  Understanding the algorithms previously proposed
- Multi-layered structure.
  High probability of defect occurrence at the inside of panel
  Needs of high cleaning level
- The array of many integrated semi-conductor
  Adjust the amount of light from light source
  Adjust the amount of light which are emitted by itself
- Products
  TFT-LCD, PDP, OEL, OLED, CELL, BLU, FILM, etc

Elimination parts for compensation



Compensation approach

$$F(\omega) = (HH_1 + HL_1 + LH_1) + (HH_2 + HL_2 + LH_2) \ldots\ldots (LL_k + HH_k + HL_k + LH_k)$$

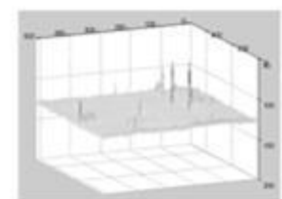
$$F_h(\omega) = HH_1 + HL_1 + LH_1$$

$$F_l(\omega) = LL_k$$

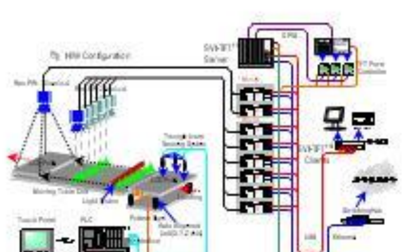
$$F_d(\omega) = (HH_{3a} + HL_{3a} + LH_{3a}) + (HH_{4a} + HL_{4a} + LH_{4a}) + (HH_{5a} + HL_{5a} + LH_{5a})$$

$$F'(\omega) = F(\omega) - F_h(\omega) - F_l(\omega) - F_d(\omega)$$

Compensated image result



Detected result by simple threshold



Perfomance

CPU : 3GHz, Memory : 1GB

Input size / Procedure	1MB	16.8MB	19.5MB	22MB	53MB
Wavelet Decomposition	0.015	0.328	0.375	0.437	1.062
Wavelet Synthesis	0.032	0.328	0.375	0.438	1.031
Thresholding	0.016	0.282	0.298	0.38	0.88
Blob analysis	0.063	1.683	1.823	2.021	6.20
Total	0.126	2.261	2.869	3.256	9.153

Conclusion and further research

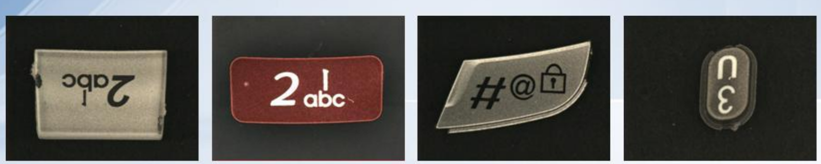
- Mathematical analysis using surface approximation for illumination compensation
- Performance
  Accuracy, Speed, Reliability
- General method for various defect types

iVision 아이비젼

Digital DSU Dongseo University

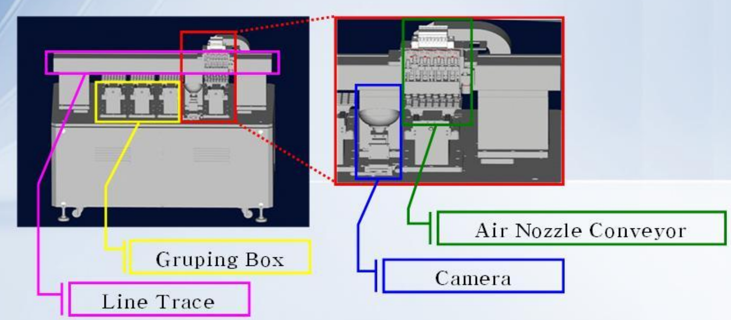
Keypad Inspection System of Cellular Phone

Seung Il Han, Du Cheol Gang, Byung Gook Lee, Joon Jae Lee
Graduate School of Design & IT, Dongseo University
{ted12, newsephiro, lbg, jjlee}@dongseo.ac.kr



Inspection Machine

- Part
  - Air Nozzle Conveyor
  - Camera
  - Grouping Box
  - Line Trace



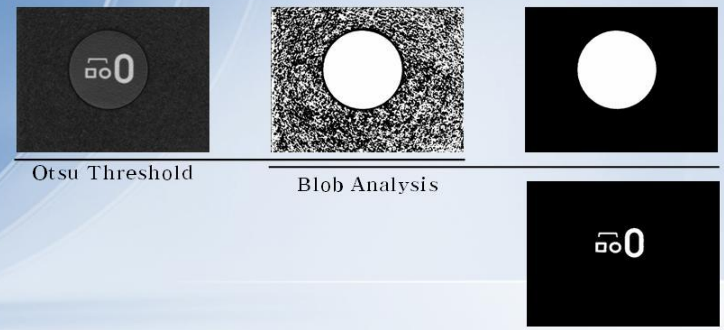
Inspection Object

- Color Grade

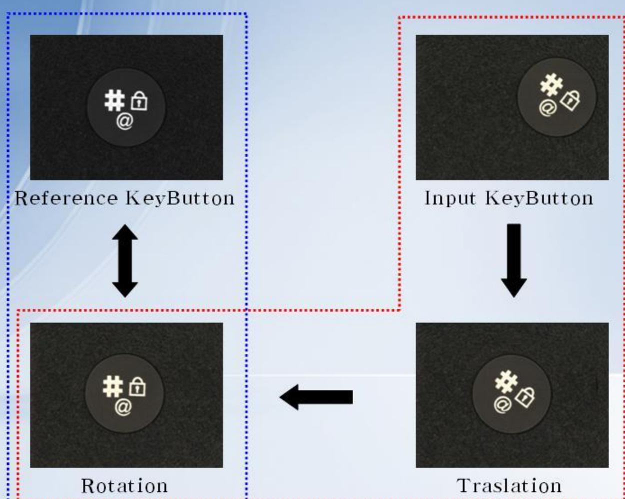
- KeyButton Defect Detection
  - Font Defect Detection
  - Scratch Detection

Font Defect Scratch

KeyButton & Font Area Detection

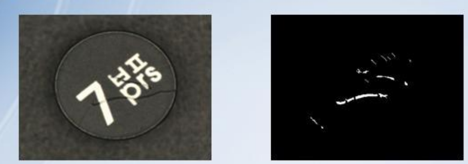


Affine Transformation



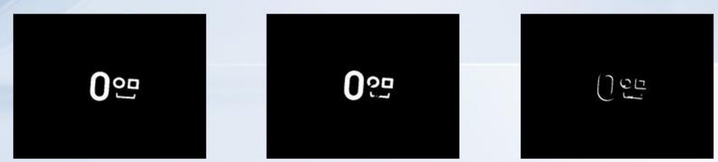
Scratch & Font Defect Detection

- Scratch Detection



Input KeyButton Scratch

- Font Defect Detection

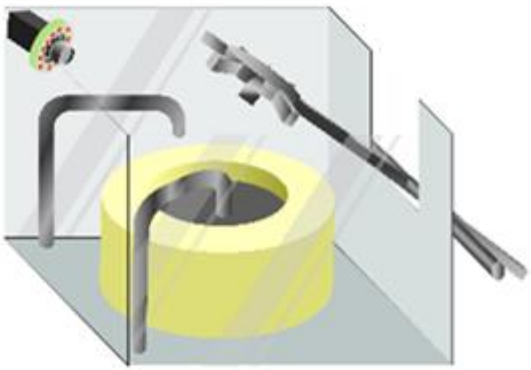


Reference KeyButton Input KeyButton Font Defect Detection

lbg@dongseo.ac.kr

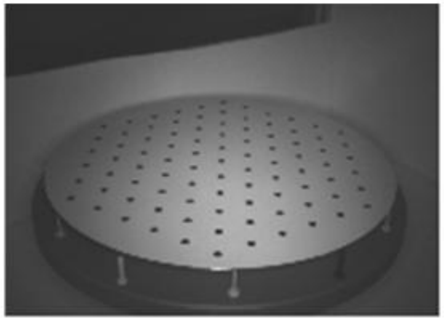
Development of Vision System for Wafer Position Recognition usiong Radial Shape Calibrator

lbg@dongseo.ac.kr 2008.12.03



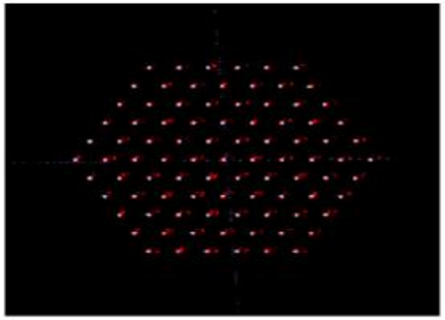
System Overview

Radial Shape Calibrator



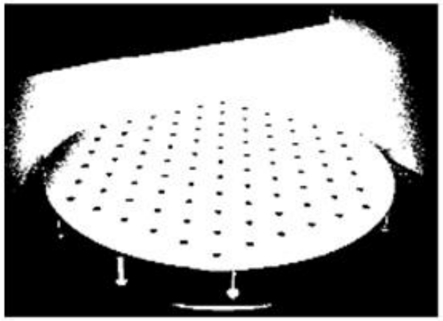
$$x_p = \frac{m_0 x_u + m_1 y_u + m_2}{m_6 x_u + m_7 y_u + 1}$$

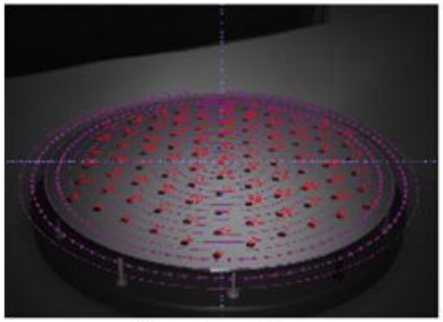
$$y_p = \frac{m_3 x_u + m_4 y_u + m_5}{m_6 x_u + m_7 y_u + 1}$$



Calibration

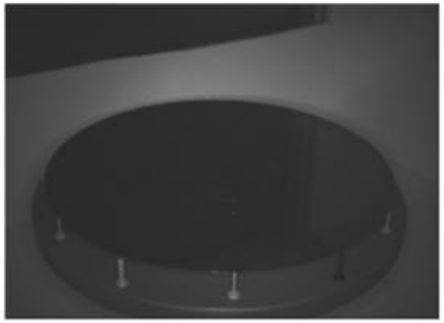
Binary Image



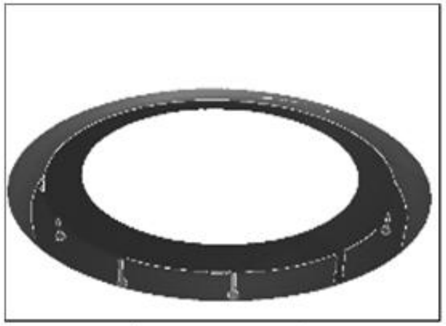


Numbering

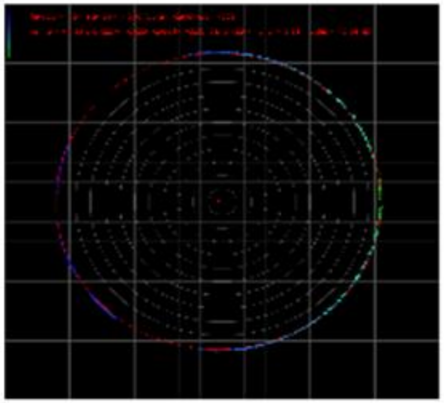
Digital Area Scan Camera



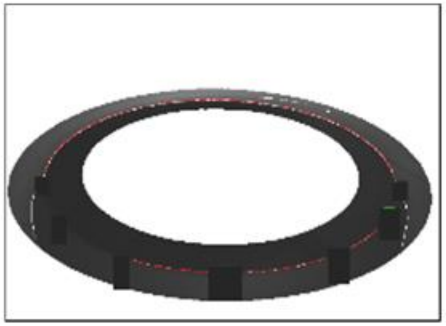
Clipping



Edge Detection



Wafer Circle Estimation



Wafer Edge Detection

Ubiquitous Frontier
DSU
Dongseo University

Image Deformation using Radial Basis Function Interpolation

Jung Hye Kwon, Byung Gook Lee, Jungho Yoon, Jun Jae Lee

kjh@dit.dongseo.ac.kr, lbg@dongseo.ac.kr,
yoon@ewha.ac.kr, joonlee@kmu.ac.kr

The 17-th International Conference on Computer Graphics, Visualization and Computer Vision
February 2-5,2009, Plzen, Czech Republic

Image Deformation

- As one field of computer graphics
- The deformation method of changing image to be wanted by user
  - Used in the filed of computer animation, morphing and medical image
- To perform deformation the user selects some set of handle
  - Points, lines, or grids

Previous Deformation Techniques

- Mesh base method
  - T. Igarashi, T. Moscovich, and J. F. Hughes, "As-rigid-as-possible shape manipulation .", ACM Trans. Graph 2005, 24, 3, pp 1134-1141 (2005).
  - Y. Weng, W. Xu, Y. Wu, K. Zhou, B. Guo, "2D shape deformation using nonlinear least squares Optimization.", The visual computer, pp 653-660(2006).
- Approximation method
  - S. Schaefer, T. McPhail, J. Warren, "Image deformation using moving least squares.", Proceedings of ACM SIGGRAPH , pp. 533-540 (2006).
  - N. Arad, N. Dyn, D.Reisfeld, Y.Yeshurun, "Image warping by radial basis functions :Application to facial expressions", Computer Vision Graphics and Image Processing , p.p 161-172 (1994).

Radial Basis Function

- A function $f:\mathbb{R}^{d_1}\to\mathbb{R}^{d_2}$ is known only at a set of discrete points $U:=\{u_1,u_2,\cdots,u_n\}$ and desired function values $V:=\{v_1,v_2,\cdots,v_n\}$, we can define

$$S_{f,U}(u)=\sum_{i=1}^{n}\alpha_i\phi(\|u-u_i\|)+\sum_{j=1}^{m}\beta_j p_j(u)$$

with the constraints

$$\sum_{i=1}^{n}\alpha_i p_j(u_i)=0,\ j=1,2,\cdots,m$$

Here, $p_j(u)\in\Pi_r^{d_1}$ is the space of polynomial of total degree r in d spatial dimensions

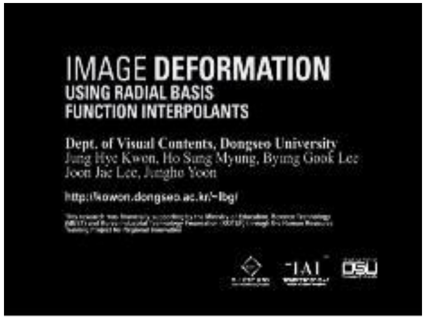
Image deformation using RBF

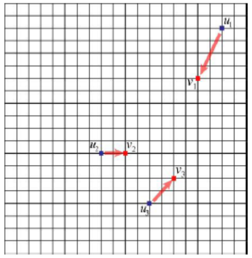
- Since constructing a deformed image from an original one is a mapping from $\mathbb{R}^2$ to $\mathbb{R}^2$, we have given two sets of 2-dimensional data $U:=\{u_1,u_2,\cdots,u_n\}$ and deformed position $V:=\{v_1,v_2,\cdots,v_n\}$. We solve for the radial basis function interpolation $S_{f,U}(u)$, satisfying

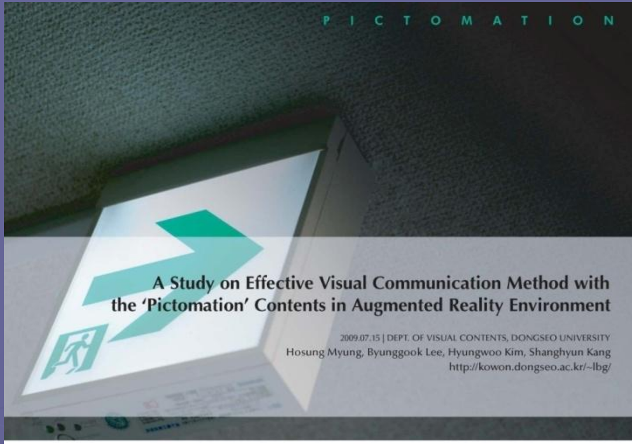
$$S_{f,U}(u_i)=v_i-u_i,\quad i=1,2,\cdots,n.$$

where v_i-u_i is difference vector v .
Finally, we obtain a deformed position

$$v=u+S_{f,U}(u)$$







Definition of pictogram

- The pictogram is a compound word where means the picture and a telegram.
- The pictogram delivers information easily & quickly.

pictogram = picture + telegram

Functions of pictogram

Guidance Function
Public people understand some information easily.

Command Function
The human being must observe.

Conditions of pictogram

Must read quickly, easily and exactly.
Must deliver the meaning easily.
Must be considered the brief expression and an esthetic characteristic.
Must be induced the act of consumer to original intent.
Must be popular, public and convenient to use.

A Study on the 'PICTOMATION' Contents Effective Visual Communication Method in Augmented Reality Environment

Dept. of Visual Contents, Dongseo University
Hosung Myung, Namseok Choi, Hohwan Shin,
Eunkyung Jung, Byunggook Lee, Hyungwoo Kim
http://kowon.dongseo.ac.kr/~lbg/

This research was financially supporting by the Ministry of Education, Science Technology (MEST) and Korea Industrial Technology Foundation (KOTEF) through the Human Resource Training Project for Regional Innovation.

Pictomation using ARToolkit

Ⓐ Marker pattern input
Ⓑ Video output (computer graphics area)
Ⓒ Video output (real world area)

Proposal of the pictomation

Visual elements of pictogram should be expressed and reconstituted in common experience, not creation a new one.

'A **MAN** IS DRINKING **WATER**'
Visual elements : 'Man', 'Water' : [noun]

'A MAN IS **DRINKING** WATER'
Animation elements : 'Drinking' : [verb]

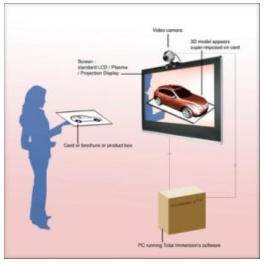
First, I abstracted 'man' and 'water' from linguistic element in 'a man is drinking water' and expressed it as visual elements. Second, I made an animation with behavior elements which is 'drink'.

Proposal of the pictomation

Pictomation = Pictogram + Animation

['DRINKING FOUNTAIN' PICTOMATION]

Augmented Reality



AR(augmented reality) provide vivid 3d information
[http://www.mini.de/webcam]

Thanks

Lee Byung Gook, Professor
Division of Computer Information Engineering
Dongseo University

http://kowon.dongseo.ac.kr/~lbg/
e-mail : lbg@dongseo.ac.kr

uBiquitous fRontier !

fRontier in uBiquitous Computing

fRontier in uBiquitous Education

fRontier in uBiquitous Culture

lbg@dongseo.ac.kr

Background Modeling

Bayesian Modeling of Dynamic Scenes for Object Detection

IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, VOL. 27, NO. 11, NOVEMBER 2005
Yaser Sheikh, and Mubarak Shah by lbg@dongseo.ac.kr 2009.02.25

Background $\varphi_b = \{y_1, y_2, \cdots, y_n\}, y = (r, g, b, x, y) \in \mathbb{R}^5$

$$P(x \mid \psi_b) = \frac{1}{n}\sum_{i=1}^{n} \varphi_H(x - y_i)$$

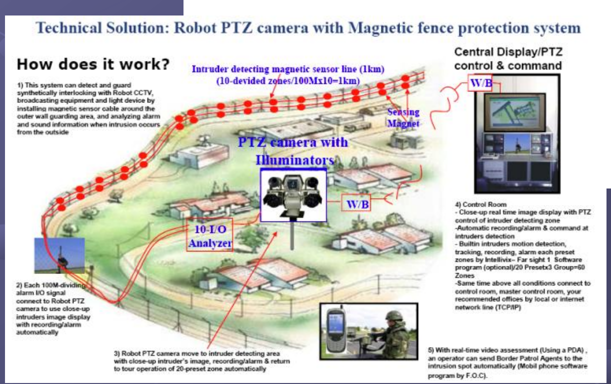
d-variate Gaussian density

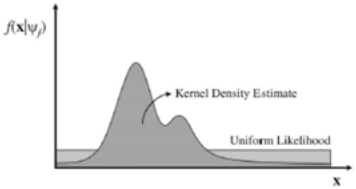
$$\varphi_H^{(N)}(x) = |H|^{-1/2} (2\pi)^{-d/2} \exp(-\frac{1}{2} x^T H^{-1} x)$$

Foreground $\varphi_f = \{z_1, z_2, \cdots, z_m\}$

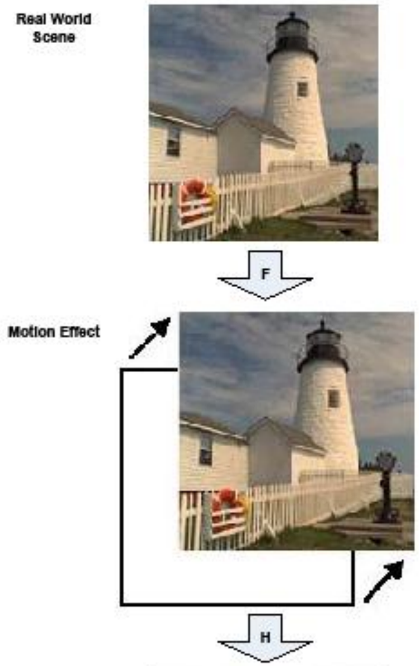
$$P(x \mid \psi_f) = \alpha\gamma + (1-\alpha)m^{-1}\sum_{i=1}^{m} \varphi_H(x - z_i)$$

Likelihood ratio classifier $\tau = -\ln \frac{P(x \mid \psi_b)}{P(x \mid \psi_f)}$





SuperResolution



Fast and Robust Multiframe Super Resolution

IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 13, NO. 10, OCTOBER 2004
Sina Farsiu, M. Dirk Robinson, Michael Elad, and Peyman Milanfar
by lbg@dongseo.ac.kr 2009.02.26

$$\underline{Y}_k = D_k H_k F_k \underline{X} + \underline{V}_k$$

$$\underline{X} = \underset{\underline{X}}{ArgMin}\left[\sum_{k=1}^{N}\left\|D_k H_k F_k \underline{X} - \underline{Y}_k\right\|_p^p\right] \qquad \underline{X} = \underset{\underline{X}}{ArgMin}\left[\sum_{k=1}^{N}\left\|D_k H_k F_k \underline{X} - \underline{Y}_k\right\|_p^p + \lambda \Upsilon(\underline{X})\right]$$

$$\Upsilon_T(\underline{X}) = \left\|\Gamma \underline{X}\right\|_2^2 \qquad \Upsilon_{TV}(\underline{X}) = \left\|\nabla \underline{X}\right\|_1 \qquad \Upsilon_{BTV}(\underline{X}) = \underbrace{\sum_{l=-P}^{P}\sum_{m=0}^{P}}_{l+m\geq 0} \alpha^{|m|+|l|}\left\|\underline{X} - S_x^l S_y^m \underline{X}\right\|_1$$

$$\underline{X}_{n+1} = \underline{X}_n - \beta\{\sum_{k=1}^{N} F_k^T H_k^T D_k^T sign(D_k H_k F_k \underline{X}_n - \underline{Y}_k) + \lambda \underbrace{\sum_{l=-P}^{P}\sum_{m=0}^{P}}_{l+m\geq 0} \alpha^{|m|+|l|}[I - S_y^{-m} S_x^{-l}] sign(\underline{X}_n - S_x^l S_y^m \underline{X}_n)\}$$

Robust Method

$$\underline{X}_{n+1} = \underline{X}_n - \beta\{H^T A^T sign(AH\underline{X}_n - A\underline{Z}) + \lambda \underbrace{\sum_{l=-P}^{P}\sum_{m=0}^{P}}_{l+m\geq 0} \alpha^{|m|+|l|}[I - S_y^{-m} S_x^{-l}] sign(\underline{X}_n - S_x^l S_y^m \underline{X}_n)\}$$

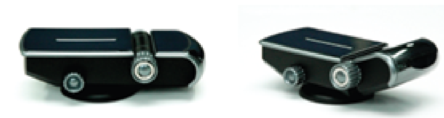
Fast Robust Method

lbg@dongseo.ac.kr

U-Pointer 전자 판서 시스템

Byung-Gook Lee lbg@dongseo.ac.kr

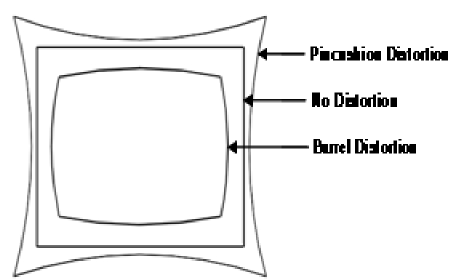
2008.12.29~2009.02.11



- U-Pointer Calibration
- Calibration을 위한 효율적인 feature point 위치 선정
- 광각렌즈 적용 Calibration 오차 보정
- 단 초점 projector U-Pointer의 좌표 매핑 알고리즘
- 유연한 판서를 위한 세부 알고리즘

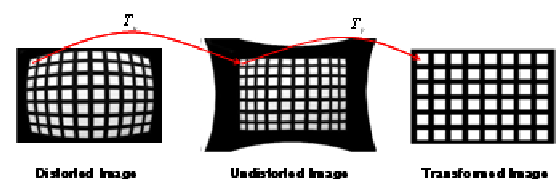
Lens Distortion

어안렌즈에 따라 생기는 왜곡의 종류



Zoom Lens Distortion

줌 렌즈(Zoom Lens)를 사용하면 Pincushion Distortion이 생기고, 어안 렌즈(Wide Angle Lens)를 사용하면 Barrel Distortion이 생긴다. 따라서 기존의 방법과 다르게 렌즈의 왜곡을 먼저 보정한 후 이미지의 왜곡을 보정하면 좀 더 정확한 결과가 나올 것이다. 아래의 그림은 렌즈의 왜곡 보정과 이미지의 보정을 도식화한 그림이다.



Calibration

위와 같은 과정을 거치기 위해서는 아래와 같은 수식을 사용한다. 아래의 식을 사용하기 위해서 θset을 구하여야 한다.

$$I_i(i,j) = I_d(x(\Theta,i,j), y(\Theta,i,j))$$

θset은 그림 2의 T_u와 T_p에서 각각 구해야 한다. 먼저 T_u를 구하는 식은 아래와 같다.

$$x_u = C_x + (x_d - C_x) f_2(r_d^2) = C_x + (x_d - C_x)(1 + k_1 r_d^2 + k_2 r_d^4 + k_3 r_d^6)$$

$$y_u = C_y + (y_d - C_y) f_2(r_d^2) = C_x + (y_d - C_y)(1 + k_1 r_d^2 + k_2 r_d^4 + k_3 r_d^6)$$

$$r_d^2 = (x_d - C_x)^2 (y_d - C_y)^2$$

여기서 이미지의 왜곡 중심 (C_x, C_y)와 K에 관한 내용을 모르기 때문에 이를 $\Theta^d = \{C_x, C_y, K_1, K_2, K_3\}$로 정의 한다.

T_p를 구하는 식은 아래와 같다. 우리는 아래의 식에서 m 값을 모르기 때문에 $\Theta^p = \{m_0, m_1, m_2, m_3, m_4, m_5, m_6, m_7\}$ 로 정의 한다.

$$M = \begin{bmatrix} m_0 & m_1 & m_2 \\ m_3 & m_4 & m_5 \\ m_6 & m_7 & 1 \end{bmatrix}$$

$$x_p = \frac{m_0 x_u + m_1 y_u + m_2}{m_6 x_u + m_7 y_u + 1}$$

$$y_p = \frac{m_3 x_u + m_4 y_u + m_5}{m_6 x_u + m_7 y_u + 1}$$

위에서 구한 θ^d와 θ^p의 합집합을 θ 라고 정의 한다. 따라서 $\Theta = \Theta^d \cup \Theta^p$ 로 정의됨을 알 수 있다. 그리고 아래의 수식을 이용하여 error가 가장 최소가 될 때의 값을 획득하여 Calibration 하게 되면 그림 2와 같은 이미지 보정을 할 수 있다.

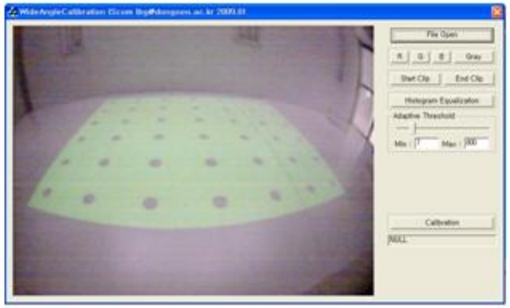
$$\epsilon_{xk} = x_p(\Theta, x_{dk}, y_{dk}) - x_{rk}$$

$$\epsilon_{yk} = y_p(\Theta, x_{dk}, y_{dk}) - y_{rk}$$

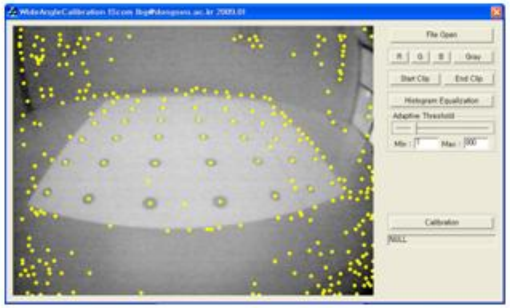
$$E(\Theta) = \sum_{k=1}^{n} ((\epsilon_{xk})^2 + (\epsilon_{yk})^2)$$

$$\Theta = \arg\min E(\Theta)$$

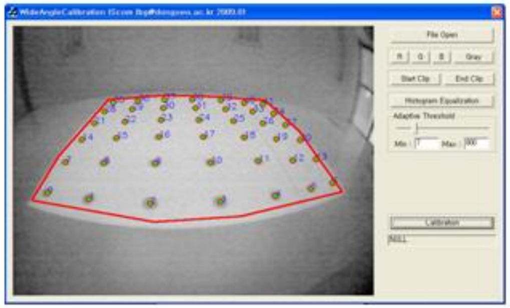
Calibrator Image



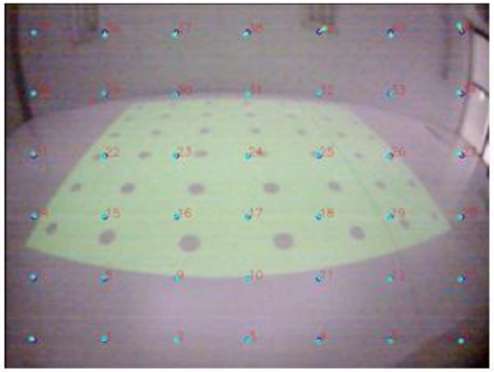
Blob Analysis



Clipping & Numbering



Calibration Result



A New Class of Non-Stationary Interpolatory Subdivision Scheme based on Exponential Polynomials

Yoo-Joo Choi[a], Yeon-Ju Lee[†], Jungho Yoon[†], Byung-Gook Lee[‡], Young J. Kim[†]
[a]Seoul University of Venture and Information, [†]Ewha Womans University, [‡]Dongseo University

INTRODUCTION

- The Butterfly scheme, which is a stationary interpolatory scheme based on cubic polynomial interpolation, may not accurately reproduce highly oscillatory triangular mesh data. It has been shown that a non-stationary subdivision scheme based on exponential or trigonometric polynomials with a suitable frequency factor works more effectively on highly oscillatory signals than stationary interpolatory scheme based on polynomials.
- We introduce a new class of non-stationary interpolatory subdivision schemes that can exactly reproduce a complicated, parametric surface including exponential polynomials in the sense of complex numbers. In our scheme, exponetial polynomials constitute a shift-invariant space and the mask of our subdivision scheme is constructed in such a way as to find the values of the exponential polynomials that correspond to the initial control points.

METHODS

Basic Interpolatory Subdivision Scheme

Construction Rules

- **Parametric surface** $F(u,v)$ on a planar parametric domain $\Omega \subset R^2$ can contain polynomial, trigonometirc and exponential functions.
- **Shift invariant space S**:

$$f \in S \text{ imples } f(\cdot - \alpha) \in S, \quad \alpha \in Z \qquad (1)$$

$$\phi(u,v) = u^{\alpha 1} v^{\alpha 2} e^{\beta 1 u} e^{\beta 2 v}, \quad (u,v) \in \Omega \subset R^2, \qquad (2)$$

where $\alpha_i = 0, ..., \mu$ for some non-negative integer μ and complex numbers $\beta_i (i=1,2)$.

$$S = span\{\phi_n(u,v) \mid n = 1, ..., N\}$$

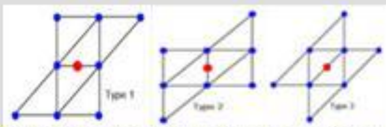
$$\phi_n = (p2^{-k-1}) = \sum_{\ell \in \kappa} a^{[k]}_{p-2\ell} \phi_n(\ell 2^{-k}), \quad \phi_n \in S, k = 0,1,..., \qquad (3)$$

where $p/2$ is the insertion point in the triangulation at level 0 and κ is its corresponding stencil.

Example (Sphere and Torus)

S := span{ sin u, cos u, sin v, cos v, sin u sin v, cos u cos v, sin u cos v, cos u sin v}

The three types of refinement rule are obtained by solving the linear system of Eq. 3 using the butterfly stencil.

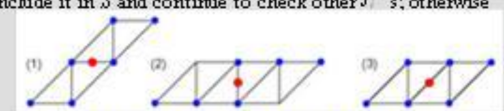


Subdivision stencils based on butterfly shapes

Reconstruction of Complicated Surfaces

Finding the shift Invariant Space in the smallest dimension

1. Initially, we set S to be the same as span a finite collection of functions B, whose elements generate F via a linear combination.
2. We pick an element f from S and perform a constant shifting of f_i as shown in Eq. 1.
3. We enumerate all the monomials f_i^j constituting $f_i(\cdot - \alpha)$.
4. For each f_i^j, if it can be generated by the current S, then we do not include it in S and continue to check other f_i^j s; otherwise we add it to S.
6. Repeat between 2 and 4 until there is no possible new addition to S.
7. Finally, we have the shift invariant space S := span S.

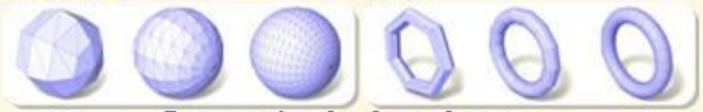


Type 1, 2 and 3 stencils for a möbius strip

Stencil Generation Algorithm

- We construct a stencil starting from a newly inserted point p. First, we choose two stencil verteces (say v_1 and v_2) connected to p and continue to search for other stencil vertices by expanding v_1 and v_2 to their neighborhood while keeping the stencil shape symmetric.
- the n-ring neighbors of v are defined as vertices that are reachable from v by traversing no more than n edges in the mesh.
- This search process continues until the associated matrix B satisfies dim B = dim S.

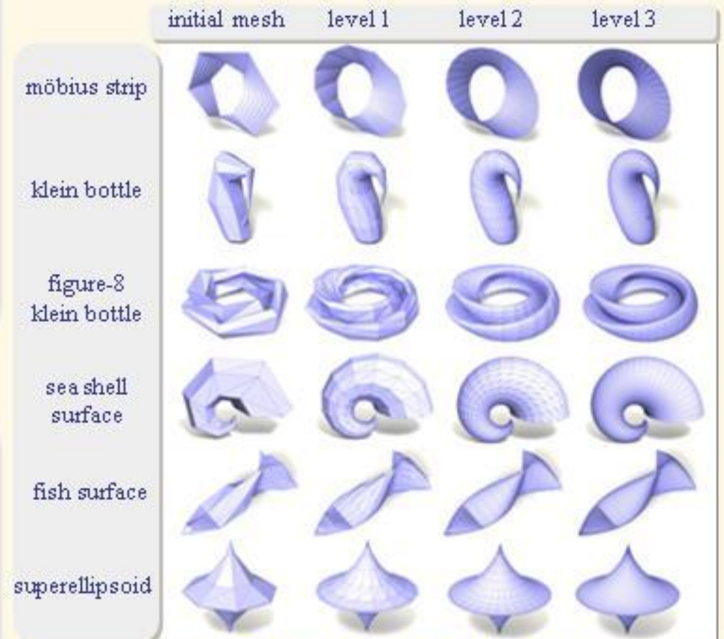
RESULTS



Reconstruction of a sphere and a torus

(a) our scheme (b) the Butterfly scheme

Exact reconstruction of a torus.



Reconstruction of complicated surfaces.

CONCLUSION

- The shift-invariant property ensures that local weights corresponding to local control points are invariant, regardless of their locations, which ultimately enables parametric surfaces to be generated exactly.
- A complicated surface generated from both polynomials and trigonometric polynomials can be exactly reproduced from a set of coarse initial points

CONTACT | Prof. Young J. Kim, Ewha Womans University. E-MAIL. kimy@ewha.ac.kr TEL. +82-2-3277-4068 http://graphics.ewha.ac.kr

A New Class of Non-Stationary Interpolatory Subdivision Scheme based on Exponential Polynomials

Yoo-Joo Choi[a], Yeon-Ju Lee[†], Jungho Yoon[†], Byung-Gook Lee[‡], Young J. Kim[†]
[a]Seoul University of Venture and Information, [†]Ewha Womans University, [‡]Dongseo University

INTRODUCTION

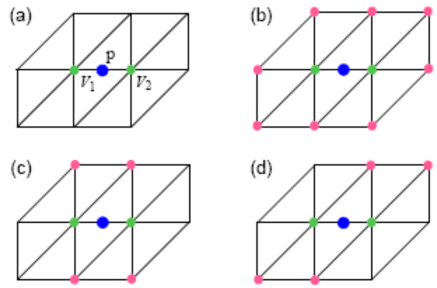


Fig. 5. *Type 1 stencil for a Möbius strip. (a) The newly inserted point p is colored blue and the two green points are chosen as the immediate neighbors (v_1, v_2). (b) The one-ring neighbors of v_1, v_2 are colored pink. (c) A candidate stencil, turns out to be invalid. (d) A valid stencil.*

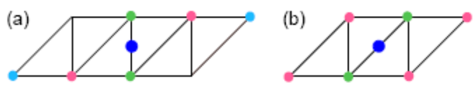


Fig. 6. *Type 2 and 3 stencils for a Möbius strip.*

Example 2. (Möbius strip) The parametric equation $F(u,v)$ for Möbius strip is given by

$$x(u,v) = a\cos u + v\cos(u/2),$$
$$y(u,v) = a\sin u + v\cos(u/2),$$
$$z(u,v) = v\sin(u/2),$$

where $0 \le u \le 2\pi$, $-w \le v \le w$, and w and a are constants.

Then the space that generates the parametric surface with the smallest dimension is

$$B := \{\sin u, \cos u, v\sin(u/2), v\cos(u/2)\},$$

and the corresponding shift-invariant space S that generates $F(u,v)$ is

$$S := \mathrm{span}\{\sin u, \cos u, \sin(u/2), \cos(u/2), v\sin(u/2), v\cos(u/2)\}.$$

nay not accurately
e based on exponential
signals than stationary

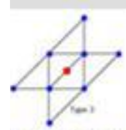
omplicated, parametric
nomials constitute a
s of the exponential

and exponential functions.

(1)

(2)

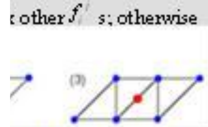
(3)



butterfly shapes

a a linear combination.

: other f s; otherwise



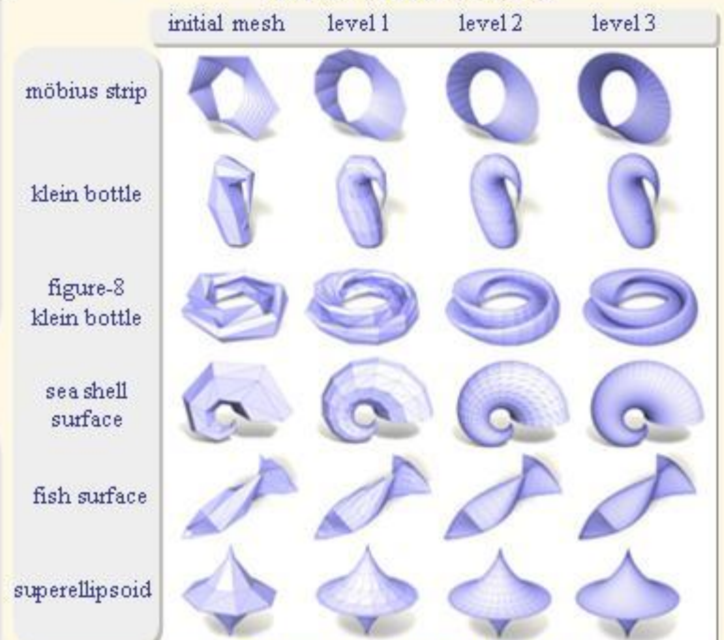
: a möbius strip
y v_i and v_j) connected
keeping the stencil

dges in the mesh.

RESULTS

Reconstruction of a sphere and a torus

(a) our scheme (b) the Butterfly scheme
Exact reconstruction of a torus.



Reconstruction of complicated surfaces.

CONCLUSION

- The shift-invariant property ensures that local weights corresponding to local control points are invariant, regardless of their locations, which ultimately enables parametric surfaces to be generated exactly.
- A complicated surface generated from both polynomials and trigonometric polynomials can be exactly reproduced from a set of coarse initial points

CONTACT | Prof. Young J. Kim, Ewha Womans University. E-MAIL. kimy@ewha.ac.kr TEL. +82-2-3277-4068 http://graphics.ewha.ac.kr

A New Class of Non-Stationary Interpolatory Subdivision Scheme based on Exponential Polynomials

Yoo-Joo Choi[*], Yeon-Ju Lee[†], Jungho Yoon[†], Byung-Gook Lee[‡], Young J. Kim[†]
[*]Seoul University of Venture and Information, [†]Ewha Womans University, [‡]Dongseo University

INTRODUCTION

- The Butterfly scheme, which is a stationary interpolatory scheme based on cubic polynomial interpolation, may not accurately reproduce highly oscillatory triangular mesh data. It has been shown that a non-stationary subdivision schem or trigonometric polynomicals with a suitable frequency factor works more effectively on highly oscillatory interpolatory scheme based on polynomials.
- We introduce a new class of non-stationary interpolatory subdivision schemes that can exactly reproduce a c surface including exponential polynomials in the sense of complex numbers. In our scheme, exponetial pol shift-invariant space and the mask of our subdivision scheme is constructed in such a way as to find the valu polynomials that correspond to the initial control points.

METHODS

Basic Interpolatory Subdivision Scheme

Construction Rules

- **Parametric surface** $F(u,v)$ on a planar parametric domain $\Omega \subset R^2$ can contain polynomial, trigonometirc
- **Shift invariant space S**:

$f \in S$ implies $f(\cdot - \alpha) \in S, \quad \alpha \in Z$

$\phi(u,v) = u^{\alpha_1} v^{\alpha_2} e^{\beta_1 u} e^{\beta_2 v}, \quad (u,v) \in \Omega \subset R^2,$
where $\alpha_i = 0,\ldots,\mu$ for some non-negative integer μ and complex numbers $\beta_i (i=1,2)$.

$S = span\{\phi_n(u,v) \mid n = 1,\ldots,N\}$

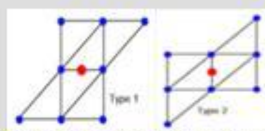
$\phi_n = (p2^{-k-1}) = \sum_{\ell \in \kappa} a^{[k]}_{p-2\ell} \phi_n(\ell 2^{-k}), \quad \phi_n \in S, k = 0,1,\ldots,$

where $p/2$ is the insertion point in the triangulation at level 0 and κ is its corresponding stencil.

Example (Sphere and Torus)

S := span{ $\sin u$, $\cos u$, $\sin v$, $\cos v$, $\sin u \sin v$, $\cos u \cos v$, $\sin u \cos v$, $\cos u \sin v$ }

The three types of refinement rule are obtained by solving the linear system of Eq. 3 using the butterfly stencil.

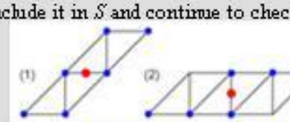


Subdivision stencils based on

Reconstruction of Complicated Surfaces

Finding the shift Invariant Space in the smallest dimension

1. Initially, we set S to be the same as span a finite collection of functions B, whose elements generate F v
2. We pick an element f from S and perform a constant shifting of f_i as shown in Eq. 1.
3. We enumerate all the monomials f_i^j constituting $f_i(\cdot - \alpha)$.
4. For each f_i^j, if it can be generated by the current S, then we do not include it in S and continue to chec we add it to S.
6. Repeat between 2 and 4 until there is no possible new addition to S.
7. Finally, we have the shift invariant space S := span S.

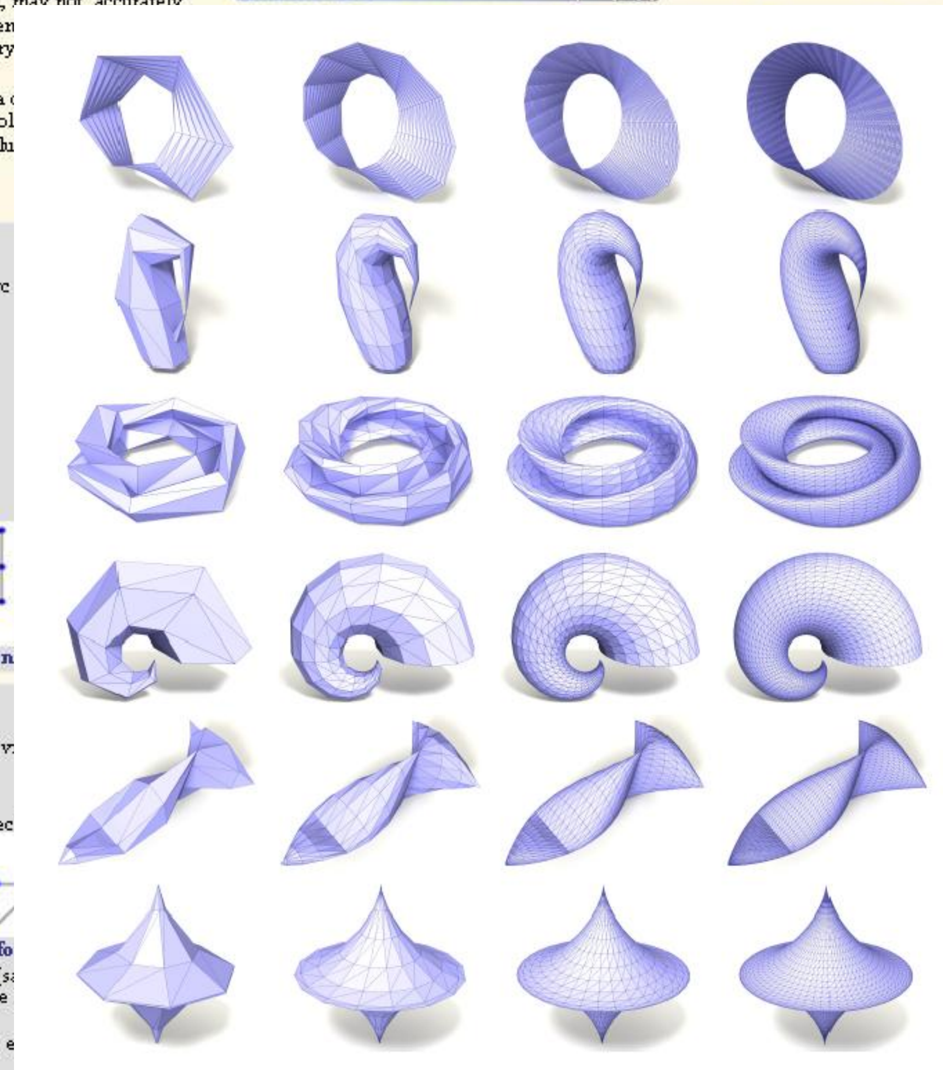


Type 1, 2 and 3 stencils fo

Stencil Generation Algorithm

- We construct a stencil starting from a newly inserted point p. First, we choose two stencil verteces (s to p and continue to search for other stencil vertices by expanding v_1 and v_2 to their neighborhood while shape symmetric.
- the n-ring neighbors of v are defined as vertices that are reachable from v by traversing no more than n e
- This search process continues until the associated matrix B satisfies dim B = dim S.

RESULTS



polynomials can be exactly reproduced from a set of coarse initial points

CONTACT | Prof. Young J. Kim, Ewha Womans University. E-MAIL. kimy@ewha.ac.kr TEL. +82-2-3277-4068 http://graphics.ewha.ac.kr

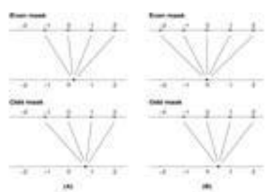
Stationary Subdivision Schemes Reproducion Polynomials

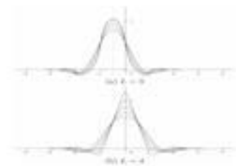
Sung Woo Choi, Byung-Gook Lee, Yeon Ju Lee, Jungho Yoon
swchoi@dnksung.ac.kr, lbg.@dongseo.ac.kr,
lee08@ewhain.net, yoon@ewha.ac.kr

Sixth International Conference on
Curves and Surfaces
organized by SMAI-AFA

Avignon - FRANCE
June 29 - July 5, 2006

- Subdivision Scheme
- Construction of Polynomial Reproducing Scheme
- Smoothness of the scheme
- Approximation order of the scheme
- Example





Stationary Subdivision Schemes Reproducion Polynomials

Sung Woo Choi, Byung-Gook Lee, Yeon Ju Lee, Jungho Yoon
swchoi@dnts.snu.ac.kr, bg.@dongseo.ac.kr,
lee08@ewhain.net, yoon@ewha.ac.kr

Case 1: L is even, i.e., $L =: 2N$.

For the construction of the odd mask, we use the stencil of $L = 2N$ points to reproduce polynomials in $\Pi_{<L}$. That is, the odd mask $\{a_{1-2n}\colon n = -N+1, \ldots, N\}$ is obtained by solving the linear system:

$$p_\ell\left(\frac{1}{2}\right) = \sum_{n=-N+1}^{N} a_{1-2n}\, p_\ell(n), \quad \ell = 1, \ldots, L, \tag{4}$$

where $p_1, \ldots, p_L$ is a basis of $\Pi_{<L}$. Obviously, there is a unique solution of the linear system (4), and it is exactly the same as the odd mask of the L-point Deslauriers–Dubuc scheme. Next, for the construction of the even mask, we use the stencil of $L + 1 = 2N + 1$ points to reproduce polynomials in $\Pi_{<L}$. That is, the even mask $\{a_{2n}\colon n = -N, \ldots, N\}$ is obtained by solving the linear system:

$$p_\ell(0) = \sum_{n=-N}^{N} a_{-2n}\, p_\ell(n), \quad \ell = 1, \ldots, L. \tag{5}$$

This is an underdetermined system of $L + 1$ unknowns in L equations so that there is one degree of freedom which will be used as a tension parameter ω. One may set

$$\omega := a_{2N}. \tag{6}$$

If $\omega = 0$, then the scheme becomes the L-point Deslauriers–Dubuc interpolatory scheme, as we will see later in Example 1. Note that the support of the mask is $\mathbb{Z} \cap [-L, \ldots, L]$. As an example, the stencil for the case $L = 4$ is described in Fig. 1(B).

Case 2: L is odd, i.e., $L =: 2N + 1$.

On the purpose of obtaining symmetric rules, we employ $L + 1 = 2(N + 1)$-point scheme reproducing polynomials in $\Pi_{<L}$, and define new (refined) values at $\frac{1}{4}$ and $\frac{3}{4}$ locations between successive old points. Based on this idea, the masks $\{a_{j-2n}\colon n = -N, \ldots, N+1\}$ with $j = 0, 1$ can be given by solving the linear systems: For the even mask $\{a_{2n}\colon n \in \mathbb{Z}\}$,

$$p_\ell\left(\frac{1}{4}\right) = \sum_{n=-N}^{N+1} a_{-2n}\, p_\ell(n), \quad \ell = 1, \ldots, L, \tag{7}$$

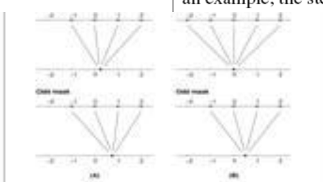
where $p_1, \ldots, p_L$ is a basis of $\Pi_{<L}$. Next, for the odd mask $\{a_{1-2n}\colon n = -N, \ldots, N+1\}$,

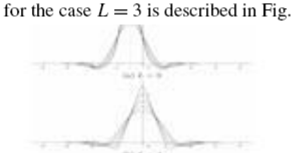
$$p_\ell\left(\frac{3}{4}\right) = \sum_{n=-N}^{N+1} a_{1-2n}\, p_\ell(n), \quad \ell = 1, \ldots, L. \tag{8}$$

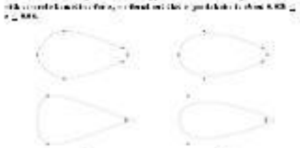
Then the obtained subdivision rule satisfies the following relation

$$a_{-2n} = a_{2(n-1)+1}, \quad n = -N, \ldots, N+1,$$

and hence, the basic limit function becomes also symmetric. Each of the systems (7) and (8) consists of $L + 1$ unknowns in L equations and eventually has one degree of freedom which is used as the tension parameter ω. One may set $\omega := a_{2N}$ and $\omega := a_{-2N-1}$ for (7) and (8) respectively. The support of the mask is $\mathbb{Z} \cap [-L-1, \ldots, L]$. As an example, the stencil for the case $L = 3$ is described in Fig. 1(A).







Stationary Subdivision Schemes Reproducion Polynomials

Sung Woo Choi, Byung-Gook Lee, Yeon Ju Lee, Jungho Yoon
swchoi@duksung.ac.kr, lbg@dongseo.ac.kr,
lee08@ewhain.net, yoon@ewha.ac.kr

Case 1: L is even, i.e., $L =: 2N$.
For the construction of the odd mask, we use the stencil of $L = 2N$ points to reproduce polynomials in $\Pi_{<L}$. That is, the odd mask $\{a_{1-2n}\colon n = -N+1, \ldots, N\}$ is obtained by solving the linear system:

$$p_\ell\left(\frac{1}{2}\right) = \sum_{n=-N+1}^{N} a_{1-2n}\, p_\ell(n), \quad \ell = 1, \ldots, L, \tag{4}$$

where $p_1, \ldots, p_L$ is a basis of $\Pi_{<L}$. Obviously, there is a unique solution of the linear system (4), and it is exactly the same as the odd mask of the L-point Deslauriers–Dubuc scheme. Next, for the construction of the even mask, we use the stencil of $L+1 = 2N+1$ points to reproduce polynomials in $\Pi_{<L}$. That is, the even mask $\{a_{2n}\colon n = -N, \ldots, N\}$ is obtained by solving the linear system:

$$p_\ell(0) = \sum_{n=-N}^{N} a_{-2n}\, p_\ell(n), \quad \ell = 1, \ldots, L. \tag{5}$$

This is an underdetermined system of $L+1$ unknowns in L equations so that there is one degree of freedom which will be used as a tension parameter ω. One may set

$$\omega := a_{2N}. \tag{6}$$

If $\omega = 0$, then the scheme becomes the L-point Deslauriers–Dubuc interpolatory scheme, as we will see later in Example 1. Note that the support of the mask is $\mathbb{Z} \cap [-L, \ldots, L]$. As an example, the stencil for the case $L = 4$ is described in Fig. 1(B).

Case 2: L is odd, i.e., $L =: 2N+1$.
On the purpose of obtaining symmetric rules, we employ $L+1 = 2(N+1)$-point scheme reproducing polynomials in $\Pi_{<L}$, and define new (refined) values at $\frac{1}{4}$ and $\frac{3}{4}$ locations between successive old points. Based on this idea, the masks $\{a_{j-2n}\colon n = -N, \ldots, N+1\}$ with $j = 0, 1$ can be given by solving the linear systems: For the even mask $\{a_{2n}\colon n \in \mathbb{Z}\}$,

$$p_\ell\left(\frac{1}{4}\right) = \sum_{n=-N}^{N+1} a_{-2n}\, p_\ell(n), \quad \ell = 1, \ldots, L, \tag{7}$$

where $p_1, \ldots, p_L$ is a basis of $\Pi_{<L}$. Next, for the odd mask $\{a_{1-2n}\colon n = -N, \ldots, N+1\}$,

$$p_\ell\left(\frac{3}{4}\right) = \sum_{n=-N}^{N+1} a_{1-2n}\, p_\ell(n), \quad \ell = 1, \ldots, L. \tag{8}$$

Then the obtained subdivision rule satisfies the following relation

$$a_{-2n} = a_{2(n-1)+1}, \quad n = -N, \ldots, N+1,$$

and hence, the basic limit function becomes also symmetric. Each of the systems (7) and (8) consists of $L+1$ unknowns in L equations and eventually has one degree of freedom which is used as the tension parameter ω. One may set $\omega := a_{2N}$ and $\omega := a_{-2N-1}$ for (7) and (8) respectively. The support of the mask is $\mathbb{Z} \cap [-L-1, \ldots, L]$. As an example, the stencil for the case $L = 3$ is described in Fig. 1(A).

The general forms of the masks of S_L. The last two columns indicate the maximum smoothness of S_L and the corresponding ranges of ω, which are obtained by computing $\|(\frac{1}{2}S_L)^{13}\|_\infty < 1$ with MAPLE 8, digits = 15

L	Mask	C^ν	Range of w
1	$[w, 1-w, 1-w, w]$	C^1	$w = \frac{1}{4}$
2	$[w, \frac{1}{2}, 1-2w, \frac{1}{2}, w]$	C^2	$w = \frac{1}{8}$
3	$[-w, -\frac{3}{32}+w, \frac{5}{32}+3w, \frac{15}{16}-3w, \frac{15}{16}-3w, \frac{5}{32}+3w, -\frac{3}{32}+w, -w]$	C^2	$0.030799 < w < 0.085930$
4	$[-w, -\frac{1}{16}, 4w, \frac{9}{16}, 1-6w, \frac{9}{16}, 4w, -\frac{1}{16}, -w]$	C^3	$0.020262 < w < 0.044039$
5	$[w, \frac{35}{2048}-w, -\frac{45}{2048}-5w, -\frac{63}{512}+5w, \frac{105}{512}+10w, \frac{945}{1024}-10w,$ $\frac{945}{1024}-10w, \frac{105}{512}+10w, -\frac{63}{512}+5w, -\frac{45}{2048}-5w, \frac{35}{2048}-w, w]$	C^3	$0.006261 < w < 0.016737$
6	$[w, \frac{3}{256}, -6w, -\frac{25}{256}, 15w, \frac{150}{256}, 1-20w, \frac{150}{256}, 15w, -\frac{25}{256}, -6w, \frac{3}{256}, w]$	C^4	$0.004495 < w < 0.008855$
7	$[-w, -\frac{231}{65536}+w, \frac{273}{65536}+7w, \frac{1001}{32768}-7w, -\frac{1287}{32768}-21w, -\frac{9009}{65536}+21w,$ $\frac{15015}{65536}+35w, \frac{15015}{16384}-35w, \frac{15015}{16384}-35w, \frac{15015}{65536}+35w,$ $-\frac{9009}{65536}+21w, -\frac{1287}{32768}-21w, \frac{1001}{32768}-7w, \frac{273}{65536}+7w, -\frac{231}{65536}+w, -w]$	C^4	$0.001598 < w < 0.003228$
8	$[-w, -\frac{5}{2048}, 8w, \frac{49}{2048}, -28w, -\frac{245}{2048}, 56w, \frac{1225}{2048}, 1-70w,$ $\frac{1225}{2048}, 56w, -\frac{245}{2048}, -28w, \frac{49}{2048}, 8w, -\frac{5}{2048}, -w]$	C^5	$0.001132 < w < 0.001754$
9	$[w, \frac{6435}{8388608}-w, -\frac{7293}{8388608}-9w, -\frac{8415}{1048576}+9w, \frac{9945}{1048576}+36w,$ $\frac{85085}{2097152}-36w, -\frac{109395}{2097152}-84w, -\frac{153153}{1048576}+84w,$ $\frac{255255}{1048576}+126w, \frac{3828825}{4194304}-126w, \frac{3828825}{4194304}-126w, \frac{255255}{1048576}+126w,$ $-\frac{153153}{1048576}+84w, -\frac{109395}{2097152}-84w, \frac{85085}{2097152}-36w,$ $\frac{9945}{1048576}+36w, -\frac{8415}{1048576}+9w, -\frac{7293}{8388608}-9w, \frac{6435}{8388608}-w, w]$	C^5	$0.000394 < w < 0.000629$
10	$[w, \frac{35}{65536}, -10w, -\frac{405}{65536}, 45w, \frac{567}{16384}, -120w, -\frac{2205}{16384}, 210w,$ $\frac{19845}{32768}, -252w+1, \frac{19845}{32768},$ $210w, -\frac{2205}{16384}, -120w, \frac{567}{16384}, 45w, -\frac{405}{65536}, -10w, \frac{35}{65536}, w]$	C^6	$0.000301 < w < 0.000355$