



FURQAN ULLAH

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RESEARCH INTERESTS

3D Computer Vision, Computer Graphics, 3D Reconstruction, 3D Measurement Methods and Systems, Structured Light Technology, 3D Laser Scanning, Active and Passive Stereo Vision, Real-time 3D (Rendering, Visualization, and Applications), Computational Geometry, Geometric Modeling and Processing, Virtual and Haptic Realities, Medical Image Rendering and Processing, Machine Learning, C++ and Software Development

WORK EXPERIENCE

- 2017 - 2018 **Postdoctoral Fellow**, Dhofar University, Salalah, Sultanate of Oman.
Department: Computer Science (CS)
Project: Intelligent Monitoring Systems
- 2016 - 2017 **Assistant Professor**, University of Central Punjab (UCP), Lahore, Pakistan.
Department: Computer Science (CS)
BS Courses: Object Orientated Paradigm (C++), Computer Graphics
MS Courses: Visual Computing
- 2015 - 2016 **Postdoctoral Scholar**, University of California Berkeley (UCB), USA.
Department: Electrical Engineering and Computer Sciences (EECS)
Project: Development of a dynamic human musculoskeletal modeling platform
Supervisor: Prof. Ruzena Bajcsy
- 2014 - 2015 **Vision Team Manager/Head**, Daemyung TS Co., Ltd., S. Korea. (Hyundai Motors)
Responsibilities: Development of 2D-3D vision inspection systems, development of Micro-scale 3D scanning systems
- 2013 - 2014 **Software Engineer**, Orapix Co. Ltd, Seoul, S. Korea.
Responsibilities: Development of 3D scanning systems including software and hardware, development of dentistry applications
- 2011 - 2014 **Lab Instructor**, Intelligent Manufacturing Lab, Myongji University, South Korea.
Responsibilities: 3D Computer Vision, Computer Graphics
- 2009 - 2010 **CAD/CAM/CAE Engineer**, Marriala Technologies Pvt. Ltd., Lahore, Pakistan.
Responsibilities: Software development, 3D scanning, CAD/CAM software and simulator, RP manufacturing

EDUCATION

- 2010 - 2014 **PhD in 3D Computer Vision & Computer Graphics**, Myongji University, South Korea.
Research field: Structured-light based 3D shape measurement systems, 2D-to-3D conversion, Active and passive stereo, Computational geometry, Geometric modeling, Image processing, ...



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LINKEDIN

- 2007 – 2009 **MS in 3D Computer Graphics & Virtual Reality**, Myongji University, South Korea.
Research field: Computer graphics, Virtual reality, Haptic rendering, Computational geometry, Geometric modeling and processing, Real-time 3D rendering and visualization, ...
- 2002 – 2006 **BS in Engineering**, Univ. of Agriculture, Faisalabad, Pakistan.
Research field: CAD, Computer graphics

HONORS & AWARDS

- Jan – 2014 Nomination in the 2013 **Young Scientist Award**.
- Feb – 2014 Received the “**Best Thesis Award**” at Myongji University.
- Dec – 2013 Received the “**Bronze Paper Award**” at the IEEE Seoul Section Student Paper Contest 2013.
- Aug – 2013 Received the “**Best Journal Paper** of 2012” Award by Trans. of the Society of CAD/CAM Eng.
- Feb – 2013 Received the “**Best Paper Award**” at the Society of CAD/CAM Engineers Conference 2013
- Dec – 2012 Received the “**Bronze Paper Award**” at the IEEE Seoul Section Student Paper Contest 2012.
- Aug – 2012 Received the “**Best Paper Award**” at the Society of CAD/CAM Engineers Conference 2012
- May – 2012 Received the “**Best Paper Award**” at the 2012 International Conf. on Info. Sci. & App. (ICISA)
- Feb – 2007 Pakistan Govt. HEC **Scholarship Award** for MS from Myongji Univ. South Korea.
- Nov – 2005 Received “**Student of the Year 2005 Award**” in B.Sc. Engineering awarded by Vice-Chancellor.

DEVELOPED SOFTWARE & LIBRARIES (WRITTEN IN C++)

1. Real3d Renderer (*an advanced volume, mesh, points processing system*)
2. Real3d Scanner (*an extensible mesh and points processing system with a real-time SL 3D scanner*)
3. Real3d VoViCon (*an advanced application for visualization and reconstruction of CT and MR images*)
4. The Fast Visualization Kit (*C++ based library for 3D computer graphics, image processing, and visualization*)
5. FL-Essentials (*C++ based library that helps in building (responsive) GUI applications*)
6. Real-Time Virtual 3D Scanner (*a perfect simulator to analyze and perform structured-light 3D scanning*)
7. 3D Intraoral Scanning System (*optical 3D scanner for dentistry, 3D reconstruction of human jaws*)
8. Musculoskeletal Modeling & Motion Capture Viewer (*simulator platform*)
9. Virtual Dental Treatment Simulator (*simulator to perform dental treatment operations using haptics*)
10. Machining Simulator (*highly similar to the real-world wood cutting machining center with 3D Laser Scanner*)

PROGRAMMING LANGUAGES & EXPERIENCE:

C/C++/OOP (10 yrs)	OpenGL (10 yrs)	OpenCV (8 yrs)
VTK, ITK (8 yrs)	PCL (8 yrs)	OpenHaptics (5 yrs)
FLTK, Qt, Win32 (8 yrs)	OpenAL (2 yrs)	MATLAB (2 yrs)
CUDA	OpenCL	Python
JavaScript/HTML/CSS	Node.js	Vtk.js

Computer Graphics (10 yrs), 3D Scanning/Reconstruction (8 yrs), Virtual Reality (4 yrs), Software Development (agile scrum) (7 yrs)

Git (GitHub, Bitbucket, SourceTree), Jenkins, JIRA, TDD, Continuous Integration

Author of several mesh, point cloud, and image processing algorithms such as filtering, cleaning, smoothing, fairing, subdivision, decimation, triangulation, registration, reconstruction, phase wrapping and unwrapping, and image filtering, etc.



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RESEARCH PROJECTS

- 2018 – Done Dynamic Markups over DICOM Volume for Dental Surgery Applications.
- 2017 – Current Intelligent Monitoring Systems for Cooperating Objects using 6LoWPAN (6-IMS).
- 2015 – 2016 Dynamic musculoskeletal modeling for potential clinical applications such as non-invasive assessment of joint function (collaboration with UC Davis, UCSF, and Stanford).
- 2014 – Ongoing 3D vision projects with US and UK based startups.
- 2010 – 2014 Development of the Digital Fusion Artificial Tooth Treatment Supporting System under Grant of the Strategic Technology Development Project on Biomedical Supplier (3D Intraoral Scanner).
- 2010 – 2013 High tech Urban Development Program funded by Ministry of Land, Transport and Maritime Affairs of Korean government (Development of a Rafter Processing CNC Machine).
- 2007 – 2009 Development of Virtual Dental Treatment Training System using Haptic Interface.

SELECTED PROJECTS (AS ADVISOR)

- 3D shape measurement using active stereo vision technology
- Development of a software application for medical imaging analysis and visualization
- Development of a survival 3d game using virtual reality
- Development of platform independent text extraction software application
- Development of a virtual reality based magnifier application for android

ENGINEERING SOFTWARES

MasterCAM X (CNC), Pro-Engineer, ANSYS, SolidWorks, Solid Edge, Catia, ESI ProCAST, Simufact, Altair HaperWorks, Magics, Matrix 6.0, CIMCO, MATLAB, AutoCAD

EXPERTISE

TECHNOLOGIES

- Structured-light fringe projection based 3D shape measurement systems
- Active and passive stereo vision systems
- Research and development of 3D laser scanning systems
- Some knowledge of confocal technology which is being used for 3D dental scanning and micro-scale 3D reconstruction
- 3D computer vision for optics based hardware and software
- 3D intraoral scanning for dentistry
- Machine vision for 3D inspection systems
- 3D graphics for both mesh and volume rendering engines
- 2D and 3D image processing include medical DICOM images
- Virtual reality for physics based 3D simulations
- Haptic display for realistic sense of touch
- Dynamic musculoskeletal modeling and motion capturing
- Robotic Kinematics
- Intelligent monitoring systems (Internet of Things IoT)
- GUI based software development with latest tools and methods
- Waterfall model / agile scrum, Git, Testing, Continuous Integration
- Computer programming and languages



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KNOWLEDGE AND SKILLS (BUT NOT LIMITED TO...)

- LiDAR pointclouds – knowledge of handling gigantic pointcloud data
- Optics and optical systems – knowledge of depth sensors, and camera and projector based systems
- 3D scanning/reconstruction – 3D vision, 2D image processing, hardware synchronization, retrieval, geometric modeling and processing, calibration, 3D registration, merging, smoothing, filtering, texturing, rendering and visualization, structured-light and phase-shifting methodology
- Multi-view reconstruction, photogrammetry, structure-from-motion (SfM), bundle adjustment
- Laser scanning – knowledge of dental and industrial laser scanners
- Confocal optics – knowledge of dental scanning and micro-scale reconstruction
- Machine vision – knowledge of industrial 2D-3D inspection systems
- Machine learning – knowledge of some of machine learning algorithms and methods
- 3D graphics and tools – visualization and rendering, mesh and volume rendering engines, real-time 3D applications, computational geometry, geometric modeling and processing, author of many mesh and image processing algorithms such as filtering, cleaning, smoothing, fairing, subdivision, decimation, triangulation, registration, reconstruction, phase wrapping and unwrapping, and image filtering, etc.,
- Skills of C/C++/OOP, OpenGL, OpenCV, OpenCL, CUDA, OpenHaptics, VTK, ITK, FLTK, Qt, Win32, Git, JIRA, Jenkins, software testing, continuous integration, etc.
- Experience of tens of 3D geometry programming libraries
- Image processing – image analysis, feature detection, 3D information retrieval from 2D images, 3D volume and mesh rendering from medical images such as CT scan DICOM format
- Algorithms – design, development, analysis of 2D, 3D, geometry algorithms
- Virtual and haptic realities – development of various kind of simulators
- Musculoskeletal modeling – development of a dynamic human skeleton modeling platform for static, dynamic and kinematic scenarios
- Kinematics – analysis of human skeleton kinematics and motion capturing
- Software development – design, develop and modify GUI based software systems using scientific analysis and mathematical models

PUBLICATIONS

Journal Publications (10), Conference Publications (21)

PH.D. DISSERTATION

Furqan Ullah, “Analysis of 3D Shape Measurement for Fringe Projection Profilometry based Intraoral Scanner,” Ph.D. Dissertation, 2014, Myongji University, South Korea.

COVERED AREAS

3D reconstruction (active stereo, passive stereo, 3D optics, image processing, synchronization, retrieval, geometric modeling and processing, calibration, 3D registration or alignment, 3D fusion, 3D mesh merging, smoothing, filtering, texturing, rendering and visualization), structured light phase-shifting methodology, fringe projection profilometry, camera-projector systems, 3D shape measurement systems, 3D laser scanner, intraoral scanners, real-time data capturing and processing, development of 2D-3D algorithms, analysis of geometry algorithms, computer graphics, rendering engine, development of real-time virtual systems, 3D simulators, robotics, medical imaging, volumetric visualization, C++ based software development, programming libraries and



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languages

MS THESIS

Furqan Ullah, "Virtual Dental Treatment Training System using a Haptic Device," MS Thesis, 2009, Myongji University, South Korea.

COVERED AREAS

Virtual reality, haptic display, computer graphics, rendering and visualization, scientific visualization, volume rendering, analysis of geometry algorithms, 3D collision detections, mesh processing, signal processing, software development, programming libraries and languages

PROFESSIONAL TALKS

I have been given more than 15 talks in Oman, Korea, Taiwan, Switzerland, Germany, Netherlands, United States, and Pakistan.

SELECTED TALKS

- Mar - 2018 Advancements in 3D Computer Vision, Amsterdam, Netherlands.
- Feb - 2018 3D Viewer for Gigantic Point Clouds, Stuttgart, Germany.
- Oct - 2017 3D Surface Reconstruction from 2D Images at Collage of Engineering, Dhofar University, Oman.
- Dec - 2015 3D Reconstruction in Medical Images, Geisinger Health, Pennsylvania, US.
- Nov - 2015 Dynamic Human Musculoskeletal Modeling. Berkeley Vision & Learning Center Fall 2015 Retreat at Sutardja Dai Hall, UC Berkeley Campus, California, US.
- Oct - 2015 Musculoskeletal Modeling Framework. Computer Vision Symposium at Amazon, Seattle, Washington, US.
- Oct - 2015 Development of Dynamic Human Musculoskeletal Modeling Framework. Computer Vision Symposium at A9/Amazon, Silicon Valley, California, US.

BUSINESS TRIPS

Oman, Qatar, Korea, Taiwan, Germany, Netherlands, Switzerland, USA (California, Oregon, Philadelphia, Seattle, Pennsylvania)



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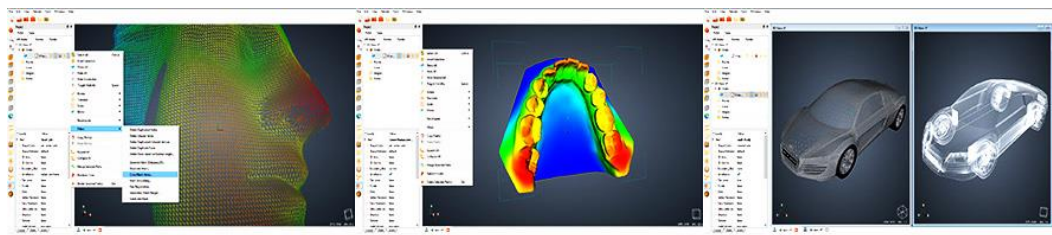
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DESCRIPTION OF SELECTED SOFTWARE AND LIBRARIES

I have done tens of small projects for the industry from US, UK, Hong Kong, Germany, Korea, etc. Following are some of my developed software and libraries that are freely available on my website.

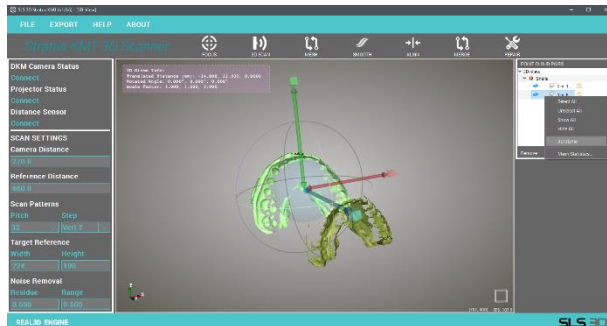
1. REAL3D RENDERER (<http://real3d.pk/rend.html>)

Real3d Renderer is a 3D point cloud and triangular mesh processing software. It can be used for high-quality 3D visualization, processing, and editing of point cloud and triangular mesh. It offers a large number of features (i.e., triangulation, smoothing, cleaning, filtering, decimation, reconstruction, registration, merging, and hole filling, etc.) for processing point clouds and meshes produced by 3D digitization tools/devices and for preparing models for 3D printing. It has the ability to import and export more than 60 well-known 3D geometry file formats, including, PLY, STL, OBJ, OFF, 3DS, WRL, AMC, BVH. It is written in my own Real3D Engine, which is C++/OpenGL/Qt based 3D rendering library.



2. SLS3D SCANNER (<http://sls3d.co.uk>)

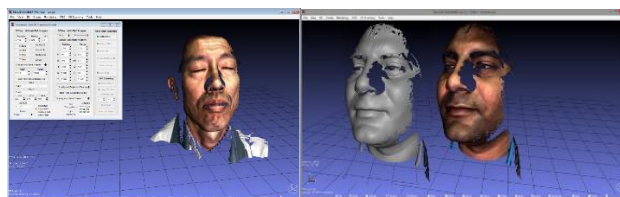
A professional scanner that uses only one camera and a video projector to retrieve 3D information from the scanned object. (Written in C++/OpenGL/Qt based Real3d engine FVtk)



3. REAL3D SCANNER (<http://real3d.pk/3dracs.html>)

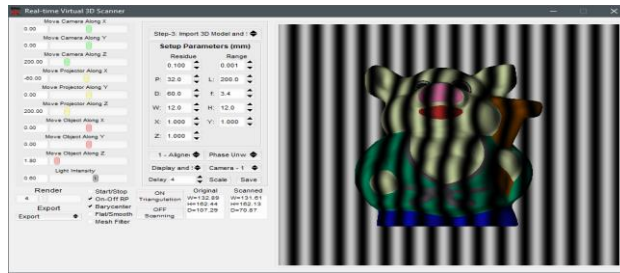
Real3d Scanner is an advanced piece of software designed to help you create and edit 3D models with only a camera and a video projector. (says softpedia.com)

It is being used by hundreds of researchers, professionals, and startups, in all over the world, includes America, Korea, Turkey, Germany, Italy, India, Australia, Slovakia, Spain, UK. Downloaded more than 70,000 times. (Written in C/C++, OpenGL, OpenCV, VTK, ITK, FLTK, FL-Essentials, and tens of 3D geometric libraries.)



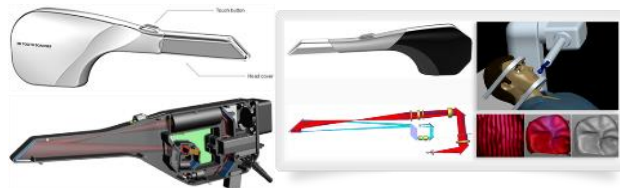
4. REAL-TIME VIRTUAL 3D SCANNER (<http://real3d.pk/virtual3dscanner.html>)

This is a high resolution real-time Virtual 3D Scanner that scans a virtual object in the virtual environment. It simulates the complete procedure of structured-light based real-world scanner in the virtual environment with various algorithms and mathematical models. (Written in C/C++, OpenGL, OpenCV, FLTK, FL-Essentials.)



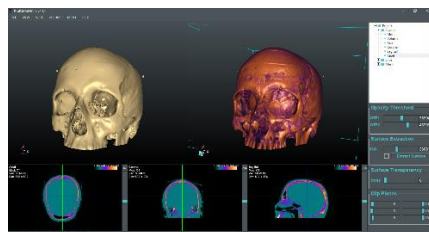
5. 3D INTRAORAL SCANNING SYSTEM (<http://real3d.pk/intraoralscanner.html>)

A system was developed for an intraoral scanning that can be used for the measurement of tooth profiles in the mouth cavity. Structured-light technology was utilized for 3D surface acquisition.



6. REAL3D VOLVICON (<http://real3d.pk/volvicon/>)

VolViCon is an advanced application for reconstruction of computed tomography (CT), magnetic resonance (MR), ultrasound, and x-rays images. It gives features for exporting 3D surfaces or volume as triangular mesh files for creating physical models using 3D printing technologies. It also provides high-quality visualization, linear and angular measurement tools, and various type of markups. It takes a single raw volume file or a sequence of 2D (i.e., DICOM) files and reconstructs 3D volume (voxels) and mesh (surfaces) models. (Written in C++, OpenCV, VTK, ITK, FL-Essentials)



7. MUSCULOSKELETAL MODELING & MOTION CAPTURE VIEWER

This platform was developed in Teleimmersion Lab, University of California Berkeley under the project of dynamic musculoskeletal modeling for potential clinical applications such as non-invasive assessment of joint function.

8. VIRTUAL DENTAL TREATMENT SIMULATOR (<http://real3d.pk/dentalsculptingsimulator.html>)

This is a surface-based virtual dental sculpting simulator based on auditory, visual, and tactile realities. It can be used to perform different dental procedures such as grinding, drilling, or scrubbing, etc. Haptic Omni was utilized for realistic sense of touch. (Written in C/C++, OpenGL, OpenUI, OpenHaptics)

9. MACHINING SIMULATOR (http://real3d.pk/3dracs_cnccs.html)

Developed world's first CNC machine with 3D laser scanning for curved rafter processing in Intelligent Manufacturing Lab, Korea. This simulator is highly similar to the real-world rafter-machining center.

(Written in C/C++, OpenGL, FLTK, and 3D geometric libraries)

10. FL-ESSENTIALS (<https://github.com/dr4urqan/FL-Essentials.git>)

FL-Essentials (FLE) is a FLTK based software system that provides extreme easiness in building (responsive) GUI applications. It consists of C++ class library and gives thread-safe image processing support for OpenCV. It also provides OpenGL based 3D classes to create computer graphics applications with fully featured GUI. Real3d Photo Viewer (<http://www.real3d.pk/photo.html>) and Real3d Camera Viewer (<http://www.real3d.pk/cam.html>) is written in Essentials.

(I wrote this library to make FLTK a lot easier for real-time image and camera handlings, responsive GUI applications as well as OpenGL based 3D graphics applications)

11. FVK-CAMERA (<https://github.com/dr4urqan/FVK-CAMERA>)

The Fast Visualization Kit (FVK) is a software package for 3D computer graphics, image processing, and visualization. It consists of a C++ class library with several 3D geometric as well as vision algorithms. It provides C++ classes for 2D-to-3D conversion algorithms specifically for DFP based structured light technology, various algorithm for mesh and pointcloud processing, and a complete software interface for developing fast 3D graphics and vision based applications. FVK supports visualization algorithms including scalar, vector, texture, and volumetric methods, as well as advanced modeling techniques such as implicit modeling, polygon reduction, mesh smoothing, cutting, contouring, and Delaunay triangulation.

The FVK-CAMERA is one of its modules that gives multithreading based camera handlings using OpenCV. It can be utilized with any GUI based library to handle multiple cameras with multithreaded interface.