# Thesis Plan for Bachelor Thesis



Alexey Tukalo, EFA12SF, Information Technology, Savonia University of Applied Sciences Thesis Plan

### 1 Introdaction

Volume rendering is a well not consept as computer graphics, the main theoretical base was developed at 80s and early 90s. Nowdays an ordinary work station gives as an opprotunity to render an interactive volume scenes and as result the topic is experiencing a significant revival. The technoly is used for visualisation of medical studies, scientific data collected by different types of sensors and physical models for particles, fluids and gases.

I made myself familiar with a concept of volume rendering during my internship at Karlsruhe Institute of Technology(KIT), there I worked on modification of Tomoraycaset 2 to give it an opportunity to render multimodal volume data.

I am going to implement an enging for volume rendering with DirectX in C#, the enging will became a part of LightingChart. LightningChart is a proprietary library for visualisation of scintific data developed by Arction Oy. Arction wants to add volume rendering possibalities to their product, but any exicting solution do not suites them well, because they need to have very deep integration with their current engin and they want to keep their source code as independent as it is possible.

### 2 Theory base

As I already noticed, the theoretical base for the volume rendering was developed more than 20 years ago. The idea started from the rendering equation simultaneously derived by David Immel and James Kajiya in 1986. There are four main volume rendering technics:

- Volume ray casting
- Splatting
- Shear warp
- Texture-based volume rendering

I am going to start the development from an implementation of the most basic Ray Casting algorithm. The Ray Casting also called image-ordered volume rendering. Basically, it shoots rays from every pixel in the screen and samplee tha data from the volume in according with so called ray function. The ray function is an equation which determines how the volume would be sampled.

The technique has two main advantages:

- Very high qality with very low amount of artifacts
- Number of variouse ray functions gives as an extra flexablity

But the Ray Casting has a vary big disadvatages, it contains a lot of interpolations for the calculations of the ray, it makes the algorithm relatively slow.

So, I am going to speed the engin up by moving the implementation to the Shear warp realisation. Basically the algorithm is an optimisation of ray casting approach which is created to avoid any kind of calculations realted with an interpolation at the sampling stage. It is realised by an additional preprocessing stage called Shear. The stage contributes some artifacts which are reduced at the last step of rendering called Warp. In other words, Shear-warp is realisation of Volume Ray Casting with two additional pre and postprocesing steps.

# 3 Objectives and results

The final result of the project is realisation of an interectev volume rendering enging integrated into two versions of LightningChart(DX9 and DX11) which will became private property of Arction Oy.

Thesis Plan

### 4 Implementation

The enging has to be integrated inside LightningChart, so on the one hand it restricts me to use C#, HLSL and DirectX as my main tools. In the other hand I can get significant profit from the features already implemented inside the library, for example it will help me to implement rotation of the object, mouse interaction detection and so on.

I will be resposible for the development of the entier engin and visualisation based on the engin. The visualusation would be an example of the main possibilities which the engin will provide to the LightningChart. It will give us an opprotunty to test and verify the software quality. The project will be implemented under mentoring of Mr. Pasi Toumainen<sup>1</sup>, he will guide me in terms of source code organisation and evaluation of the final solution.

I brouke the development to the several steps:

- 1. Create testing application with a cube which would represent the inner boundaries of the volume.
- 2. Implement the most basic shader and new type of objects which will be rendering with this shader.
- 3. Read the volume data as set of textures.
- 4. Preprocess the texture to fit the hardware.
- 5. Implement the most basic Volume Ray Casting.
- 6. Implement a mouse interactions with the volume.
- 7. Optimaze the volume rendering:
  - (a) Add Shear and Warp steps to the Ray Caster
  - (b) Add spatial structure optimazation
- 8. Implement rotation.
- 9. Implement lightning effects.
- 10. Port the solution for an other version of LightningChart.

#### 5 Resources

All the resources needed for the development are provided by Arction Oy:

- The workstation with Windows
- Visual Studio and other software
- Development version of LightningChart

The main part of the work would be made by myself, so any addition human resources are not needed. In according with my calculations the project will took me from 240 to 360 hours, and it will cost Acrtion from 1500 to  $2000 \in$ .

### 6 Risk

The project has very low risks, because I am going to use well known techniqs based on fundamental reasearches and my implementation is going to be made on the highly relaible technologies widly used in the market. The solution will became a part of the LightningChart to give current Acrtion's customers new possibilities and atract new ones interested in the feature.

The source code created during the project will became private property of Arction Oy.

<sup>&</sup>lt;sup>1</sup>CEO of Arction Oy

Thesis Plan

## 7 Report documentation

Preliminary table of contents and a documentation plan of the final thesis:

- 1. Introdaction to Volume Rendering
  - 1.1 Motivation
  - 1.2 Introdaction to LightingChart
  - 1.3 Volume Rendering Algorithms
- 2. Implementation of the Volume Rendering
  - 2.1 Implementation of Volume Ray Casting
  - 2.2 Optimization of the engin
  - 2.3 Advantages of Shear Warp
- 3. Results
  - 3.1 Evaluation
  - 3.2 Discusion
  - 3.3 Conclusion
- 4. References

Arction does not request any additional reports. Results of the project will be presented to the University on the seminar presentation.

# 8 Appendix



#### PERSONAL INFORMATION

### Alexey Tukalo



- 💎 Taivaanpankontie 14 A 14/1, 70200 Kuopio (Finland)
- x airtucha@icould.com
- Skype AIRTucha

Sex Male | Date of birth 21/07/1994 | Nationality Russian

#### **WORK EXPERIENCE**

#### 20/05/2013–20/06/2013 Intern (

#### Intern Computer Support Specialist

LLC "Center of Information Technologies" All-In " trademark "Access Point", Belomorsk (Russia)

#### 07/07/2015-18/10/2015

#### Image processing

Karlsruhe Institute of Technology, Karlsruhe (Germany)

- Development of combined 3D USCT volume data visualization on Java(ImageJ) and MATLAB
- Development of prototypes for 4D information visualization
- Implementation of the data visualization in our customized DICOM viewer including the data handling and user interface design.
- WebGL visualisation of 3D volums

Related document(s): KIT.pdf

#### 01/05/2015-31/10/2015

#### Team Leader

Pricelizer, Inc., Stockholm (Sweden)

- Management of teams distributed around the world
- Work experience in start-up
- Remote work
- Management of it projects

Related document(s): Pricelizer.pdf

#### 01/12/2015-Present

#### Data Visualization with C#

Arction Oy, Kuopio (Finland)

- LigthningChart related software development
- Customer projects programming
- Testing
- Quality control

#### **EDUCATION AND TRAINING**

#### 16/01/2015-31/05/2015

Institute of Technologies Tralee, Tralee, Éire/Ireland

Erasmus+ Program Exchange

- Project Management,
- System Architecture,
- Game Mechanics (Game Development with Unity and C#)



Curriculum vitae Alexey Tukalo

- Big Data
- Visual Communication

Related document(s): Tralee Transcript.pdf

#### 03/09/2012-Present

#### BEng in Information Technologies

EQF level 6

- Savonia University of Applied Sciences, Kuopio (Finland)
- Web and Mobile Development
- Embedded Systems
- Databases
- Object-orientated programming
- Computer Networks
- Digital-signal processing
- Control Engenering

Related document(s): Savonia Transcript.pdf, Karelia Transcript.pdf

#### 01/09/2001-27/06/2012

Secondary Comprehensive School number 3, Belomorsk (Russia)

#### 01/09/2003-16/01/2009

School of The Art, Belomorsk (Russia)

- Drawing
- Painting
- Sculpture
- History of Art
- Composition.

#### PERSONAL SKILLS

#### Mother tongue(s)

Russian

### Other language(s)

UNDERS	TANDING	SPEAKING		WRITING
Listening	Reading	Spoken interaction	Spoken production	
C1	C1	B2	B2	B2

English

Levels: A1 and A2: Basic user - B1 and B2: Independent user - C1 and C2: Proficient user

Common European Framework of Reference for Languages

#### Communication skills

- To be honest, I am not extremely communicative, but I always like to meet new people and new teams.
- During the travels related to my studying, I gained a lot of experience in multicultural communication.
- Due to very good analytical skills, I am able to make very quick and accurate evaluation of a new person's abilities and so on.

#### Organisational / managerial skills

I fond of well organised work and I can take responsibility to organise my own work and the work of my teammates. But I would prefer to avoid any kind of conflicts with current team leader and chiefs.



Curriculum vitae Alexey Tukalo

Job-related skills

Java, C#, Java, C++, C, JavaScript(D3.js, WebGL, Node.js, ReactJS), Image Processing, MatLab, R, SQL, MongoDB.

#### Digital competence

		SELF-ASSESSMENT		
Information processing	Communication	Content creation	Safety	Problem solving
Proficient user	Proficient user	Proficient user	Independent user	Proficient user

Digital competences - Self-assessment grid

Office applications, LaTex, Adobe Photoshop, Adobe Illustrator, Adobe Lightroom, Unity3D, PostgreSQL Server, Microsoft SQL Server, work with MS-Windows, OS X and Debian Linux.

Other skills

Raster graphics, colour correction, vector graphics, colour theory, composition, photography.

Driving licence

A, B

#### **ANNEXES**

- Pricelizer.pdf
- KIT.pdf
- Savonia Transcript.pdf
- Karelia Transcript.pdf
- Tralee Transcript.pdf



# Alexey Tukalo

Mother tongue(s)
Russian

Other language(s)

English

		English					
	S	self-assessment of languag	e skills				
UNDERS	TANDING	SPE	AKING		W	'RITING	
Listening	Reading	Spoken interaction	Spoken pro	duction		Writing	
C1 Proficient user	C1 Proficient user	B2 Independent user	B2 Independe	_	B2 Independent user		
		Certificates and diplom	as				
Title		Awarding body		Da	ite Level		
_		-		-		_	
	Lir	nguistic and intercultural ex	perience				
Description					Duratio	on	
Using languages for study Almost graduated Bachelor Savonia UAS.	•	f Information Technology with instruct	ion in English at		3/9/12-Pre	sent	
Using languages for study Technology	or training: One semes	ster exchange studying in Ireland at T	ralee Institute of		18/1/15–24/	/5/15	
Using languages at work:	Internship at Karlsruhe In	stitute of Technology			7/7/15–18/1	0/15	
Using languages at work:	Internship at Pricelizer as	a part of distributed team			1/5/15–31/1	0/15	





<sup>\*</sup> Indicate level of the Common European Framework of Reference (CEFR) if specified on certificate or diploma. The Europass Language Passport is part of the European Language Portfolio developed by the Council of Europe (www.coe.int/portfolio).

# Common European Framework of Reference for Languages - Self-assessment grid

		A1 Basic User	A2 Basic User	B1 Independent user	B2 Independent user	C1 Proficient user	C2 Proficient user
Inderstanding	Listening	I can understand familiar words and very basic phrases concerning myself with familiar words and fundation of the surroundings when people speak slowly and clearly.	I can understand phrases and the highest frequency vocabulary related to areas of most Immediate personal relevance (e.g. very basic personal and family information, shopping, local area, employment). I can catch the main point in short, clear, simple messages and announcements.	I can understand the main points of clear standard speech on familiar matters regularly encountered in work, school, leisure, etc. I can understand the main point of many radio or TV programmes on current affairs or topics of personal or professional interest when the delivery is relatively slow and clear.	I can understand extended speech and lectures and follow even complex lines of argument provided the topic is reasonably familiar. I can understand most TV news and current affairs programmes. I can understand the majority of films in standard dialect.	I can understand extended speech even when it is not clearly structured and when relationships are only implied and not signalled explicitly. I can understand television programmes and films without too much effort.	I have no difficulty in understanding any kind of spoken language, whether live or broadcast, even when delivered at fast native speed, provided I have some time to get familiar with the accent.
Under	Reading	I can understand familiar names, words and very simple sentences, for example on notices and posters or in catalogues.	I can read very short, simple texts. I can find specific, predictable information in simple everyday material such as advertisements, prospectuses, menus and timetables and I can understand short simple personal letters.	I can understand texts that consist mainly of high frequency everyday or job- related language. I can understand the description of events, feelings and wishes in personal letters.	I can read articles and reports concerned with contemporary problems in which the writers adopt particular attitudes or viewpoints. I can understand contemporary literary prose.	I can understand long and complex factual and literary texts, appreciating distinctions of style. I can understand specialised articles and longer technical instructions, even when they do not relate to my field.	I can read with ease virtually all forms of the written language, including abstract, structurally or inguistically complex texts such as manuals, specialised articles and literary works.
Speaking	Spoken interaction]	can interact in a simple way provided the other persons is prepared to repeat or rephrase things at a slower rate of speech and help me formulate what I'm trying to say. I can ask and answer simple questions in areas of immediate need or on very familiar topics.	I can communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar topics and activities. I can handle very short social exchanges, even though I can't usually understand enough to keep the conversation going myself.	can deal with most situations likely to arise whist travelling in an area where the language is spoken. I can enter unprepared into conversation on topics that are familiar, of personal interest or pertinent to everyday life (e.g., family, hobbies, work, travel and current events).	I can interact with a degree of fluency and spontaneity that makes regular interaction with native speakers guite possible. I can take an active part in discussion in familiar contexts, accounting for and sustaining my views.	I can express myself fluently and spontaneously without much obvious searching for expressions. I can use language flexibly and effectively for social and professional purposes. I can formulate ideas and opinions with precision and relate my contribution skilfully to those of other speakers.	Ican lake part effortlessly in any conversation or discussion and have a good familiarity with idiomatic expressions and olloquialisms. I can express myself fluently and convey finer shades of meaning precisely. If I do have a problem I can backtrack and restructure around the difficulty so smoothly that other people are hardly aware of it.
S.	Spoken production	I can use simple phrases and sentences to describe where I live and people I know.	I can use a series of phrases and sentences to describe in simple terms my family and other people, living conditions, my educational background and my present or most recent job.	I can connect phrases in a simple way in order to describe experiences and events, my dreams, hopes and ambitions. I can briefly give reasons and explanations for opinions and plans. I can narrate a story or relate the plot of a book or film and describe my reactions.	I can present clear, detailed descriptions on a wide range of subjects related to my field of interest. I can explain a viewpoint on a topical issue giving the advantages and disadvantages of various options.	I can present clear, detailed descriptions of complex subjects integrating sub-themes, developing particular points and rounding off with an appropriate conclusion.	I can present a clear, smoothly-flowing description or argument in a style appropriate to the context and with an effective logical structure which helps the recipient to notice and remember significant points.
Writing	Writing	I can write a short, simple postcard, for example sending holiday greetings. I can fill in forms with personal details, for example entering my name, nationality and address on a hotel registration form.	I can write short, simple notes and messages. I can write a very simple personal letter, for example thanking someone for something.	I can write simple connected text on topics which are familiar or of personal interest. I can write personal letters describing experiences and impressions.	I can write clear, detailed text on a wide range of subjects related to my interests. I can write an essay or report, passing on information or giving reasons in support of or against a particular point of view. I can write letters highlighting the personal significance of events and experiences.	I can express myself in clear, well- structured text, expressing points of view at some length. I can write about complex subjects in a letter, an essay or a report, underlining what I consider to be the salient issues. I can select a style appropriate to the reader in mind.	I can write clear, smoothly-flowing text in an appropriate style. I can write complex letters, reports or articles which present a case with an effective logical structure which helps the recipient to notice and remember significant points. I can write summaries and reviews of professional or literary works.

Common European Framework of Reference for Languages (CEF): © Council of Europe



# Pricelizer.pdf @



# Internship Certificate

Alexey Tukalo Period May to November 2015

Alexey Tukalo is a highly skilled professional who has been able to

Although we do not want to lose Alexey, we do not have a paid position for him at this point in the company. I am pleased to recommend him for any related position in your company..

As part of ongoing duties at Pricelizer he have been working hard with a distributed team with resources in multiple countries and timezones.

During his months here at Pricelizer, he conducted significant changes assuring the future growth and strength of our company.

I am particularly impressed by Alexeys ability to update himself and handle new challenges and his multi-tasking skills.

Overall Alexey Tukalo is a dedicated, analytical and exemplary intern. I can see a bright future ahead of him.

Work responsibilities: Front-end development Leads tracker tool developer Team leader of growth hackers team

Karl Lillrud CEO and Founder



# KIT.pdf 🕖



#### CERTIFICATE

Mr. Alexey Tukalo, born on 21/07/1994, has worked from 07/07/2015 to 18/11/2015 as an intern at the Institute for Data processing and Electronics (IPE) of the Karlsruhe Institute of Technology (KIT).

His work was focused on the following topic: "Visualization of multimodal 3D Ultrasound Computer Tomography (USCT) volume images".

Mr. Tukalo was very good organized and worked target oriented to achieve the goals of the internship. He managed to first of all get familiar with the existing methods for image fusion of 3D USCT images and then he started to make substantial extensions and improvements by developing a prototype for a novel image fusion method using the HSV color space. He integrated his developments into the USCT DICOM Viewer application. Developing the software, Mr. Tukalo made extensive use of MATLAB and Java. He furthermore developed a web-based rendering of multimodal USCT data in a WebGL ray casting application.

To demonstrate the functionality of the developed software, Mr. Tukalo presented his work in the working group seminar and tested the application with several user tests. The obtained results were evaluated and discussed with the imaging experts during the weekly USCT project meeting. The DICOM viewer application as well as the WebGL volume visualization is currently in use in a clinical study with USCT respectively in a public relations campaign for USCT.

The developed methods pave the way for the analysis of different image fusion methods in a radiological reader study. The contributions of Mr. Tukalo are very useful for the USCT team and the visualization research community.

We thank Mr. Tukalo for the very good work he did in the short time of his internship, demonstrating solid knowledge of medical image processing and software development. He easily learned how to work with new tools and techniques like WebGL. His profound and broaden expertise and his scientific curiosity facilitated the success of his work. It was a pleasure to discuss and work with him. We wish him all the best in his professional development and personal future.

Karlsruher Institut für Technologie (KIT)

Karlsruhe, 7th December 2015

i. A. Michael Markert

.

Karlsruher Institut für Technologie (KIT) Kaiserstraße 12 Präsident: Prof. Dr.-Ing. Holger Hanselka Vizepräsidenten: Dr. Elke Luise Barnstedt, Dr. Ulrich Brauer Prof. Dr.-Ing. Dettef Löhe, Prof. Dr. Alexander Wanner Bundesbank Karlsruhe BLZ 660 000 00 | Kto. 66 001 508 BIC/SWFT. MARK DE F1660 IBAN: DE57 6600 0000 0066 0015 08 Baden-Württembergische Bank, Stuffgärt BLZ 600 501 01 | Kto. 7495501296 BIC: SOLADEST BAN: DE18 6005 0101 7495 5012 96

KIT – Universität des Landes Baden-Württemberg und nationales Forschungszentnum in der Helmholtz-Gemeinsch

www.kit.edu



# Savonia Transcript.pdf @

Transcript of records

(1/2)

## Tukalo Alexey ( 21.07.1994 )

School Savonia UAS School of Engineering and Technology Kuopio

Degree Bachelor of Engineering

Degree programme in Information Technology

Date of enrollment 03.09.2012 Language of instruction English

Microsensors and Mechanics

Wireless Technologies Database Servers

Mobile Programming 1)

Project

#### BASIC STUDIES

BASIC STUDIES			
Communication Skills	3 cr	3	06.05.2014
English for Information Technology	3 Cr	3	01.02.2013
Mathematical Tools	3 cr	5	20.12.2013
Differential Calculus	5 cr	5	27.09.2013
Integration and Differential Equations	3 cr	1	19.12.2013
Statistics	3 cr	4	26.09.2014
Mechanics (Physics 1)	3 or	5	30.03.2014
Electricity (Physics 2)	4 cr	2	04.04.2014
Experimental Natural Science	3 cr	4	18.12.2013
Laboratory Work in Physics	3 cr	S	07.06 2014
COMMON PROFESSIONAL COURSES			
Electrical Measurements	Zcr	5	00.40 0040
Personal Computing	2 cr	5	29.12.2013
Profitability and Investments	2 cr 3 cr	2	22 10.2012
Introduction to Business Processes	5 cr	5	16.12.2015
SPECIALISED PROFESSIONAL STUDIES IN INFORMATION		3	19.12.2014
	TECHNOLOGY		
Electrical Circuit Analysis	2 cr	4	06.05.2013
Basics of Programming	9 cr	5	02.06,2013
Object Oriented Programming JAVA	7 cr	5	09.04.2014
Algorithms and Data Structures	3 cr	5	09,12,2013
Browser Programming	3 cr	5	17.05,2013
Data Management and SQL	4 cr	5	28.02.2014
Analog Electronics	4 cr	4	11.04.2014
Digital Electronics	h cr	4	07.06.2014
Laboratory Work in Electronics	3 cr	4	07.06.2014
Basics of Computer Technology	4 cr	5	27.05.2013
Basics of Microprocessor Programming	3 cr	4	17.05.2013
Telecommunications Engineering	4 cr	4	07.06.2014
Computer Networks (CGNA 1)	3 cr	4	28.12.2012
Digital Signal Processing	4 cz	4	19.12,2014
Control Engineering	4 ar	4	19.12.2D14
Basics of Microprocessor Technology	4 cr	4	19.12.2014
Laboratory Work in Telecommunications	6 cr	4	31.05.2015
ADVANCED PROFESSIONAL STUDIES IN TELECOMMUNICA	TIONS ENGINEERING		
Healthcare Technology	3 ст	3	19.12.2012
Basics of Sensor Technology	3 cr	2	07.06.2014
C++ Programming	2 cr	5	07.06.2014
ICT Services and RDI	3 cr	4	1B.12.2015
Microsensors and Mechanics	U GI	7	10.12.2015

3 cr 4 3 cr 3

3 gr 5 16.01.2015 5 cr 4 19.12.2013

3 cr 4 18.12 2015

17.12.2014 19.12.2014



(2/2)

## Tukalo Alexey (21.07.1994)

Compensated Professional Studies 2)	25 cr	Н	04.06.2015
PRACTICAL TRAINING			
Practical Training 1	6 cr	8	26.09.2013
Practical Training 2	12 cr	\$	17.12.2015
Practical Training 3	12 cr	S	17.12.2015
OPTIONAL STUDIES			
Survival Finnish	2 cr	s	25.10.2012
Finnish for Foreigners 1	2 cr	1	12.12.2012
Orientation to the Higher Education Studies	1 cr	s	20.12.2012
Linux Operating System	2 cr	3	26.02.2013
Elementary mathematics	3 cr	5	22.03.2013
Cisco CCNA 2	3 cr	5	19.12.2013
Compensated Elective Studies 1)	4 cr	4	19.12.2013

Degree studies 217 credits.

Certified by Kuopio 12.01.2016

Seija jantti Student Advisor

#### Grading Scale

Excellent (5), very good (4), good (3), satisfactory (2), sufficient (1), fail (0), pass (S), credits accepted as part of the degree (H). The grading scale for the other national language is good (4-5) and satisfactory (1-3).

### Compensating studies

- 1) Karelia Open UAS 2013-2014 2) TRALER Institute of Technology 2015

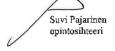


# Karelia Transcript.pdf @

Karelia-ammattikorkeakoulu		Opintosuoritusote				
Tikkarinne 9 80200 JOENSUU		10,09.2014				
Opiskelija	Alexey Tukalo 1301633 210794-291U		MUUS	99AK14 01.0	08.2013 - 31.07.2014	
Ohjelma	Muu ammattikorkeakoulutus, tekniikk				9,00 ор	
Suunta	Avoimen ammattikorkeakoulun opinno	ot	Suori	tettu	9,00 op	
Opinnot		<u>Laaju</u> us	<u>Λrv</u>	<u>Pvm</u>	<u>Opetlaja</u>	
Artifical Intelliger Android Mobile P		4,00 op 5,00 op	4 4		Nevalainen Seppo Nevalainen Seppo	

Opinnot ovat Karelia-ammattikorkeakoulun tutkintovaatimusten mukaisia.

Joensuussa 10. syyskuuta 2014







# **Tralee Transcript.pdf** ②



Fax: 066 7126711, Telephone: 066-7145640 Website: www.ittralee.le

T00185074

Alexey Tukalo Taivaanpankonie 14 A 14/1 70200 Kuopio Finland

Date:

18th June 2015

Programme Code: TL\_XERAS\_X

Term Code:

201400

Class Code:

#### Statement of Provisional Examination Results

Dear Alexey

Following consideration of your performance in the recently held examinations in:

Programme Title: ERASMUS Students taking Mixed Courses

AY 2014/2015

The Examination Board has recommended as follows:

Individual Subject Results

Stage: 3

Sitting	CRN	Course Code	Course		Credits	Result
F\$\$	44847	COMP 81003	System Architecture		5	61
FSS	46319	<b>DBMS 81000</b>	Big Data		5	63
FSS	44889	MGMT 71003	Computer Services Managemen	t	5	67
FSS	48409	OFFS 61002	Visual Communication		5	78
FSS	47375	SWDV 61018	Games Mechanics		5	99
	Stage F	assed	Stage Credits Earned	Stage Credits Required	,	Stage %
	N		25	200		73.6

Overall Result: Noted - Not Eligible for Award

You have passed the modules listed above.

huchnetfell.

Results subject to ratification by the Academic Council of IT, Tralee

Registrar