

**DYNAMIC PIVOT POINT TECHNIQUE (DYOP)
IN NARROW-PHASE COLLISION DETECTION**

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**THIS IS SUBMITTED IN PARTIAL
FULFILMENT OF THE REQUIREMENTS FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY**

**FACULTY OF SCIENCES AND NATURAL
RESOURCES
UNIVERSITI MALAYSIA SABAH
2015**

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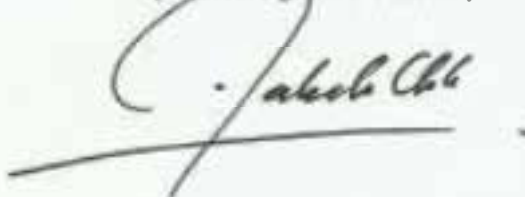
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DEGREE : DOCTOR OF PHILOSOPHY (COMPUTER GRAPHICS
WITH MATHEMATICS)
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ACKNOWLEDGEMENT

Assalamualaikum and Alhamdulillah, I would to thank Allah S.W.T. for giving me countless strength in mental and physical ways, in helping me to see this dissertation thoroughly and for blessings of great or small. This dissertation is a proof of His guidance with help from a lot of people surrounding me in order to complete this doctorate level of degree.

First, my utmost appreciation and deepest gratitude goes to Dr. Abdullah Bin Bade and Prof. Datuk. Dr. Mohd Harun Bin Abdullah from Faculty of Sciences and Natural Resources who provided the academic supervisions for this dissertation. Their timely feedback, constructive criticism, directions and patience made the process an academically stimulating and rewarding exercise. I would like to extend my thanks for their mentorship and friendship, and pushing me so that I could accomplish within my schedules. Without this combined supervisory help and assistance, my dissertation would not have completed.

Furthermore, I would like to express my sincere appreciation to some of my fellow researchers whom are Muhammad Nazreen, Salina, Iznora, Siti Hasnah, Rechard Lee Abdullah and the others for their help and supports throughout the semesters. I would also like to give special thanks to Raima Binti Hassim for thesis reformatting and editing for Hard Binding Cover.

Finally, I would like to give most special thank to my wife, Nur Baizura Binti Abdul Jalal, and my daughter Izz Nur Zahra Binti Hamzah Asyrani, who have to endure all complaints, nags and stressful stuff during my doctorate completion. I thank them for their enormous prayers, understanding, unstinting support, sacrifices, patience and love.

Walaikumsalam,

Hamzah Asyrani Sulaiman

1 August 2015

ABSTRACT

Contact determination between nearly colliding objects is one of the crucial issues in virtual environment simulation particularly for collision detection system such as in medical simulation, computer games, and engineering visualization. The contact determination technique consists of distance computation, point of contact and depth penetration phase. It requires information of object direction towards other object that moves in opposite direction namely intersection. The main problem in this research is to study a nearly accurate distance approximation computation caused by heavy calculation that deteriorating speed and efficiency of collision detection system. This thesis aims to introduce an agile and new technique for contact determination in narrow phase collision detection that increases speed and improves the efficiency of narrow phase collision detection. The proposed narrow phase collision detection technique in this study consists of distance computation method, point of contact between nearly collided object and depth penetration method namely Dynamic Pivot Point (DyOP). The technique enables numbers of testing to be reduced as compared to the prominent techniques such as Lin-Canny and GJK technique. The proposed technique starts by first identifying the nearest triangle of corresponding objects that is going to be intersected with another triangle that are bound with an Axis Aligned Bounding-Box (AABB). Then, we need to find the parallel line distribution created by each axis of AABB for each triangle. Next, an internal intersection using internal AABB by using maximum and minimum parallel line distribution of each object. A pivot point called DyOP will be calculated as a reference point to the contact determination technique. The proposed technique is able to reduce nine vertices testing down to six vertices testing and nine vertex-edge testing's down to only two vertex-edge testing's. Three sets of testing have been conducted to evaluate and verify the proposed technique with two other prominent techniques. The first test was conducted by investigating time execution of ten different triangles with pre-defined size but vary in distance computation phase. Based on the experiments, out of 90 concurrent testing's, the proposed technique managed to achieve 187.3% improvements with the fastest execution time about 55 milliseconds. The subsequent test was conducted with the point of contact phase. Based on the experiments conducted, the proposed technique successfully attained 79.05% improvement with an average of 7.6 milliseconds and almost similar to Lin-Canny technique for point of contact. The final test to determine depth penetration, the technique managed to achieve 53.63% better improvement and an average of 10.75 milliseconds per test with similar accuracy. The results from the experiments showed that the DyOP technique is efficient to perform contact determination in narrow phase collision detection and increase the speed of distance computation, point of contact and depth penetration by reducing the number of testing. These indicated that, the DyOP technique is efficient, accurate and robust not only to the tested environment but other unprepared environment and could be adapted to any desired target area or domain.

ABSTRAK

TEKNIK TITIK PIVOT DINAMIK (DYOP) DALAM PENENTUAN PERLANGGARAN UNTUK FASA GENTING SISTEM PENGESANAN PERLANGGARAN N-BADAN

Penentuan perlanggaran antara objek yang hampir berlanggar adalah salah satu isu kritikal dalam simulasi persekitaran maya untuk sistem pengesanan perlanggaran hampir tepat seperti dalam simulasi perubatan, permainan komputer, dan visualisasi kejuruteraan. Teknik penentuan perlanggaran terdiri daripada pengiraan jarak, penentuan titik perlanggaran dan fasa penentuan kadar penembusan kedalaman. Ia memerlukan maklumat arah objek yang akan berlanggar bergerak ke arah satu lagi objek yang bergerak ke arah yang bertentangan yang mewujudkan satu perlanggaran. Masalah wujud apabila satu anggaran jarak yang dikira dalam cara yang rumit mungkin mengurangkan kelajuan dan kecekapan laporan perlanggaran. Tesis ini bertujuan untuk memperkenalkan teknik baru untuk penentuan perlanggaran dalam fasa teliti untuk pengesanan perlanggaran yang meningkatkan kelajuan dan kecekapan jarak pengkomputeran, titik hubungan antara objek hampir bertembung dan penentuan kadar penembusan kedalaman dengan melaksanakan teknik Titik Asalan Dinamik (DyOP). Ia membolehkan bilangan ujian dikurangkan berbanding kaedah konvensional Lin-Canny dan Gilbert-Keerthi-Johnson (GJK). Teknik ini bermula dengan menentukan segitiga yang terdekat dengan objek yang akan bertembung dengan segi tiga lain yang disempadani dengan Ruang Lingkup Tertutup (AABB) yang sepadan. Berdasarkan maklumat di atas, kita perlu mencari garis persempadanan yang dihasilkan oleh setiap AABB. Setelah menentukan garis persempadanan tersebut, kita akan mewujudkan satu AABB dalaman yang menggunakan maklumat garis persempadanan maksimum dan minimum oleh kedua-dua AABB yang hampir bertembung ini. DyOP akan dikira sebagai titik rujukan yang akan menentukan dan membantu mendapatkan maklumat perlanggaran. Teknik kami dapat mengurangkan sembilan ujian titik bucu ke enam bucu dan sembilan ujian bucu-garis tepi turun ke hanya dua ujian bucu-garis tepi. Tiga set ujian telah dijalankan untuk menilai dan mengesahkan teknik yang dicadangkan dengan dua teknik biasa iaitu Lin-Canny dan GJK. Ujian pertama dijalankan dengan menentukan masa pelaksanaan untuk sepuluh jenis segitiga yang telah diisytiharkan untuk kegunaan eksperimen yang juga berlainan saiz antara satu sama lain. Berdasarkan eksperimen yang melibatkan 90 simulasi perlanggaran serentak, teknik kami berjaya mendapatkan peningkatan sebanyak 187.3% dengan masa terpantas iaitu 55 milisaat. Ujian kedua pula merujuk kepada fasa penentuan titik perlanggaran antara dua segitiga ini. Teknik kami berjaya mendapatkan peningkatan sebanyak 79.05% dengan masa terpantas iaitu 7.6 milisaat dengan titik perlanggaran yang hampir sama dengan teknik yang lain sehingga lima tempat perpuluhan. Ujian terakhir adalah melibatkan penentuan kadar penembusan kedalaman di mana sebanyak 53.63% peningkatan dicapai dengan masa terpantas sebanyak 10.65 milisaat secara purata. Dari eksperimen yang dijalankan, teknik DyOP berupaya meningkatkan keupayaan penentuan fasa teliti perlanggaran objek dan meningkatkan kelajuan penentuan jarak perlanggaran, penentuan titik perlanggaran dan seterusnya kadar penembusan kedalaman objek berlanggar. Ini menunjukkan bahawa teknik DyOP kami adalah cekap, tepat dan mantap bukan sahaja kepada persekitaran yang diuji tetapi persekitaran simulasi yang lain dan boleh menjadi mudah alih kepada mana-mana kawasan sasaran yang diingini.

TABLE OF CONTENTS

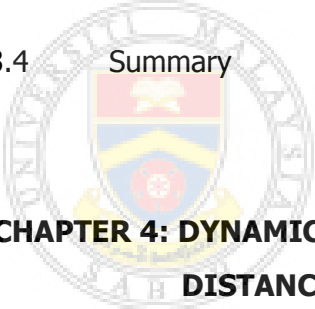
	Page
TITLE	i
SUPERVISOR DECLARATION	ii
DECLARATION	iii
ACKNOWLEDGEMENT	iv
ABSTRACT	v
<i>ABSTRAK</i>	vi
TABLE OF CONTENTS	vii
LIST OF TABLES	xiv
LIST OF FIGURES	xv
LIST OF ABBREVIATIONS	xxix
LIST OF SYMBOLS	xxx
CHAPTER 1 : INTRODUCTION	
1.1 Introduction	1
1.2 Motivation	2
1.3 Problem Background	6
1.4 Problem Statement	15
1.5 Research Question	16
1.6 Aim and Objectives of the Research	17

1.7	Scope of the Research	17
1.8	Organization of the Thesis	19

CHAPTER 2 : LITERATURE REVIEW

2.1	Introduction	20
2.2	Computer Graphics	20
2.3	Virtual Environment	25
	2.3.1 Rigid Bodies and Deformable Models for Collision Detection	25
	2.3.2 Types of 3D File	29
2.4	Collision Detection	31
	2.4.1 Discrete Collision Detection	31
	2.4.2 Continuous Collision Detection	36
2.5	Phase in Collision Detection	38
	2.5.1 Broad Phase Collision Detection	38
	a. Bounding-Volume	39
	i. Axis-Aligned Bounding Boxes (AABBs)	40
	ii. Sphere BV	42
	iii. Oriented Bounding Box (OBB)	43
	iv. Discrete oriented polytopes (k-dops)	44
	v. Oriented Convex Polyhedra (Oriented DOPs)	45

a.	Hierarchical Approach	46
i.	Concept of Hierarchical Tree Creation	46
2.5.2	Narrow Phase Collision Detection	50
2.6	Distance Computation	50
2.6.1	Application of Distance Computation	51
2.6.2	Criteria and Characteristic of Distance Computation	51
a.	Vertex-Vertex Applicability	52
b.	Edge-Edge Applicability	53
c.	Face-Face Applicability	54
2.6.3	Former Techniques of Distance Computation	54
a.	Lin-Canny Technique	54
b.	GJK Technique	57
2.7	Point of Contact	66
2.7.1	Voronoi Region	70
2.8	Penetration Depth	72
2.8.1	General Penetration Depth Technique	73
2.8.2	Penetration Depth Issues and Application	75
2.9	Summary and Discussion	77
 CHAPTER 3 : RESEARCH METHODOLOGY		
3.1	Overview	80

3.2	Research Design and Methodology	82
3.3	Proposed Technique Architecture	84
3.3.1	Setting up Environment	86
3.3.2	Object Loading and Bounding-Volume Construction	87
3.3.3	Axis-Aligned Bounding-Box (AABB) Construction	88
3.3.4	Broad Phase Collision Detection	93
3.3.5	Narrow Phase Collision Detection	93
3.3.6	Default Experiment Procedure and Collision Reporting	94
3.3.7	Collision Response and Output	97
3.4	Summary	97
 CHAPTER 4: DYNAMIC PIVOT POINT TECHNIQUE WITH DISTANCE COMPUTATION		
4.1	Introduction	99
4.2	Dynamic Pivot Point (DyOP)	101
4.3	Identification of Object Direction based on two AABB	101
4.3.1	Getting Internal AABB with Minimum and Maximum point of each Triangle	103
4.3.2	Special Case 1: Triangle ABC is in much higher location than Triangle PQR	105
4.3.3	Special Case 2: Minimum Y Triangle ABC point equal with Maximum Y Triangle PQR point	106

4.3.4	Special Case 3: Triangle ABC and Triangle PQR have equal points of Minimum Y points	108
4.4	Internal AABB	109
4.4.1	Distance Calculation	110
4.5	Experiment Setup for Dynamic Pivot Point (DyOP) of Distance Computation	119
4.5.1	DyOP Technique Implementation	121
a.	Initialize the DyOP	121
b.	Vertex to DyOP Calculation	126
c.	Finding Nearest Edge	128
d.	Vertex to Vertex Based on Two Candidates	129
e.	Vertex to Edge Calculation	131
4.5.2	Testing Environment	133
4.6	Performance Testing for Distance Computation	134
4.7	Distance Check Result	138
4.8	Distance Computation Implementation for 3D object	143
4.8.1	Vector to Face (Calculating distance between face) Calculation	146
4.9	Stanford Model 3D Experiment Setup	150
4.9.1	Time Detection and Computation Result and Analysis	152
a.	Stanford Model Time Detection	152
b.	Stanford Model Distance Check Experiment	158

4.10	Summary	165
------	---------	-----

CHAPTER 5: DyOP – POINT OF CONTACT

5.1	Introduction	166
5.2	Point of Contact (POC) Determination for 2D Concept	167
5.2.1	Triangle Point of Contact (2D Concept)	168
5.2.2	Finding Exact POC	170
5.3	Object Setup for Lin Canny and DyOP Technique	173
5.3.1	Lin-Canny Setup for Point Of Contact (POC)	173
5.4	Experiment Setup for DyOP POC technique	175
5.5	Result Analysis	179
5.6	Summary	187

CHAPTER 6: PENETRATION DEPTH BASED DYNAMIC PIVOT POINT (DyOP-PD)

6.1	Introduction	189
6.2	Penetration depth techniques for DyOP (DyOP-PD) for 2D Concept	191
6.2.1	DyOP Penetration depth for Triangle (2D Concept)	191
6.3	Object Setup for DyOP Penetration Depth	195
6.4	Experiment Analysis	196

6.4.1	DyOP-PD Technique	196
6.5	Result Analysis	197
6.6	Summary	204

CHAPTER 7 : CONCLUSION AND FUTURE WORK

7.1	Conclusion	205
7.2	Contributions – Dynamic Origin Point	207
4.9.1	Dynamic Origin Point for Distance Computation technique	207
7.2.2	Dynamic Origin Point for Point of Contact technique	208
7.2.3	Dynamic Origin Point for Penetration Depth	209
7.3	Future Work	209
7.3.1	Smart Edge Detection for Long Edge Triangle	209
7.3.2	BV Representation of DyOP	210
7.3.3	Multi-Dynamic Origin Point (MDyOP)	211

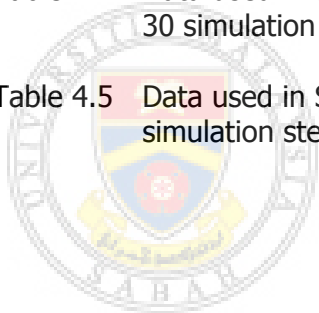
REFERENCES	212
-------------------	-----

APPENDICES

Appendix A – List of Publications	234
-----------------------------------	-----

LIST OF TABLES

	Page
Table 1.1 Techniques for Distance Computation	11
Table 1.2 Techniques for Point of Contact	12
Table 1.3 Techniques for Penetration Depth	14
Table 3.1 Four Orientation Tests for Object Movement	97
Table 4.1 Data for technique speed of distance computation	138
Table 4.2 Experiment for 3D DyOP Distance Computation	151
Table 4.3 Data used in Stanford Bunny experiment in Figure 4.57 for 30 simulation steps	162
Table 4.4 Data used in Stanford Teapot experiment in Figure 4.58 for 30 simulation steps	163
Table 4.5 Data used in Stanford Venus experiment in Figure 4.59 for 30 simulation steps	164



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LIST OF FIGURES

	Page
Figure 1.1: Application of Collision Detection. (a) Distance between complex objects (Ma <i>et al.</i> , 2012). (b) Point of Contact Determination (Bartoň <i>et al.</i> , 2010). (c) Penetration depth (Je <i>et al.</i> , 2012)	4
Figure 1.2: Collision Detection pipeline (Zachmann, 2001)	8
Figure 2.1: Rendering the Transformers "Megatron" (from Google Images)	22
Figure 2.2: Virtual Surgery simulation let the physician learn how to minimize the impact of risk for patient (De <i>et al.</i> , 2006)	22
Figure 2.3: ACM Classification System ((ACM), 2012)	24
Figure 2.4: Rigid Bodies (silver balls) and Deformable Bodies (yellow balls) (Shinar <i>et al.</i> , 2008)	26
Figure 2.5: (a) Tangential Collision and (b) Boundary Collision (Ming C. Lin <i>et al.</i> , 2004)	27
Figure 2.6: Several 3D Modelling software for creating 3D models	29
Figure 2.7: Lucy Model	30
Figure 2.8: World of Warcraft 3D online game (and soon to be in film) where players are free to communicate and interacting with each other (Entertainment, 2014)	32
Figure 2.9: Components of Collision Detection that is currently being researches by researchers	33
Figure 2.10: An example of computing distance between two objects where the d_{14} and d_{35} representing the distance between	34

two known points and projected along a continuous path
(Gilbert *et al.*, 1988)

Figure 2.11:	Differences between normal oct-tree and medial axis surface introduced by Hubbard (Hubbard, 1996)	35
Figure 2.12:	Continuous Collision Detection categories	36
Figure 2.13:	Differences between DCD method (a) and CCD method (b). DCD check for certain time steps, while CCD using advance motion calculation technique that continuously checks for intersection, which is more expensive in term of computation cost (Kipfer, 2007)	38
Figure 2.14:	Examples of common BVs as described in (Bade <i>et al.</i> , 2006)	40
Figure 2.15:	AABB representation: (a) Min-max; (b) Min-widths; (c) Centre-radius. X and Y coordinates system is shown in order to visualize the corresponding AABB into Cartesian coordinate in this example (source (Ericson, 2004))	41
Figure 2.16:	Sphere representations. " r " is the radius while " C " is the sphere centre	42
Figure 2.17:	Creation of OBB. " $e[0..2]$ " is the world coordinate for axis while " $u[0..2]$ " is the coordinate of OBB itself. " X " is the midpoint for the OBB located at very centre of the OBB	43
Figure 2.18:	Construction of Slab from two parallel planes by (Bade <i>et al.</i> , 2006)	43
Figure 2.19:	Approximation as depicted in (Klosowski <i>et al.</i> , 1998) where (a) is an AABB, (b) is an OBB, and (c) is the proposed k-dops where $k=8$	44
Figure 2.20:	An aircraft enclosed with a few k-dops	44

Figure 2.21:	Two sample of 3D set models (Santa and Dragon) bounded by Oriented Dops (Bade <i>et al.</i> , 2006)	45
Figure 2.22:	Space subdivision (a) and BVH (b). From (a), it encloses whole environment and divides the whole environment into two equal sizes while (b) only covers the whole objects and divides using splitting rules into certain sizes	46
Figure 2.23:	Hierarchy tree based of four objects using (a) top-down, (b) bottom-up, and (c) insertion construction (Ericson, 2004)	47
Figure 2.24:	Rule 1(left) group o has p as a child. Rule 2(middle) merging two primitive to create new o'. Rule 3(right) recursively insert primitive into parent nodes (Goldsmith <i>et al.</i> , 1987)	49
Figure 2.25:	Vertex to vertex applicability criterion where the closest features can be determined when both edges that represent point A and point B is collided	52
Figure 2.26:	Edge-Edge applicability criterion for closest distance between Edge A and Edge B that is always parallel for the nearest edge	53
Figure 2.27:	Face-face applicability test criterion where Face A is located at the bottom of cube M and Face B is located at the top of cube N	54
Figure 2.28:	Example of six possible cases proposed by M.C. Lin in order to determine the closest features between two convex polyhedral	56
Figure 2.29:	Convex shape of Obj_C obtained from the Minkowski Sum of all points from Obj_A and Obj_B	58

Figure 2.30:	Minkowski Difference of object A and Object B	59
Figure 2.31:	<i>Obj_C</i> obtained from Minkowski Difference operation and <i>Obj_D</i> obtained from Minkowski Sum operation	61
Figure 2.32:	Obtaining point $p1$ and $p2$ for the support function from <i>Obj_A</i> and <i>Obj_B</i> using positive-X direction	62
Figure 2.33:	Triangle region (called Simplex) that contain the origin (in red color) based on the support function procedure	64
Figure 2.34:	Simplex used for 2D distance computation	65
Figure 2.35:	POC connected by line segment (Chakraborty <i>et al.</i> , 2008)	67
Figure 2.36:	Lin Canny POC determination using Voronoi Region	68
Figure 2.37:	Voronoi region where space are filled with certain size of region based on the technique (WHITELAW, 2010)	69
Figure 2.38:	Voronoi Regions that is defined around a convex polygon (Kawachi <i>et al.</i> , 2000)	70
Figure 2.39:	Closest Feature of Voronoi Region in <i>Rb</i> (Kawachi <i>et al.</i> , 2000)	71
Figure 2.40:	Seven Voronoi feature region of triangle with one face region (F), three edge regions ($E_1 - E_3$) and three vertex regions ($V_1 - V_3$)	71
Figure 2.41:	Example of 3D Voronoi feature region where the left one is an edge region, the middle one is vertex region, and the right one is the face region	72
Figure 2.42:	Interpenetration technique let the user precisely position the door (B. V. Mirtich, 1996; Stéphane Redon <i>et al.</i> , 2002)	73

Figure 2.43:	A colliding pair between object A and object shows an arrow that represent total depth of overlap/penetration occurred. The image on the right side shows a corresponding Minkowski sum region when 0 is depicted as an origin point. The arrow also shows the same penetration depth using generalized penetration depth technique (Bergen, 2004)	74
Figure 2.44:	Spherical parameterization method that used binary classification in (X. Zhang <i>et al.</i> , 2014) where both object is bounded together and obtained their penetration depth	77
Figure 3.1:	Research Methodology	81
Figure 3.2:	IPO architecture for our proposed technique	85
Figure 3.3:	Setting up the environment development flow	87
Figure 3.4:	Stanford 3D Library models	88
Figure 3.5:	Continuous loops on finding the best maximum and minimum points for all axes in order to construct AABB based on the maximum and minimum points	89
Figure 3.6:	Coordination of AABB points	89
Figure 3.7:	Number assignment of each point for drawing AABB.	90
Figure 3.8:	(a) Pseudo code of drawing AABB bounding-volume	91
	(b) <i>GL_QUADS</i> function to draw six faces from AABB vertices where each arrow represents sequence of reading <code>glVertex3f</code>	91
Figure 3.9:	Transformation update for AABB	92

Figure 3.10:	Realignment of AABB based on transformation matrix for coordinate P into P'	92
Figure 3.11:	Initial Configuration for Collision Detection System	95
Figure 3.12:	Conditional for Four Orientation tes	96
Figure 4.1:	Dynamic Pivot Point with Distance Computation breakdown (red dash outline) from DyOP architecture for chapter four	100
Figure 4.2:	Overlap area (in red color) is shown for intersection between Obj A and Obj B that are bound with an AABB	100
Figure 4.3:	Dynamic Pivot Point construction process flow for this research	101
Figure 4.4:	Nearly intersected triangle ABC and PQR with their AABB in their simulation to perform distance computation	102
Figure 4.5:	Direction for example of triangle ABC and triangle PQR is indicated with two red arrows	103
Figure 4.6:	(a) Vertical parallel line (black bold line) created using vertex of C from Triangle ABC and vertex of P from Triangle PQR. These line is created using X_C and X_R from both triangles	104
	(b) Another horizontal parallel line (black bold line) created using vertex of A from Triangle ABC and vertex of Q from Triangle PQR for X_A and X_Q from both triangles	104
Figure 4.7:	A case where a Triangle ABC AABB is located at much higher location where the same X_A and X_C are used to create vertical parallel line and Y_A and Y_Q for horizontal parallel line	106

Figure 4.8:	A case where either each triangle has a same minimum or maximum point where in this example Y_A and Y_Q shared the same line thus creating a single horizontal line	107
Figure 4.9:	A case where the minimum points of Y_A , Y_P and Y_R are shared between Triangle ABC and Triangle PQR	108
Figure 4.10:	Internal AABB (in green border line) created using horizontal and vertical black bold line from four vertex points of Triangle ABC and Triangle PQR. A midpoint (in blue dot color) is calculated using these vertex points	109
Figure 4.11:	Finding shortest distance between two triangles	110
Figure 4.12:	Process of finding the distance between edge AC and edge PQ using 90 degrees of straight line between Triangle PQR to Triangle ABC through Dynamic Pivot Point (DyOP)	113
Figure 4.13:	By given an example of coordinates for all corresponding vertex points, we can determine the perpendicular line between both edges of AC and PQ	115
Figure 4.14:	Distance of D, between edge AC and edge PQ computed from all above steps	119
Figure 4.15:	Ten different sizes of triangle used in controlled experiment for Dynamic Pivot Point (DyOP) technique	120
Figure 4.16:	Initialize the DyOP	121
Figure 4.17:	Case 1 DyOP for X axis which is represented by TempMin line border and TempMax line border. Red arrow represented the direction of object movement	122
Figure 4.18:	Case 2 DyOP for X axis where object B is located now above the object A with the same direction. TempMax and	122

TempMin line borders have been changed for other candidates (vertex point)

Figure 4.19:	Case 3 DyOP where object B is located at the right hand side of the object A where TempMax and TempMin line borders have been changed to other candidates	123
Figure 4.20:	Initialize the DyOP using only $O(n)$ simulation step	124
Figure 4.21:	Case 1 DyOP for Y axis where TempYMax is represented the line border for object B and TempYMin line border for object A based on their best candidates selected from object A and object B AAB	124
Figure 4.22:	Case 2 DyOP for Y axis with different object location where TempYMax and TempYMin have been changed to new candidates from both object	125
Figure 4.23:	Case 3 DyOP for Y axis with different location where TempYMax and TempYMin also have changed their candidates	125
Figure 4.24:	Finding the X DyOP and Y DyOP	126
Figure 4.25:	Simple technique to compute all six vertex points	127
Figure 4.26:	Calculate Distance between Two Points	127
Figure 4.27:	Vertex to DyOP distance for each vertex points of both triangles	128
Figure 4.28:	Finding two vertex from a triangle. Each iteration consist of $O(n) + O(n)$ or $O(2n)$ complexity in Big-O notation	129
Figure 4.29:	Finding the distance between two candidates of both triangles	129

Figure 4.30: Finding the minimum distance with only $O(n)$ Big-O complexity notation (single for loop)	130
Figure 4.31: Vertex to Edge Calculation using Two Candidates	131
Figure 4.32: Finding 'm' and 'c' for both nearly intersected triangle	132
Figure 4.33: Test the condition of 90 degree straight line between a vertex point to an edge	132
Figure 4.34: Overall Speed for Distance Computation	135
Figure 4.35: Overall Speed in Percentage for Distance Computation	137
Figure 4.36: Minimum Distance Experiment DyOP with Lin Canny and GJK (where Lin Canny is overlapped with DyOP)	139
Figure 4.37: Minimum Distance for Obj1	140
Figure 4.38: Minimum Distance for Obj2	140
Figure 4.39: Minimum Distance for Obj3	140
Figure 4.40: Minimum Distance for Obj4	141
Figure 4.41: Minimum Distance for Obj5	141
Figure 4.42: Minimum Distance for Obj6	141
Figure 4.43: Minimum Distance for Obj7	142
Figure 4.44: Minimum Distance for Obj8	142
Figure 4.45: Minimum Distance for Obj9	142
Figure 4.46: Minimum Distance for Obj10	143
Figure 4.47: Proposed 3D Distance Computation Main technique for DyOP	143