**DYNAMIC IMITATION OF A HUMANOID ROBOT THROUGH NON PARAMETRIC PROBABILISTIC INFERENCE**

***BY***

**OLAWUYI SEGUN ORISUNOLA 20150204039**

**OMOLOLU ESTHER OLUWASEYI 20150204038**

**OYEBAMIJI OLUWAKEMI ESTHER 20150204029**

**IDOWU SADIAT MORENIKEJI 20150204075**

**OLATUNDE HAMMED 20140204077**

**A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF COMPUTER SCIENCE, TAI-SOLARIN UNIVERSITY OF EDUATION IJEBU-ODE, OGUN STATE.**

**IN PARTIAL FULLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELORS OF SCIENCE DEGREE IN EDUCATION (B.SC.Ed) COMPUTER SCIENCE.**

**OCTOBER, 2018**

**CERTIFICATION**

We certify that this research work was carried out by **OLAWUYI SEGUN ORISUNOLA** with matric number **20150204039**, **OMOLOLU ESTHER OLUWASEYI** with matric number **20150204038, OYEBAMIJI OLUWAKEMI ESTHER** with matric number **20150204029, IDOWU SADIAT MORENIKEJI** with matric number **20150204075, OLATUNDE HAMMED** with matric number **20140204077.**  Under the supervision in the Department of Computer Science, College of Science and Information Technology, Ijebu Ode, Ogun State.

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_**

**SUPERVISOR DATE**

**MR.OMILABU A.A**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**H.O.D DATE**

**DR. RUFAI K.I**

**DEDICATION**

This research project is dedicated to God Almighty, the guardian, protector and keeper of our life. We also dedicate it to our lovely and wonderful parents for their care and support for our life.

**ACKNOWLEDGMENT**

Our foremost acknowledgement goes to God almighty; the author and the finisher of our faith for the enablement given to me embark on this journey. All glory to His hallowed name.

We also give special thanks to our wonderful and loving parents who took pains, hardship and courage in making us who we are today to the glory of God. Regardless of the challenge and circumstance that surrounds them, they took it upon themselves to make sure we and our siblings get educated to become somebody great in life. We say a million thanks to them and we pray that they shall eat the fruit of their labour.

Our indebtedness also goes to our supervisor Mr. Omilabu A.O who out of his tight schedule still found time to supervise our project without negative reactions; the Lord will continue to be her strength. In the same way we wish to place on records our debt of gratitude to all our lecturers, they are: Dr. Rufai K.I (H.O.D), Dr. Alaba, Dr. Ogunsanwo, Mr. Usman, Mrs. Adedeji, Mrs Olusanya, Mr. Odulaja, Mrs. Ogunbanwo, Mrs. Abimbola, Mr. Adenubi

We also appreciate our friends and all our course mates, hostel mates for their immerse contributions to this research work.

Finally, we appreciate the typist who types this research work with patient and we also those who have contributed to the success of this project work in one way or the other. May God in his mercy bless you all (Amen).

***Abstract***

*We tackle the problem of learning imitative whole-body motions in a humanoid robot using probabilistic inference in Bayesian networks. Our inference-based approach affords a straightforward method to exploit rich yet uncertain prior information obtained from human motion capture data. Dynamic imitation implies that the robot must interact with its environment and account for forces such as gravity and inertia during imitation. Rather than explicitly modeling these forces and the body of the humanoid as in traditional approaches, we show that stable imitative motion can be achieved by learning a sensor based representation of dynamic balance. Bayesian networks provide a sound theoretical framework for combining prior kinematic information (from observing a human demonstrator) with prior dynamic information (based on previous experience) to model and subsequently infer motions which, with high probability, will be dynamically stable. By posing the problem as one of inference in a Bayesian network, we show that methods developed for approximate inference can be leveraged to efﬁciently perform inference of actions. Additionally, by using nonparametric inference and a nonparametric model, our approach does not make any strong assumptions about the physical environment or the mass and inertial properties of the humanoid robot. We propose an iterative, probabilistically constrained for exploring the space of motor commands and show that the model can quickly discover dynamically stable actions for whole-body imitation of human motion. Experimental results based on simulation and subsequent execution by a humanoid robot demonstrates that our algorithm is able to imitate a human performing action such as squatting.*

**TABLE OF CONTENTS**

TITLE PAGE i

CERTIFICATION ii

DEDICATION iii

ACKNOWLEDGEMENT v

ABSTRACT vi

TABLE OF CONTENTS vii

**CHAPTER ONE**

1. INTRODUCTION 1

1.1 BACKGROUND TO THE STUDY 1-2

1.2 STATEMENT OF THE PROBLEM 2

1.3 PURPOSE OF THE STUDY 2-3

1.4 SIGNIFICANCE OF THE STUDY 3

1.5 SCOPE/DELIMITATION OF THE STUDY 3

1.6 LIMITATION OF THE STUDY 3-4

1.7 OPERATIONAL DEFINITION OF TERMS 4-6

**CHAPTER TWO**

2.0 REVIEW OF RELATED LITERATURE 7

2.0 INTRODUCTION 8

2.1 THEORETICAL FRAMEWORK 8-10

2.2 HISTORY OF ROBOTS 10-11

2.2.1 ROBOTIC CONCEPTS 11-12

2.2.2 EARLY BEGNINIG IN ROBOT DEVELOPMENTS 12-15

2.2.3 ROBOTIC BEYOND 2000 15-16

2.3 MODERN AUTONOMOUS ROBOTS 16-18

2.4 HUMANOID 18

2.4.1 HUMANOID IN THEORATICAL CONVERGENT EVOLUTION 18-20

2.4.2 HUMANOID ROBOTICS 21-22

2.4.3 PURPOSE OF HUMANOID ROBOTS 22-23

2.5 SENSORS 23

2.5.1 PROPRIOCEPTIVE SENSORS 23-24

2.5.2 EXEROCEPTIVE SENSONRS 24

2.5.3 ACTUATORS 24-25

2.5 PLANNING AND CONTROL OF HUMOID ROBOTS 25-26

2.7 DYNAMIC HUMANOID ROBOTS 27

**CHAPTER THREE**

3.1 INTRODUCTION 28

3.2 RESEARCH METHODOLOGY 29

3.3 KNOWLEDGE ACQUISITION 29-30

3.4 SYSTEM DESIGN 30-34

3.4.2 NONPARAMETRIC FORWARD MODEL LEARNING 34-27

3.5 FLOWCHART OF THE PROGRAM 37-39

**CHAPTER FOUR**

4.0 INTRODUCTION 40-44

4.2 SPECIFICATIONS AND DESIGN 44-46

4.5 SYSTEM SETTINGS 46-47

4.6 SYSTEM REQUIREMENTS 47-48

**CHAPTER FIVE**

5.1 SUMMARY, CONCLUSION AND RECOMMENDATION 49

5.2 CONCLUSION OF THE STUDY 49

5.3 RECOMMENDATIONS 50

**REFERENCES**

**APPENDIX**