LEARNING THE INVERSE KINEMATICS AND DYNAMICS OF 6-DOF MANIPULATOR USING NEURAL NETWORK

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BADRI VISHAL PANDEY

(Enrollment No.131203107758)

Under the Supervision of
DR. JITENDRA KUMAR

to the

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CENTRE FOR ADVANCED STUDIES LUCKNOW

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW
(Formerly Uttar Pradesh Technical University)

September, 2022

DECLARATION

I hereby declare that the work described in the report "**Learning the Inverse Kinematics and Dynamics of 6-DOF Manipulator Using Neural Network**" submitted here is my original work and that, to the best of my knowledge and belief, it does not contain any previously published or written works by other authors or any materials that have been approved for the award of any other degree or diploma by the university or other institution of higher education, with the exception of those instances where appropriate citation has been made in the text.

Name: **Badri Vishal Pandey**

Enrollment No.: **131203107758**

Program: **Mechatronics**

(Candidate's Signature)

Date: 16/09/22

Place: CAS, Lucknow

CERTIFICATE

Certified that **Badri Vishal Pandey** (Enrollment No.131203107758) has carried out the research work presented in this thesis entitled "**Learning the Inverse Kinematics and Dynamics of 6-DOF Manipulator Using Neural Network**" for the award of **Master of Technology** from Centre for Advanced Studies, Dr. A.P.J. Abdul Kalam Technical University, Lucknow under my supervision. The thesis embodies results of original work, and studies are carried out by the student himself and the contents of the thesis do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University/Institution.

Signature
Dr. Jitendra Kumar
Assistant Professor
Manufacturing and Automation Program
Centre for Advanced Studies, AKTU, Lucknow

The M.Tech Viva-Voce examination of **Badri Vishal Pandey**, (Enrollment No.**131203107758)** has been held on 28th July 2022 and is accepted.

16/9/2022

Signature
Dr. Anuj Kumar Sharma
Program Coordinator
Mechatronics Program
Centre for Advanced Studies, AKTU, Lucknow

ABSTRACT

In the current state of industry, robot manipulators are needed to complete tasks more quickly and accurately. The serial robot manipulator has established its value in sectors like manufacturing, space exploration, and medical. Generally robot manipulators having simple geometry are preferred so that mathematical modelling may be done with ease. A trajectory is required for a robot to execute a task, and this will be investigated with the aid of the robot's kinematics and dynamics. In this thesis, the inverse kinematics (IK) and dynamics of a six-degree of freedom (DOF) robot are solved using a multilayer feedforward backpropagation type neural network (NN). Because 6-DOF robot can carry out any task (pick and place, painting, surgery, etc.) inside its workspace. Without taking forces into account, the study of kinematics focuses on joint position, velocity, and acceleration. Denavit & Hartenberg (DH) method has been used for kinematic modelling. The forward kinematics (FK) gives the position and orientation from joint angles of the robot while inverse kinematics gives the joint angles information from the position and orientation. For the first three joints, the inverse kinematics has been geometrically resolved by solving trigonometric equations and algebra using a new technique by projection on a 2D plane. Kinematics and the forces acting are both included in dynamics. The dynamics is important for the planning, simulation, and control of robot motion because it provides information on the forces acting and the robot's energy usage. The MATLAB Robotics toolbox has been used to perform dynamics and the Deep Learning Toolbox to perform neural network training. The neural network has been trained by using two algorithms Levenberg-Marquardt (LM) and Scaled Conjugate Gradient Algorithm (SCG). The trained neural network will be used to forecast joint position and torque values of the joints on a trajectory, which will save time and provide for flexibility by allowing us to construct a hypothesis about what should happen when the experiment is actually carried out. The training analysis of the neural network gives information on the neural network's predicting accuracy as well as how well it learned the dataset.

Keywords. Inverse Kinematics, Dynamics, Neural Network, Trajectory Planning

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Badri Vishal Pandey
M.Tech. (Mechatronics)
Centre for Advanced Studies, AKTU,Lucknow

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ABBREVIATIONS

ANN	Artificial Neural Network
COM	Center of Mass
DH	Denavit-Hartenberg
DOF	Degree of Freedom
FK	Forward Kinematics
IK	Inverse Kinematics
LM	Levenberg-Marquardt
MSE	Mean Squared Error
NE	Newton Euler
NN	Neural Network
PUMA	Programmable Universal Machine for Assembly
RM	Redundant Manipulator
RNE	Recursive Newton Euler
SCG	Scaled Conjugate Gradient

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