DECLARATION

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

The articulating surface of a conventional knee-component is as generic shape while every individual patient has a unique shape of knee joint and this is causes some problems. The Conventional implants give a satisfactory result in many cases that bring the patient back to a near normal and active lifestyle especially for younger patients. Most patients' gaits are altered after a total knee arthroplasty (TKA) and proper walking and ambulation has to be relearned due to the change in surface geometry. In this study, a custom design for femoral implant with maintains the articulating surface of and the implant-bone interface as natural knee is necessary to address the most common problems found with conventional knee component. This was done by creating 3D models from computerized tomography (CT) scan data through computer segmentation using Materialise MIMICS 10.01. It converts the 3D model into a stl file format. Geomagic studio 2012 was used in this study for smoothing and preparation of the model. The STL file was imported from Mimics to Geomagic Studio. The model is now ready for femoral component design; however, the best 3D CAD model file would be in STEP format. Geomagic Studio cannot directly convert STL files into STEP files. This process involves generating closed NURBS (Non Uniform Rational B-Spline) surfaces. The 3D model as STEP format was then exported from Geomagic Studio to CAD design software for design on the femoral components of the implant. Based on the powerful feature options and availability, solidworks (Solidworks, USA) was selected for this thesis. The 3D model of the femur was imported into solidworks as STEP format. From 3D model of the femur, a custom knee implant femoral component was designed. Finite Element Analysis is used to examine the stress distribution in the implant-bone interface and compare the proposed design of a custom femoral component with a conventional design. A 3D finite element (FE) model of the femoral implant was developed in ANSYS Workbench. The proposed custom design as smooth surface shows a more even stress distribution on the implant bone interface, which will reduce the uneven bone remodeling that can lead to premature loosening.

Keyword: knee-component, TKA, 3D femoral component, Conventional implants, STEP format.

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LIST OF SYMBOLS USED

ACL	Anterior Cruciate Ligament
C	Curves
CAD	Computer Aided Design
CD	Compact disc
CG	Center of mass
CoCr	Cobalt-Chromium alloy
CT	Computed Tomography
DICOM	Digital Imaging and Communications in Medicine
DXF	Drawing Exchange Format
E	Elastic Modulus
EBM	Electron Beam Melting
FE	Finite Element
FEA	Finite Element Analysis
Ib	Pound
IGES	Initial Graphics Exchange Specification
L	Line
LCL	Lateral Collateral Ligaments
MCL	Medial Collateral Ligaments
NURBS	Non Uniform Rational B-Spline
PCL	Posterior Cruciate Ligament
RT	Rapid Tooling
STEP	Standardized Graphic Exchange file format
STL	STereoLithography
TKA	Total Knee Arthroplasty
TKR	Total knee replacement
UHMWPE	Ultra High Molecular Weight Polyethylene
VRML	Virtual Reality Modeling Language
I	Moment of Inertia
M	Bending Moment
y	Deflection
ρ	apparent density
σ	Maximum bending stress
t	minimum thickness
in	Inch
mm	Millimeter
N	Newton
GPa	Giga Pascal
MPa	Mega Pascal