Multiple Configuration Shell-Core Structured Robotic Manipulator with Interchangeable Mechatronic Joints

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Abstract

With the increase of robotic technology utilised throughout industry, the need for skilled labour in this area has increased also. As a result, education dealing with robotics has grown at both the high-school and tertiary educational level. Despite the range of pedagogical robots currently on the market, there seems to be a low variety of these systems specifically related to the types of robotic manipulator arms popular for industrial applications. Furthermore, a fixed-arm system is limited to only serve as an educational supplement for that specific configuration and therefore cannot demonstrate more than one of the numerous industrial-type robotic arms.

The Shell-Core structured robotic manipulator concept has been proposed to improve the quality and variety of available pedagogical robotic arm systems on the market. This is achieved by the reconfigurable nature of the concept, which incorporates shell and core structural units to make the construction of at least 5 mainstream industrial arms possible. The platform will be suitable, but not limited to use within the educational robotics industry at high-school and higher educational levels and may appeal to hobbyists.

Later dubbed SMILE (Smart Manipulator with Interchangeable Links and Effectors), the system utilises core units to provide either rotational or linear actuation in a single plane. A variety of shell units are then implemented as the body of the robotic arm, serving as appropriate offsets to achieve the required configuration. A prototype consisting of a limited number of *'building blocks'* was developed for proof-of-concept, found capable of achieving several of the proposed configurations.

The outcome of this research is encouraging, with a Massey patent search confirming the unique features of the proposed concept. The prototype system is an economic, easy to implement, plug and play, and multiple - configuration robotic manipulator, suitable for various applications.

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List of Abbreviations

3D: 3-Dimensional
CAD: Computer Aided Design
CAM: Computer Aided Manufacturing
CAN: Controller Area Network
CD: Compact Disc
CMY: Cyan Magenta Yellow
CNC: Computer Numerical Control
CPR: Commonplace Robotics
DC: Direct Current
DOF: Degrees Of Freedom
FEA: Finite Element Analysis
FSR: Force Sensing Resistor
GUI: Graphical User Interface
HP: High-Power
I^2C: Inter-Integrated Circuit
ID: Identification
IO or I/O: Input Output
LED: Light Emitting Diode
LSC: Laser Slit-scan Camera
MOSFET: Metal-Oxide Semiconductor Field-Effect Transistor
MP: Medium-Power
MPC: Model based Predictive Controller
MTTR: Mean Time To Repair
PC: Personal Computer
PCB: Printed Circuit Board
PI: Proportional Integral
PIC: Peripheral Interface Controller
PID: Proportional Integral Derivative
PSU: Power Supply Unit
PUMA: Programmable Universal Machine for Assembly
PWM: Pulse Width Modulation
RGB: Red Green Blue
ROS: Robotic Operating System
RPM: Revolutions Per Minute
SCARA: Selective Compliance Assembly Robot Arm
SDA: Serial Data Line
SLC: Serial Clock Line
SMILE: Smart Manipulator with Interchangeable Links and Effectors
SMT: Surface Mounted Technology
STEM: Science, Technology, Engineering and Mathematics
TITO: Two Input Two Output
UK: United Kingdom
US: United States
USB: Universal Serial Bus
USD: United States Dollar
VP: Velocity Profile