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HASIL PENILAIAN SEJAWAT SEBIDANG ATAU *PEER REVIEW*
KARYA ILMIAH : PROSIDING

Judul Karya Ilmiah	:	A Low Cost Anthropomorphic Prosthetic hand Using DC Micro Metal Gear motor		
Jumlah Penulis	:	6 Orang		
Status Pengusul	:	Penulis ke-3		
Identitas Prosiding	:	a. Judul Prosiding	:	2016 3rd International Conference on Information Technology, Computer, and Electrical Engineering (ICITACEE)
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		c. Thn Terbit, Tempat Pelaks.	:	2017, Semarang-Indonesia
		d. Penerbit/Organiser	:	IEEE
		e. Alamat Repository/Web	:	https://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=7887878
		Alamat Artikel	:	https://www.researchgate.net/publication/315872909_A_low_cost_anthropomorphic_prosthetic_hand_using_DC_micro_metal_gear_motor
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Semarang, 14 Mei 2019

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4 April 2017, Article number 7892407, Pages 42-46
3rd International Conference on Information Technology, Computer, and Electrical Engineering, ICITACEE 2016; Hom HotelSemarang; Indonesia; 19 October 2016 through 21 October 2016;
Category numberCFP1689Z-PRT; Code 127215

A low cost anthropomorphic prosthetic hand using DC micro metal gear motor (Conference Paper)

Ariyanto, M. ✉, Munadi, Haryadi, G.D. , Ismail, R., Pakpahan, J.A., Mustaqim, K.A.

Department of Mechanical Engineering, Diponegoro University, Semarang, Indonesia

Abstract

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This research focus on developing of low cost anthropomorphic prosthetic hand using DC micro metal gear motor. The DC metal gear motor is selected as actuator because it is easy to find, low cost, and light weight. The prosthetic hand is based on 3D printed material that enables it light weight, low cost, easy to manufacture and easy to maintain. The mechanism of the hand is based on the tendon spring mechanism. The prosthetic hand has five degree of freedom (DOF) and two joints in each finger. For performing the activities of daily living (ADLs), the hand is designed with seven grip patterns. Based on the experimental results in grasping test and writing test on the white board, the hand can be used as low cost prosthetic hand replacing the passive prosthetic hand that has been available on the market. © 2016 IEEE.

SciVal Topic Prominence

Topic: Electromyography | Prosthetics | Prosthesis control

Prominence percentile: 99.090

Author keywords

anthropomorphic | DC motor | low cost | prosthetic hand

Indexed keywords

Engineering controlled terms: 3D printers | Costs | DC motors | Degrees of freedom (mechanics) | Micromotors

Engineering uncontrolled terms: Activities of daily living (ADLs) | anthropomorphic | Anthropomorphic prosthetic hands | Degree of freedom (dof) | Low costs | Printed materials | Prosthetic hands | Spring mechanism

Engineering main heading: Prosthetics

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as been available on the market.

ıd design in

The Developed prosthetic hand.

Complete hardware system of robotic prosthetic hand.

16 3rd Int. Conf. on Information Tech., Computer, and Electrical Engineering (ICITACEE), Oct 19-21st, 2016, Semarang, Ir

Low Cost Anthropomorphic Prosthetic h Using DC Micro Metal Gear motor

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Semarang, Indonesia

This research focus on developing of low cost hic prosthetic hand using DC micro metal gear C metal gear motor is selected as actuator because id, low cost, and light weight. The prosthetic hand printed material that enables it light weight, low anufacture and easy to maintain. The mechanism s based on the tendon spring mechanism. The d has five degree of freedom (DOF) and two joints r. For performing the activities of daily living and is designed with seven grip patterns. Based on

tal results in grasping test and writing test on the he hand can be used as low cost prosthetic hand assive prosthetic hand that has been available on

-low cost; DC motor; prosthetic hand;

hardware memory in the microcontroller. T algorithm is developed in this research using potentiometer signal to drive several grip pa hand.

Some open source hand is available today and to increase manufacturability. Open sour based on 3D print are widely used Ada Ha Bionics and Dextrus [4] from Open Hand Pr the art prosthetic hands commercially avai

Hand [5], Michelangelo [6], Bebionic [7], an have great performance in ADLs especially f manipulation but they are still very expensive

In this paper, the research goal is tr affordable five DOF robotic prosthetic hand

hic

I. INTRODUCTION

rch of robotic hand has grown significantly the development of robotic prosthetic hand research hand to commercial hand. The available nd in the market with great features is very ıt make it only certain people can buy it. The ıis research is to develop a low cost prosthetic idely used mechatronics components. The hand to manufacture, and easy to maintain with the ıponent in the market. The prosthetic hand also to perform activities of daily living (ADLs) such , and hold an object.

searches about prosthetic hand significantly the size, weight, and anthropomorphism. The ıd is used to replace the lost hand especially for nputation. In order to the prosthetic hand can command from the remaining muscle of the hand must read the muscle activities by using nost widely used sensor for reading the muscle lectromyography (EMG) sensor. Some research ttern recognition method of the EMG signal to e hand movement or gesture. One of common nition method in the EMG signal recognition is k [1,2]. This method is difficult to implement in hand control system due to the limitation of low cost DC metal gear motor incorporat mechanism. The proposed of the prosthetic to grasping task with various objects and pe daily living (ADLs). Based on the ref [9 grasping pattern is power grip followed by p prosthetic hand is designed with seven grip object grasping manipulation.

II. PROSTHETIC HAND DESIG

In this paper, five degree of freedom robotic hand was proposed and designed usin DC motor. Each finger comprises of two j Micro Metal Gear motor. As summarized ir robotic prosthetic hand have five DOF ar thumb has one DOF or two DOF. The five because it can do sufficient ADLs, reduce mechanism design, and also reduce the manu of prosthetic hands implement linkage a mechanism. The proposed prosthetic hand is v.1.

The distal interphalangeal (DIP) joint w fixed angle at 20 degrees. Where the met joint (MCP) and proximal inter-phalangeal rotated from 0 degree to 90 degrees. A torsic in the middle of 1 mm shaft. The shaft is u each finger.

The tendon-spring mechanism is connec Metal Gearmotor. For finger flexion or clos

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ıe DC motor rotates and pulls down the finger. sion or opening the finger, the DC motor rotates ection and the spring-torsion will move the finger. is designed using SolidWorks Computer Aided)) software. SolidWorks is utilized because of nd operate. The solid model of prosthetic hand e exported into SimMechanics model for 3D d kinematics analysis purposes. The 3D CAD prosthetic hand cover can be seen in Fig. 1. In

roposed of prosthetic hand has the same size and the natural human hand, all of mechatronics s are designed to fit into the hand. Five DC motor the palm. Arduino Nano microcontroller, PCB, otor are place in the back cover of the hand. The

Fig. 2. The Developed prosthetic hand.

ed on the socket or out of the hand.

TABLE I. THE FINGER LENGTH OF PROS

Fingers	Distal Medial (mm)	Prox (m
Thumb	61	4
Index	41	4
Middle	41	4
Ring	41	4
Little	34	3

The size of the prosthetic hand is 180 mm i in width, and 50 mm in thick. The ove prosthetic hand is 261 grams. The size, sha the prosthetic hand approach with the hur This is very lightweight prosthetic h user/transradial amputee used it as prosthetic manipulate object grasping task without f general characteristics comparison of AstoH summarized in Table 2. Based on the Tabl available robotic hand varies from 261 gr to 7

alm, and hand design in SolidWorks.

model is developed in SolidWorks, the model rinted using 3D printer. The hand is made from tic Acid) material. The material is selected due to roperty. The 3D hand model of this prosthetic ed by Ada Hand from Open Bionics. The 3D print n, back cover and the fingers are shown by Fig. 2. each finger is summarized in Table I. The length al in index, middle, and ring is designed with the The final assembly if proposed prosthetic hand, ttery are shown in Fig. 3.

Fig. 3. Complete hardware system of robotic prosthetic

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GENERAL CHARACTERISTICS OF SOME PROSTHETIC HANDS

-	Mass (g)	Size (length x width x thickness, mm)	Numb. of Joint	DOF	Numb. Of Actua-tor	Motor Actu-ator Type	Joint couple method
- ty	261	180 x 85 x 50	10	5	5	DC Motor	Tendon - spring
	380	215x 178 x 58	10	5	5	Lead screw	Tendon
	428	205 x 88 x 45	15	6	6	Ten-don DC Motor	Tendon
t	-	-	11	6	6	worm gear Motor	Linkage
	420	-	6	2	2	-	Cam design to all finger
	495-539	198 x 9 0 x 50	11	6	5	Lead Screw Motor	Lingkage
	495-539	190-200 x 84 -92 x 50	11	6	5	Lead Screw Motor	Lingkage
	450-615	180-182 x 75 -80 x 3541	11	6	5	worm gear Motor	Tendon
	460-465	180-182 x 75- 80 x 35 -45	11	6	5	worm gear Motor	Tendon

HARDWARE AND SOFTWARE SYSTEM

tion, the hardware and software will be presented . The main hardware components in in the hand Nano microcontroller, using DC micro metal CB, and motor driver. The control algorithm and em of the robotic prosthetic hand are developed Simulink environment.

d five DC micro metal gear motors is shown in tal mass of the motor is 45 gr. L293D Dual H- l to control the direction of rotation and angular or. The general properties of this motor can be n Table III. This motor is selected as an actuator tic hand because it gives enough torque to drive ith tendon spring mechanism. Furthermore, the ıe low energy when the motor is run.

Fig. 4. Five DC micro metal gearmotor GA12 N20 as a

TABLE III. DC MICRO METAL GEARMOTO

Properties	
Working voltage	
Current consumption with load	
Current consumption with no load	
Maximum angular velocity	300 rp

For the brain of the prosthetic hand, A chosen because it is an open source an platform. Moreover, Arduino Nano can be p widely used computational software like MA It has 32 KB flash memory for saving the c of prosthetic hand. It also has 14 digital inpu which make it suitable for controlling fi actuator. Two 18650 Li-Ion batteries is emp as power source of the motors, RGB LED, Arduino Nano microcontroller. The batte series. Each battery has voltage of 3.7 V an mAh. Before the power from battery goes micro controller, it passes to step do converting the voltage from input with 3-40 V. The selected output voltage is 5 V.

Fig. 5. 18650 Li-Ion battery.

The total mass of the hand excluding the ba

is 261 gr. The most weight of the prosthetic h 3D print material and the tendon spring-mech which can reach to 70 % of overall prosthetic

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centage of the proposed prosthetic hand.

ation of prosthetic hand, the control algorithm
n Simulink as can be seen in Fig. 7. The block is
ıto Arduino Nano using Simulink Support
Arduino that can be freely downloaded on
Website. The electromyography (EMG) or
can be used as sensor input to the hand system.
tput is red using Analog input Block. The digital
to read the tactile switch state for selecting the
atterns. The counter computation is used for
oop of seven grip patterns. The motor rotation
etermined by using digital output block and the
l is controlled using PWM output block. The
the AstoHand v.1 operation system is depicted in
urrent grip pattern is indicated by the color of
AstoHand v.1 can communicate with computer
B. The communication is based on an 115200
it word, 1 stop bit, and no parity.

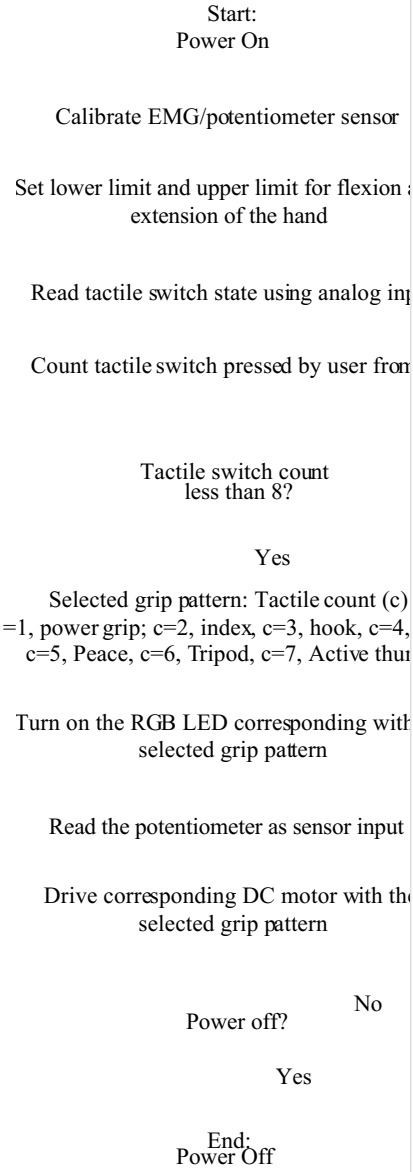

Fig. 8. AstoHand v.1 operation system.

Seven grip patterns as shown in Fig. 9 are s

d block diagram of prosthetic hand control.

IV. EXPERIMENTS AND RESULTS

mbly process of prosthetic hand main parts, the d is tested in grip pattern, grasping, and writing p pattern test, the hand is tested to perform seven using potentiometer as signal input. Based on the result shown in Fig. 9, the prosthetic hand can perform seven grip patterns. The seven grip ower grip, index, hook, pinch, peace, tripod, and The running current grip pattern is indicated with ding RGB LED on the back cover of the d.

it can perform activities of daily living grasping and hold various shape and size of next test, the proposed prosthetic hand is tes and hold six objects. Based on the exper shown in Fig. 10, the prosthetic hand can sta objects such as water in the bottle, water in screwdriver, TV Remote, and pliers. In prosthetic hand is tested to take and grasp then write the words “Asto Hand v10” on the prosthetic hand can successfully write the market as shown in Fig. 11. The performanc prosthetic hand can be seen online https://www.youtube.com/watch?v=qg3Tugz

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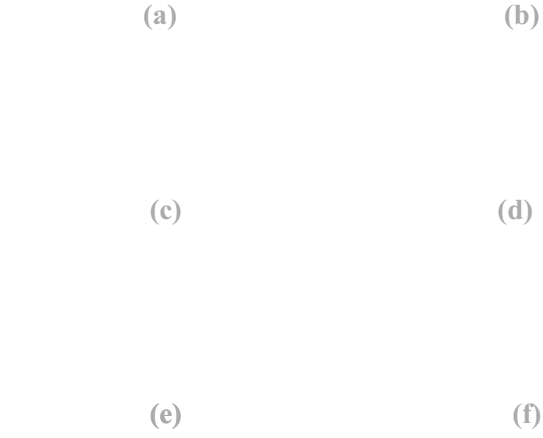
(a) **(b)** **(c)**

(d) **(e)** **(f)**

(g)

g pattern of proposed prosthetic hand: (a) Power grip, (b) d) Pinch, (e) Peace, (f) Tripod, (g) Active thumb.

turn on to indicate the selected current grip the experimental on gripping task, the pro stably grasp and hold six objects ranging in s hand can also do a writing test on whitebo experimental results, the hand can be u prosthetic hand replacing the passive pro available on the market. For further developn be integrated with socket, and 3D Animation.



objects grasping of robotic prosthetic hand: (a) Water in the in a cup, (c) Glue gun, (d) Screwdriver, (e) TV Remote,

V. CONCLUSIONS

osed of the prosthetic hand has 261 grams in DC motors as actuator give the hand lightweight low cost prosthetic hand. This hand can be used hand for transradial prosthesis because of its size which approach the human hand. The prosthetic seven grip patterns that enable it to do activities g (ADLs). The grip pattern can be selected by actile switch. The corresponding RGB LED will

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Fig. 11. Sequence images of writing test.

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prosthetic hand are aimed to get the prosthesis more lightweight, easy to maintenance, and low cost. Low etic hands for transradial prosthesis have been studied and developed based on 3D print technology [1][2] [3] ls show the promising results in object manipulation task such as grasp and hold an object in different size

d kinematics results on RT and RF, it can be concluded that to increase the workingspace of grasping, the increased. The joint angle 3 θ must be large enough if the object that must be grasped is big and long. ...

supernumerary robotic fingers as an assistive device

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een designed with great performance for carrying out the daily activities, but the problem is the price is still or the majority of Indonesian people. Ariyanto et al. [3] , in 2016, investigated about the low cost of netic hand. The target is to create a prosthetic hand that is affordable to Indonesian people. ...

ess and displacement on the index finger of the prosthetic hand due to hook position

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ies in the literature to increase the gripping ability of multi-finger robots. Machomad et al. were focus on anthropomorphic prosthetic hand, and they designed 14 Dof prosthetic hand via SimMechanics first . Asif was presented analytical modeling of hand via SimMechanics and PID controller response of five al. developed a robotic prosthetic hand capable of producing ten grip patterns and simulated hand pattern via study [43]. ...

ntrol for sEMG based prosthetic hand

r Tanyıldızı · Arif Gulten · Oguz Yakut

our proposed prosthetic hand named Asto Hand v2 has little difference in mechanical properties from the other nds. Asto Hand v2 is the extension development of the previous prosthetic hand with DC motors as actuators prosthetic hands use DC motor as actuator to drive the fingers movement. ...

c Hand Augmented with 3D Virtual Hand for Transradial Prosthesis

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e hand or foot. The research in the prosthetics hand is aimed to achieve the prosthetic more affordable, easy eliable [1][2] [3] [4]. Commonly, low cost prosthetic hands that have been studied in universities are used 3D ostheses that attached on the human foot, powered ankle-foot prosthesis has been successfully developed by [5][6]. ...

exoskeleton robotic fingers for patient with hand function disability

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Driving of Electric Arm Prosthesis by The Signal of Balloon Shaped Soft Pressure Sensors: -Picking u...

January 2016

Nozomi HAYASAKA · Shun Yamaguchi · Akitoshi ITO

Our objective is to develop soft pressure sensors to control the electric arm prosthesis by measuring the movement of muscles for the control signals instead of EMG. In our previous research, we made refined sensors that has black inner sidewall white inner ceiling at the topside. By using this refined sensor, we succeeded match better controllability of the finger opening speed and finger ... [Show full abstract]

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Design and analysis of a polymeric photo-thermal microactuator

September 2008 · Sensors and Actuators A Physical

Caglar Elbuken · Lin Gui · Carolyn L Ren · [...] · Mir Behrad Khamesee

This paper presents the modeling, simulation and characterization of a photo-thermally actuated bent-beam microactuator. The microactuator consists of a single polymeric layer (SU-8) fabricated with conventional photolithography techniques. The principle of operation is based on the thermal expansion of the bent-beams that absorb the required heat by laser illumination. This provides an effective ... [Show full abstract]

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HyPro : A multi-DoF Hybrid Powered Transradial Robotic Prosthesis

November 2017 · Journal of Robotics

Chathura Semasinghe · R. K. P. S. Ranaweera · Buddika Prasanna · [...] · Ruwan Chandra Gopura

This paper proposes a multi-DoF hybrid powered transradial robotic prosthesis, named HyPro. The HyPro consists two prosthetic units: hand and wrist, that can achieve five grasping patterns such as power grasp, tip grasp, lateral grasp, hook grasp and index point. It is an underactuated device with 15 degrees of freedom. A hybrid powering concept is proposed and implemented on hand-unit of HyPro ... [Show full abstract]

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Design and Fabrication of a Three-Finger Prosthetic Hand using SMA muscle wires

March 2015 · Proceedings of SPIE - The International Society for Optical Engineering

Filomena Simone · Alexander York · Stefan Seelecke

Bio-inspired hand-like gripper systems based on shape memory alloy (SMA) wire actuation have the potential to enable a number of useful applications in, e.g., the biomedical field or industrial assembly systems. The inherent high energy density makes SMA solutions a natural choice for systems with lightweight, low noise and high force requirements, such as hand prostheses or robotic systems in a ... [Show full abstract]

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