Design and Implementation Of Haptic Robot Arm

Hussein Hadam Olewi

Dr. Wael Rasheed Abdulmajee

Al-Khwarizmi College of engineering

University of Baghdad

Abstract: -

The present paper implement haptic's idea in both ways wire and wireless communications. The basic robot arm parts build by 3D printing technique.PID control are implementing in wiring communication by using lab view program and the temperature sensor type (LM35) is used as a feedback for PID controller. (XCTU) is the main program which is using to make Configuration for both zagbee devices router and coordinator.If the robot arm finger's touch an object with temperature more than 36^{o} the hand will be open at 180^{o} else the finger move according to flex sensor signals.

Keywords: - smart glove; flex sensor; lab view; mathematical modeling; ardunino;3d printing.

I . Introduction

Robotics is an engineering field which assisted to reduce human efforts. The contrivance of robots has helped to increase the Accuracy and frequency in many aspects of process which will be hard to use hands of human. as well as, human interference to supervise the robot through human deeds robot hand [12].Parts of robot hand make by 3D Printing can be identified as operation to create new shape from digital design by additive things. You can print with many 3D printing technologies and materials, which [4].Haptics is identified as the science of application of touch sensing and control to interact with virtual or physical applications In this paper, our aim are how to sense the environment temperature and then control the movement for robot hand finger by using PID controller second implement wireless communication between human hand and

follow the same steps: a digital model which is turned into a solid 3D physical object by adding layer up to layer and both these layer are metal[3]. lab view It is the development of a software which contains many components, several of which are required for any type of test, measurement, or control application using labview for wire communication [9].Using zagbee devices for wire less communication

II. implement haptic idea by wire communication

- **Flex sensors:**

It can use many type of sensors to implement haptics idea such as flex sensors which are used in the finger or potentiometer to trace the movements of the hands. Flex sensors are analog resistors. These resistors function as changeable analog voltage divider. within the flex sensor there are components resisting carbon with tender flex substrate. When the Interactive material is bent, the sensor generates impedance product related to the bend radius. The flex sensor achieves great form-factor on a thin flex Interactive material. When the Interactive material is bent, the sensor generates a impedance product linked to the curvature radius as shown in **Fig.1** and **Fig.2** [1]

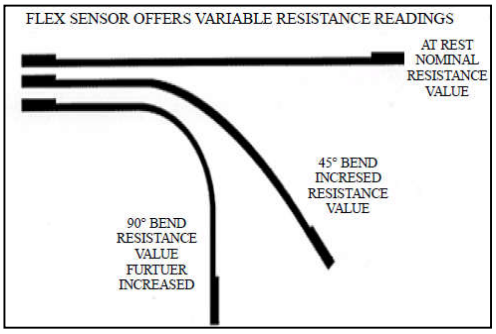

Fig. 1 Flex curvature bend relative to variuos degree of impedance [1].

Fig.2. Smart glove (flex sensor with glove).

- **Servo motor**

A Servo Motors become widely used in manufacturing implementations that need high effectiveness on placement observation, for example digitally observed machine, robots, automation and other technique where it's functions are for starting and stopping quickly and accurately. A high-velocity observation precision and a high effectiveness response are very important for these required applications In robot implementations, supporting engines are used to transmit the arm of robot to a connected to placement by methods of observers in the auto industrialization line of manufactures and connecting the servo with robot hand's finger in different ways. [2].Insert all servo motors inside the robot arm for moving robot hand's fingers known all parts of the robot arm are made by 3D printing technology.as shown in **Fig. 3.**

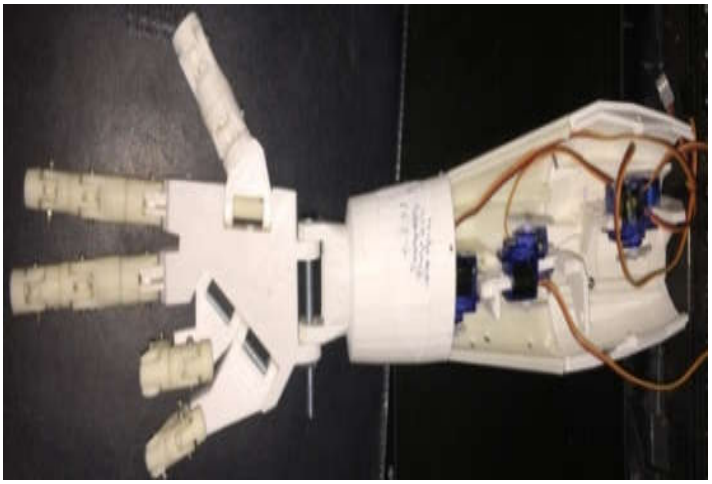

Fig .3 Robot Arm made by 3D Printer

- **Propotiona-Integral-Derivative control (PID):-**

PID controls are widely used in many manufacturing processes if the parameters differ than controller are not efficient [14]. PID controller's structure is shown in **Fig .4** below. The actions proportional, integral and

derivative are generated by error signal. The relative idiom is supplying a total control action relative to the wrong indicative within any gain factor. Stable status mistakes are reduced within mini recurrence recompense by an integrator and this was called integral term. The side term is used develop transitory reply by high frequency recompense by a recognizer [6]. The presenet reseach depends upon temperature control by using (LM35) sensor as a feed back to the PID controller

Parameter	Rise time	Overshoot	Settling time	Steady-state error
K_p	Decrease	Increase	Small change	Decrease
K_i	Decrease	Increase	Increase	Decrease significantly
K_d	Minor decrease	Minor decrease	Minor decrease	No effect in theory

Fig.4 .Parameters for pid controller [6].

- **PID controller in lab view:-**

There are two ways to design PID control in lab view program. First by using simulation way and the second way by using toolkit which is build inside lab view library as shown in **Fig .5 , Fig. 6 and Fig .7** . The aim of this work is to plan a PID temperature control lab view – with instituted self-control PID observer and to confirm its execution by an operation stream-average driller which is found at the laboratory of operation observation. For that usage, an ISA criterion sample of PID algorithm was prepared [10]. The CDSIM term is refering to control design and simulation model for lab view can be used to simulate dynamic system[11]. PID control law affecting the power indicative shall produce in a motivation in the observation indicative, this is usually greatly unwanted therefore secondary

act is extremely not used to the power indicative. To avoid this issue by purifying the power amount before f supplying it to the observer. Another potential is to allow relative acti act just on the part of the power indicative. This term means to place spot scale [7]. The object to use PID controller is to sense the temperature by the hand's fingers with the conditions. First condition if the temperature is equal or more than 36 °, the hand's finger has been opened or the servo motors will rotate to zero degree. Second, if the temperature is less than 36 °, the servo motor will rotate according to the flex sensor's signal .**Fig.8** shown below the code design for PID temperature controll in lab view.

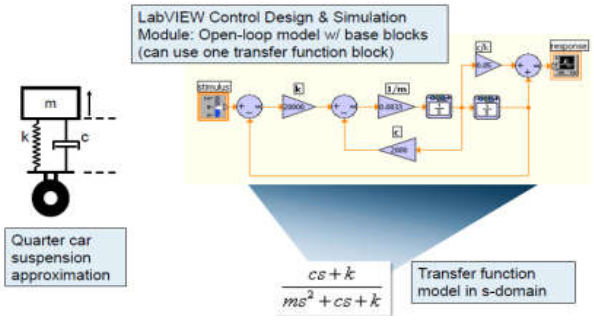

Fig. 5 Simulation PID [5].

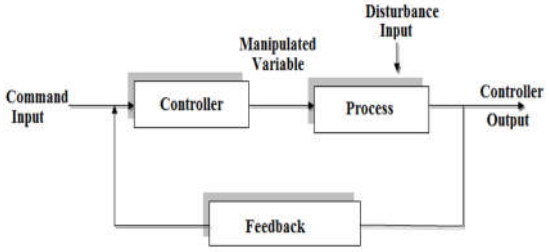

Fig .7 Close loop PID controller[13].

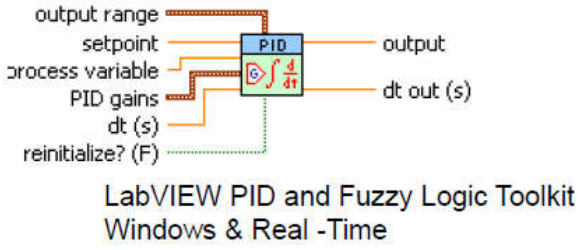

Fig .6. Toolkit PID -lab view[5].

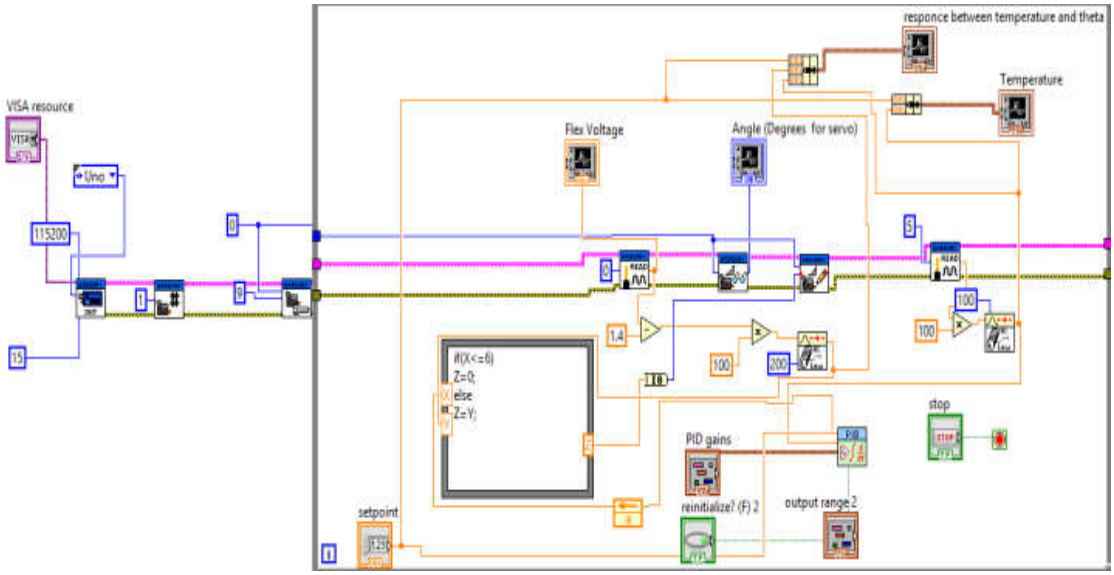

Fig. 8 Design labview code for PID temperture control.

- **Temperature sensor (LM35)**

The LM35 is an unified-circle temperature sensor whose product voltage is lineally relative to the Celsius (Centigrade) temperature. It's merit over lineal temperature sensor standardized in Kelvin, since the user is not demanded with deducting a huge stable voltage from its product to get appropriate Centigrade graduation. The other advantages does not require heat water. any external calibration. The sensor's limits to supply ideal precisions amounted ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range added to its minimal cost. **Fig.9** is shows top view for these sensors [15].**Fig 10** shown the temperature (LM35) sensor attach to robot arm sensing

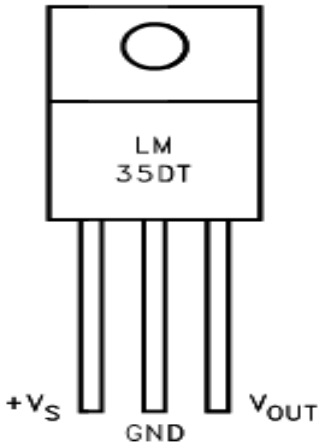

Fig. 9 Type to-220 Lm35 [15].

Fig. 10 Haptic robot

III .Wireless communication between smart glove and artificial and finger.

- **System design for wireless communication:**

The system mainly consisted of three parts[8]

1. Master (Main) Section or Router Section: This section includes the flex sensors connected to the transmitting Arduino board alongwith the ZigBee shield and the ZigBee module.

2. ZigBee Wireless Network: This is the section which physically doesn't exist. It consists of the wireless communication between the ZigBee modules attached to the Transmitter and Receiver Arduino board.

3. Slave Section or Coordinate Section: It includes the Receiver XBee unit attached to the receiver Arduino board via the XBee shield. The output of the Arduino board is. connected to the servo motors on the Robotic Arm to enable the corresponding movement of the arm. The equation for annular finger between the human hand's finger angle and the hand's angle as

shown in **Fig.11** and **Fig.12** shown the smart glove connect with robot arm by zagbee devic.

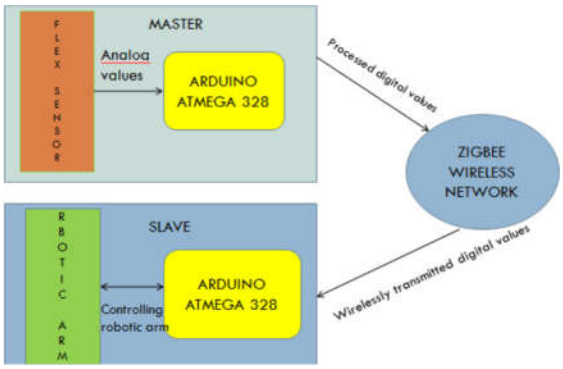

Fig. 11 A Block Diagram for wirless communication [8].

Fig. 12 Haptic robot system in wireless communication.

- **Configuration for xbee devices[8].**

XCTU is a software program which is used to make configuration for two component Xbees. One of these components should be programmed as a router device and the other will be as the coordinator device. Router works as a transmitter device, so that it should be connected with arduino which is connected to the glove and the coordinator works as the receiver device, so that it should be connected to the artificial hand to receive data from the glove and moves as the fingers move in the glove. In xbee router device should send in writing arduino's program write ( ) to enable .sending data to the receive device (coordinator). In xbee coordinator device should write and read ( ) inarduino UNO program to enable data receiving.

- **Association communicate for xbee[8]:**

Society is the institution of organism between limit apparatuses and a the regulator. The institution of organism is benefitial in stories that demand a centric unity (Regulator) to transmit letters to or collect information from

many far away unities (Limit apparatuses), set the canals or set PAN IDs. An RF information web which contains one regulator and one or more Limit apparatuses constitute a PAN (Personal Area Network). Each device in a PAN has a PAN recognizer [ID (PAN ID) factor]. PAN IDs must be individual to stop misconnecation between PANs. The regulator PAN ID is a seres using the ID (PAN ID) and A2 (Regulator Society) orders. An End Device can support to a Regulator without identifying the address, PAN ID or Regulator canal. The A1 (Limit apparatuses Society) factor part aspects specify the elasticity of a Limit apparatus through Society. The A1 factor can be utilized for a Limit apparatus to effectively adjust its end address, PAN ID and/or canal.

IV. Results

Angles for flex sensors with it's produce volts for zagbee router device with the angles for servo motor,servo motor's volt and robot finger angle that associate to ring finger for zagbee device (coordinator) has been taken as aresults as shown in **Fig.13** and **Table .1.**

Both robot and human movement are subject to equation Θh=1.142Θf+5.09 as shows in **Fig .13.**

The temperature increase with increase or with close hand finger from temperature.If the hand finger touch an object with temperature more than set point temperture (36^{o})the finger move immediately to 180 degree or the robot hand will be openelse hand finger move according to the flex sensor's signal.as shown in **Fig.14.**

Table . 1. Results for wireless communication.

Θf : flex's angle, Vf :flex's volt, Vs: servo volt, Θm: servo angle, Θh: robot hand's angle				
Θf °	Vf (V)	Vs (V)	Θm°	Θh°
0	2.6	0.74	26.64	0
10	2.7	1.295	46.62	15
20	2.8	1.85	66.6	30
30	3.05	2.59	93.24	40
40	3.2	3.33	119.88	55
50	3.25	3.7	133.2	60
60	3.3	4.44	159.84	80
70	3.35	4.625	166.5	90
80	3.45	4.81	173.16	95
90	3.5	4.99	179.64	100

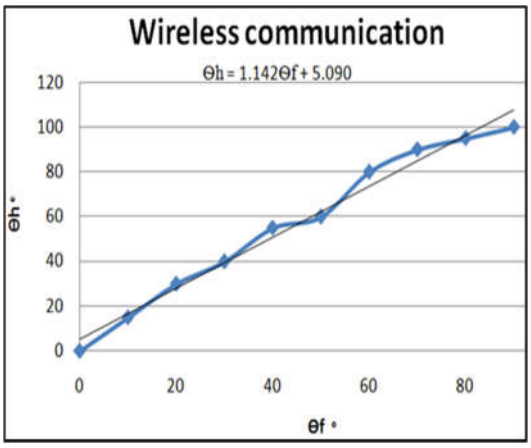

Fig.13 Angles fingers match

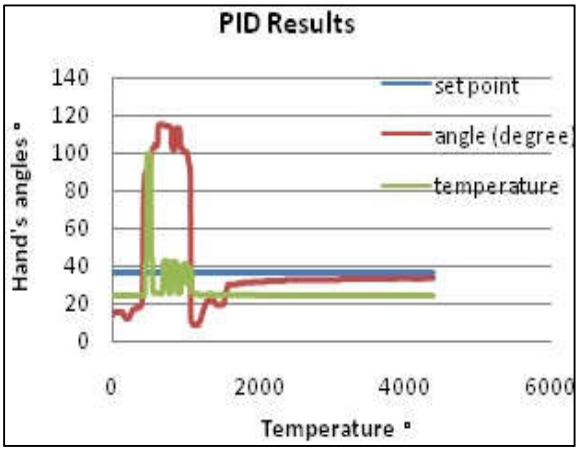

Fig.14 PID controller's parameters

V . Discussion

- The distance is (1-100) meters for verify communicate between router and coordinator in wireless communication.
- PID- Lab view program add a delay between human and robot movement .
- Angles matching with wire communication is accuracy more than wireless communication.
- There is a delay time with wireless communication more than the other.

Reference

[1]. Abidhusain Syed, Zamrrud Taj H. Agasbal, Thimmannagouday Melligeri and Bheemesh Gudur, '' Flex Sensor Based Robotic Arm Controller Using Micro Controller '' , Journal of Software Engineering and Applications,Vol.5,PP:364-366, 2012.

[2]. AhmedM.A.Haidar,ChellaliBena chaibaand MohamadZahir,''Software Interfacing of Servo Motor with Microcontroller'', J. Electrical Systems 9-1,PP: 84-99,2013.

[3]. Elizabeth Matias and Bharat Rao," 3D Printing: On Its Historical Evolution and the Implications for Business ", PICMET '15, PP: 2161-5063, 2015.

[4]. Jainish S Kothari and Tanay S Vaidya, " Analog Haptic Robotic Arm", International Journal of Scientific &

Engineering Research, Vol.5, Issue 1,2014.

[5]. Jeannie Sullivan Falcon, Ph.D.,''Beyond PID - Simulation & Advanced Control Can Save Time and Money'', www.ni.com.2017

[6]. Kambiz Arab Tehrani1 and Augustin Mpanda,'' Introduction to PID Controllers - Theory, Tuning and Application to Frontier Areas '', ISBN 978-953-307-927-1,2012.

[7]. Karl Johan Åström, ''PID Control'', from control system design,2002.

[8]. Malav Atul Doshi, Sagar Jignish Parekh and Dr.Mita Bhowmick, " Wireless Robotic Hand Using Flex Sensors " , International Journal of Scientific & Engineering Research, Vol.6, Issue 3,2015.

[9]. MEGAT ZULFADLI BIN BUANG, "PID SPEED CONTROL OF SERVO MOTOR USING LABVIEW", University Teknologi Malaysia,2015.

[10]. Mohammad A. K. Alia, Tariq M. Younes and Shebel A. Alsabbah,'' A Design of a PID Self-Tuning Controller Using Lab VIEW'', Journal of Software Engineering and Applications,Vol.4,PP,161-171.2011.

[11]. Ricardo Dunia , Eric Dean , and Dr. Thomas Edgar,'' Introduction to Lab VIEW for Control Design & Simulation'', Process Dynamics and Control 2nd edition,www.ni.com.2017.

[12]. Prof. Sheetal Nirve, Mr.Abhilash Patil, Mr.Shailesh Patil and Mr.Vishal Raut, ''A 5 Degree Feedback Control Robotic Arm (Haptic Arm) '' , IJRREEE, Vol. 2, Issue 1, pp: (75-80),2015.

[13]. Wahidul Hasan, Sajib Chakraborty, S. M. Salim Reza, K. M. Salim1, and M. A. Razzak, ''Improvement of Systems Response of a PID Controller in

ahumanoid robot hand'', Expert Systems,, Vol. 26, No. 3 291, 2009.

[15]. Lm35 data sheet http://pdf1.alldatasheet.com/datasheetpdf/view/8866/NSC/LM35.html,2011.

Under damped Condition'', International Journal of Innovation and Applied Studies ISSN 2028-9324 Vol. 12 No. 4, pp. 864-873,2015.

[14]. Yunus Ziya Arslan, Yuksel Hacioglu and Nurkan Yagiz,''Fuzzy sliding mode control of a finger of

تصميم وتنفيذ ذراع التلامس للروبوت

حسين هدام عليوي
د. وائل رشيد عبد المجيد

الخلاصة:-

الورقة البحثية تنفذ فكره التلامس بطريقتين الاتصال السلكي واللاسلكي. تصنع اجزاء الذراع الصناعي من خلال تقنيه الطباعة الثلاثية. يستخدم الكونترول بي اي دي في الاتصال السلكي وينفذ من خلال برنامج اللاب فيو ويكون الراجع لدائرته هو متحسس الحرارة نوع ل م 35. ويكون شرط الكونترول هو اذا ارتفعت درجه الحرارة لأكثر من 36 درجه مئوية فان اصابع الروبوت ستفتح بزاويه 180درجه والا فان الاصابع ستتحرك بناءا على الإشارة الخارجة من متحسس الفلكس. الاتصال اللاسلكي ينفذ من خلال برمجه اجهزه الزكبي من خلال برنامج اكس سي تي يو لكلا الجهازين المرسل والمستلم

الكلمات المفتاحية: - الكف الذكي، متحسسات الفلكس , معادلات اللاب فيو ,اردوينو , الطباعة ثلاثية الابعاد .

.