Application Design and Discussion of Automation Teaching Course

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Abstract: Robot teaching course has been gradually completed since the middle of the last century. It mainly used in industrial automation production, such as food, medicine, automobile, hardware and other industries. All industries have to rely on the robot's manipulation. Due to the strong demand of the market, colleges and universities competing to open relevant courses to train the talents of the operation. However, the robot operation-teaching course is relatively lacking in the market. in order to facilitate the entry of students and more proficient in automated production. The course need to be examine and revise, this paper is to find out more precisely the skill of robot language writing for school talent and industrial need. Ever since the first time came across automation courses, I have planted an indissoluble bond with it. I am going on to explore the farther, to discuss different versions of Robot Operation Manuals, the differences and pros and cons of it.

Keywords: Robot Operation Manuals, Automation**,** Robot programming language, Education.

1. Introduction

The COVID-19 pandemic has seen a vast increasing in chances of being infected or spreading. It caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).[1] The outbreak was first identified in December 2019 in Wuhan, China.[2][3] The World Health Organization declared the outbreak a Public Health Emergency of International Concern on 30 January 2020 and a pandemic on 11 March.[4][5] As of 10 Feb. 2021, more than 109.3 million cases of COVID-19 have been reported in more than 188 countries and territories, resulting in more than 2,350,000 deaths; more than 60.0 million people have recovered.[6] The worldwide are taking some simple precautions. "Laws and policies that are grounded in science, evidence and human rights can enable people to access health services, protect themselves from COVID-19 and live free from stigma, discrimination and violence," says Achim Steiner, UNDP Administrator.

Under this pandemic, economic gets more severe, and automation replaces manual operation, becoming more urgent. Automation teaching courses have been used widely in industry and change frequently in 20- 21century. In 1988, I arrived at Memphis State University (USA) and It was the first time I took robotic course in Mr.Day's class. Since then, I forged an indissoluble bond with Robotics course for 30 years. It was the ever been primary Robot teaching course I took. In class, we used 5.25 inch diskette to record the program and turned in when homework was due.

In 1990, I began to teach in Oriental Institute of Technology [1], department of Industrial management. From then on, I began to teach Robot language. The first Robot we bought in 1993 was RV-1 series Mitsu-bishi Electric's Robot that is so called version1. Then in 2005, we bought two RV-3s model Robot that was version2. It is sure that RV-3s model have made great changes and improvements. And also we bought RV-4F-D in 2017. I would like to explore and discuss some in this paper.

1.1 Expansion of application areas

The emergence of the term "Robot" and the world's first industrial robot has been around for decades. However, people have been imagining and pursuing robots for more than 3,000 years. Humans hope to create a human-like machine, in order to replace humans to complete a variety of work. Autonomous and dexterous operation is one of the most needed key skills for industrial development [8]. The development of an autonomous and flexible robotic system is an interdisciplinary and complex process that naturally involves a variety of research fields such as computer, visual force control, motion planning, gripping, sensor fusion, digital signal processing, human-computer interaction, learning and tactile sensing [9]. In the past few decades, industrial robots have replaced human beings in repetitive, dangerous, and unsafe manufacturing tasks [10]. The automotive, consumer electronics and aerospace industries have used programmable robots to operate simply equipped double-finger jaws on large-scale production lines. However, current manufacturing requires lower volume, assembly of more customizable and variable products, requiring robots to be more adaptable, more flexible and more maneuverable (AISBL).

1.2 Demand arises in response

All these need could fulfill by using more dexterous robot arm replacement clips, and even manipulate those using fingers [11]. The dexterous robotic arm is also essential for a new generation of society, which can replace human beings in daily life [12] and assist to the elderly and the disabled. The new challenge of robot design, unlike industrial environments, is that domestic space and often unstructured, which means that perception needs added to the robot's control strategy. In perceptual mode, tactile sensing plays an important role in physical interactions, especially with humans. Neuroscience has long proved the importance of touch and feedback is in human manipulation. Different studies have shown that people with fingertip anesthesia cannot maintain stable grip[13], and the difficulty of children with tactile sensation to perform operational tasks[14]. The tactile sensor provides information about the body contact to the robot. An autonomous robotic hand can manipulate an unknown object in an unstructured environment [15].

At the same time, the availability of the robot's sensory information ensures its safe operation in direct human-computer interaction applications. Controlling the end of a robot in a traditional industrial approach is by embedding objects and environments about clear existing knowledge and reality. The robot is therefore able to manipulate known objects in a structured environment, which means that they are less adaptable. To overcome these limitations, one approach based on active exploration, which relies on a data tactile sensor that allows the robotic hand to explore the object and run control operations in the event of an unexpected event. As long as some methods use haptic feedback schemes within autonomous control [15]. An artificial tactile sensor in a robotic application is shown through a pressure distribution detection array, a force-torque sensor, and a dynamic tactile sensor [16]. A manually acquired information sensing system used to find the location of the contact, reconstruct and identify the shape of the object, and measure contact force and temperature. Even if tactile sensory information is a fundamental operational element, tactile sensing in the artificial process of technology and research does not develop like other perceptual patterns [20]. From the agricultural era to the present industrial and commercial, factories, all of them are operated and produced by hand, which not only consumes a lot of time and manpower, but also causes quality and unevenness. In order to improve these problems and shortcomings, many industrial plants began to introduce automated machinery and equipment, such as automobile factories, parts assembly, food processing, electronics, and so on. Industrial robots include the welding, cutting, assembly, transportation, and various processing, such as welding, cutting, assembly, and heavy processing. They can be used for robots. For heavy work, they are usually fixed. The control of the sequence is executed, and in a large factory, more than one group of robots are collectively assigned to perform related works. The use of spot welding robot welding in automobile factories can improve the welding technology level and welding quality of domestic cars and solve the problem of leakage quality of the rear bridge without breaking the long break. Food industry robots that have been developed in the food processing industry include canned robots, automatic lunch robots and cutting beef robots. When the factory needs to carry articles, it can use the automatic multi-directional trackless stacker. It is a complete cargo handling equipment suitable for the main elevated warehouse. It can work in multiple shelves and roadways in the main warehouse, with good maneuverability and convenient operation.

1.3 Demand for commercial use

Today's robotics technology is developing rapidly, the application field is expanding, and the structure has undergone great changes. The international robotics scholars tend to start from the application environment and classify robots into two categories: industrial robots in the manufacturing environment. And robots in non-manufacturing environments.

The so-called industrial robots in the manufacturing environment are multi-joint robots or multi-degree-of-freedom robots for the industrial field, while the robots in the non-manufacturing environment are various machines that serve humans in addition to industrial robots in the manufacturing environment. All these, including service robots, underwater robots, entertainment robots, military robots, agricultural robots, robotic machines, etc. In the future world, robots will become smaller and smaller, and robots will become more and more intelligent, such as industrial micro-robots for inspection and maintenance, as well as various miniature sensors, microelectromechanical products, and now smart robots. Its intelligence is only equal to the intelligence level of two or three-year-old children. In the future, there will be more and more highly intelligent robots, and their intelligence level will continue to increase, slowly reaching the intelligence level of seven or eight years old, teenagers and even young people. In the process of researching and developing robots operating in unknown and uncertain environments, people gradually realize that the essence of robotics is the combination of perception, decision, and action and interaction technology; as people become more aware of the intelligent nature of robotics, Robotics began to infiltrate into all areas of human activity.

1.4 Automated production

Combining the application characteristics of these fields, people have developed a variety of special robots and various intelligent machines with sensing, decision-making, action and interaction capabilities, such as mobile robots, micro-robots, underwater robots, medical robots, military robots, and airborne space robots, entertainment robots, etc.; adaptability to different tasks and special environments is also an important difference between robots and general automation equipment.

These robots have been far removed from the appearance of the original humanoid robots and industrial robots. They are more in line with the special requirements of various application fields, and their functions and wisdom are greatly enhanced, thus opening up a broader range of robotics and more development space.

Song Jian [17], president of the Chinese Academy of Engineering, pointed out: "The advancement and application of robotics is the most convincing achievement of automatic control in the 20th century. It is the automation of the highest level in the modern era." Robotics combines the development of multidisciplinary research and represents high technology. The development frontier, its continuous expansion in the application of human life is causing the international recognition of the role and influence of robotics.

1.5 Course introduction in technical colleges

In 2000, there is a dramatically change in education and the whole industry structure. First, whatever students' age all is enthusiastic in cell-phone and game playing. The second is Robot substitute workers, and the third is the rise of artificial intelligence (AI). How a teacher draw students' attention in the class can is difficult? In the end, the goal of higher education is to foster talented people to develop the country's economic growth; however, how to draw those students' attention back and transfer to technology studying, there must have a good solution or class that students will elective.

The disaster of the world continues to emerge, the 2020 outbreak of Covit-19 pneumonia epidemic and the U.S. flu together cause a significant number of death. These affects young people's learning in all respects, in this paper, we are going to discuss its advantages and disadvantages and benefits of Robot's language in different versions of manual. Also its application that I arrange to curriculum for students in my class.

2. Literature

Technology always comes from human nature, and some human capabilities do have limits. In the near future, robots will be widely used.

2.1 Robot applications

An enabling Electroactive polymers (EAP) technology is emerging which attempts to imitate the properties of natural muscle and which, as a result, can perform a unique function in a variety of biologically-inspired robotics applications[19]. And the applications to robotic processing, the key design issues concerning algorithms, applications, and architectures are examined. A variety of neural networks is considered, including single-layer feedback neural networks, competitive learning networks, and multilayer feed-forward networks [20].

2.2 Robot technology

The critical issue facing designers of advanced robot architectures is how to take advantage of advanced electronic technology (encoders, arithmetic chips, high speed processor boards, etc.) to produce generic and more versatile mechanical robot structures at lower costs [21]. Also many different robotic systems have been developed for invasive medical procedures. They focus on robotic systems for image-guided interventions such as biopsy of suspicious lesions, interstitial tumor treatment, or needle placement for spinal blocks and neurosis. Medical robotics is a young and evolving field and the ultimate role of these systems has yet to be determined [22]. Robot technology and teleoperation is concerned with the exploration and exploitation of spaces which do not allow, because of their inaccessibility or hostility, direct access to man. It covers the advances in mastering teleoperation, using only knowledge of mechanics.

2.3 Education

Mr. Zheng Shiyan [23] said: "Education should include the following goals: to develop good attitudes, self-development, from the creation, know yourself, develop relationships, and cultivate emotions, imagination and gaining capabilities". Perry Jr[24], talking about education: A path from adolescence into adulthood is mapped from the accounts of college students. The evolution in students' interpretation of their lives is seen and understood through changes in the" forms" in which they conceptualize the issues they face. Also Geoffrey Walford [25][26][27] in his "Education Policy" mentioned: They focus on key issues with broad relevance to social scientists such as access, interviewing, data restrictions, ethical dilemmas and the role of theory.

3. Comparison of different version of Robot language

Table 1. is the first robot program I learned from Memphis State University. From the vision of this day, it is both ancient and a beginning. In the robot programming language class I taught, I used block processing for practical demonstrations [28]. The robot language we use in the classroom is the basic language. Because it is easy to learn, it has been used in all versions of the Mitsubishi Robot Operation Manual [29].

The feature of version-1 is that each movement of point must be recorded; therefore, the volume of point records is large. In Table 2., we use 5 points to record one block moving. To contrast with the first generation, we excerpted Mitsubishi Robot Operation Manual exercises as shown in Table 3. Fig 1. shows single block handling worksheet only needs three points. RV-3s model's feature is that the number of point records is reduced. The reference point is used, so the practice can be done quickly and concisely.

Table 1. Version-0 Robot language

10 D$ = CHR$(4)
20 PRINT D$;"PR#1"
30 PRINT D$;"IN#1"
40 PRINT "@DELAY 100"
50 PRINT "@STEP 200,0,0,50"
60 PRINT D$;"PR#0"
70 PRINT D$;"PR#0"
80 END

Table 2. Version-1 Robot language

10 SP 6
20 MO 1,O
30 MO 2,C
35 TI 5
40 MO 3,O
45 TI 5
50 MO 4,C
60 MO 5,C
70 NT
80 ED
PD 1, +0.0,+589.0,+300.0, +0.0, +0.0
PD 2,+119.3,+411.7,+122.6, -77.9, -12.7
PD 3,+118.3,+408.2, +59.9, -77.9, -12.7
PD 4,+118.0,+421.1, +61.6, -79.6, -8.6
PD 5,+118.0,+421.1, +61.6, -79.6, -8.6

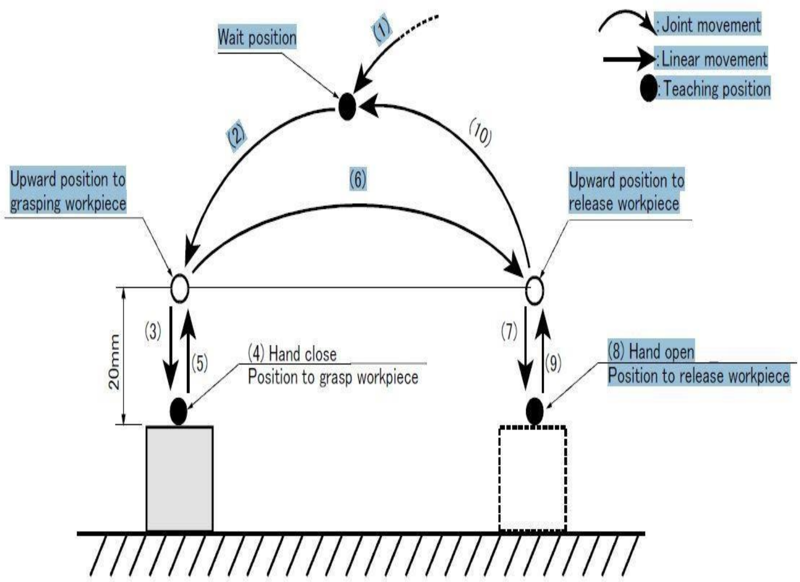


Figure 1. Single Block Handling Worksheet

Table 3. Version-2 Robot language

NO	Command	Explain
10	MOV PWAIT	
20	MOV PGET,+20	Move to 20mm upward work piece (joint movement)

30	MVS PGET	Move to position to grasp work piece (linear movement)
40	HCLOSE 1	Grasp work piece (hand close)
50	DLY 1.0	Waits for 1 seconds
60	MVS PGET,+20	Move 20mm upward (linear movement)
70	MOV PPUT,+20	Move to 20mm upward position to release work piece (joint movement)
80	MVS PPUT	Move to position to place work piece (linear movement)
90	HOPEN 1	Release work piece (hand open)
100	DLY 1.0	Waits for 1 seconds
110	MVS PPUT,+20	Move 20mm upward (linear movement)
120	MOV PWAIT	Move to wait position (joint movement)
130	END	

In the demonstration, we also found that the commands in two versions are different. The first generation used two English letters as instructions, such as MO, TI, SP. However, the second generation used three English letters as instruction, such as MOV, MVS, DLY. If you already familiar with the first generation of Mitsubishi Robot Operation Manual, then it is no problem to transfer to the second generation.

The third difference between the two versions is the existence of the Origin-Return, version one uses NT to return to the Origin, to make sure that zeroing each coordinate axis but version two does not need to return to the Origin.

Table 4. shows the latest version of RV-4F-D, which was introduced in 2017, robot language is even more easier. When the program is writing, you just follow the sequence number and if it is need, just insert and new number will come out. Also, you can change position in computer and input the current posion, and then, the new posiom is corrected.

Table 4. Version-3 Robot language

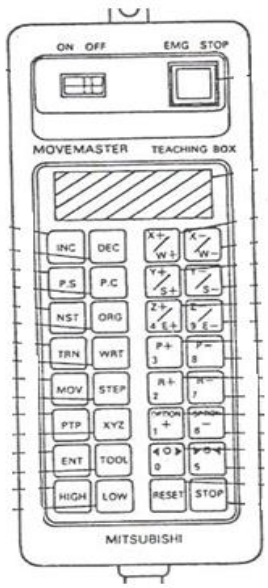
1. Mov PWAIT
2. Mov P1
3. Mvs P1, -2
4. Dly 1
5. HClose 1
6. Dly 1
7. Mov PWAIT
8. Dly 1
9. Mov P2
10. Mvs P2, -2
11. Dly 1
12. HOpen 1
13. Dly 1
14. Mov PWAIT
15. End

P1=(469.920,-179.940,202.970,178.280,-7.110,-1.350) (7,15728640)

P2=(469.640,112.310,198.740,-178.700,-2.190,0.160)(7,0)
PWAIT=(450.220,-30.300,351.500,-163.750,1.650,-97.120)(7,0)

4. Input data from teaching pendant

There are some significant differences in two versions of teaching pendant as shown in Fig. 2. and Fig. 3. The version-1 Teaching pendant is quite easy, it can go up and down, right or left, grasp open or close when you push button of X+, X-, Y+, Y-, C+, C-. and so on. When you want to record point, just press P.S. and sequence number and ENT, then, it is set. In version 2. Teaching pendant, it is more advanced and fully functional. You can open the program from editing screen panel shown as Fig 4. Also, you can practice new program. When you are going to record reference point, just follow the steps as shown in Fig 5. Also, you can save program by computer.



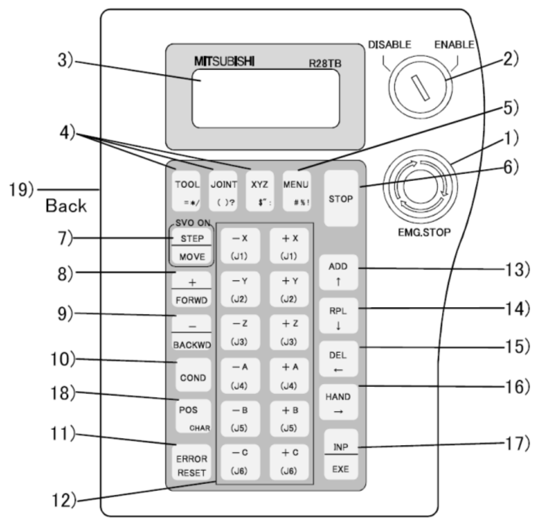


Figure 2. Version 1. Teaching pendant

Figure 3. Version 2. Teaching pendant

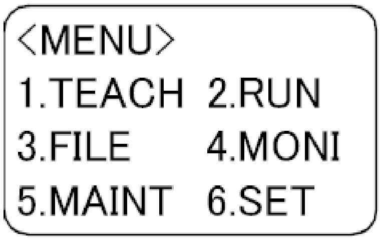


Figure 4. MENU of version 2

Press the [RPL] key while holding down the [STEP] key, and release only the [RPL] key. The buzzer will sound a "beep", and a confirmation message will appear.
While holding down the [STEP] key, press the [RPL] key again.
The buzzer will sound a "beep", and the message "Replacing" will appear. Then, the current position will be registered.

Figure 5. Recording points

5. Practice design

From the time I began teaching Robot Language, I designed 5 labs, shows in Table5- Table9.

Table 5. lab 2.

Lab 2 –2006 Name ___________
AUTOATION & ROBOTICS
Material Required:
1. 3 1/2" Disc (formatted)
Purpose:
Require:
1. Return the robot to the Origin first.
2. The computer calls out the point definition in the disk
3. Computer write BASIC program, move the robot arm to five points.
4. End.
5. Store in your student ID.
6. Submit homework.
Score ratio:
There are a total of five exercises, each accounting for 15%. Topical group assignments 25%.

Table 6. lab 3.

Lab 3 –2006 Name___________
AUTOMATION & ROBOTICS
Experimental Required: Operation accuracy
Purpose:
Steps in this exercise:
1. Return the robot to its origin.
2. The learner guides the robot to the first block and clamps it.
3. Move the robot arm to the second block, align and release.
4. Clamp the square below, raise it, and pause for five seconds.
5. Return to the first square point in the original order, let go, and end.
6. Store in your student ID.
7. Submit homework.
Score ratio:
There are a total of five exercises, each accounting for 15%. Topical group assignments 25%.

Table 7. lab 4.

Lab4 –2006 Name ___________
AUTOMATION & ROBOTICS
Topic: Robotic gymnastics show
Procedure:
Steps in this exercise:
1.Robot first returns the robot to its origin.
2. The learner guides the robot to the first point A and grabs the side Block 1, carry to point c. Let go of the claws ...
3. Move the robot arm to the second point B, grab the side Block 2, move it to block 1 at point c, and release the claws.
4. The robot arm grabs the block 2, moves it to point O, releases the paw and pauses for five seconds.
5. Go back along the original path. Form a loop, go back and forth three times, and end.
6. Store in your student ID.
7. Submit the assignment.

Score ratio:
There are a total of five exercises, each accounting for 15%. Topical group assignments 25%.

Table 8. lab 5.

Lab5 –2006 Name ____________
AUTOMATION & ROBOTICS
Topic: Robot Cube Lohan Show
Procedure:
1. Steps in this exercise: Robot first returns the robot to its origin.
2. The learner guides the robot to the first point A and grabs the side Block 1, Carry to point o. Release the claws ...
3. Move the robot arm to the second point B, grab the side Block 2, move it to o point block 1 and release claws.
4. The robot reaches the first point A, grabs block 3, and transports it to point o. Release the paw.
5. Move the robot arm to the second point B, grab the block 4, and move to the o point block 3 Above, let go of the paw.
6. Follow the original path back. Form a loop, go back and forth three times, and end.
7. Store in your student ID.
8. Submit homework.

6. Discussion and Conclusion

Industrial Robot Operation manuals have benefited so many learners on industry. In the paper, we discussed what the difference between two versions, though version 2 is better than version one, there still have some advantages in version 1, such as it does not need to change battery by year and it is a lot of budget saving and also durable.

The demand for industrial robots will continue to increase with the advent of an elderly society, a shortage of labor population, and high-tech and high-quality requirements. The use of industrial robots will continue to increase. It is necessary to combine the efforts of industry and academia to jointly solve the technical challenges mentioned above and overcome the obstacles caused by the above challenges. In this way, robots will play an indispensable role in the sustainable civilization of human society. With the fierce competition in the global market, various industries are facing the challenge of transforming or opening up new situations in order to continue to respond to the changing market structure and environment.

In addition to the wide application of traditional manufacturing industries, the intelligent automation technology application level is also expected to be popularized into daily life applications such as health care and service industries through the development of technology and complete specification construction. In the 21st century, the demand for intelligent automation technology from various industries will help promote the growth of each other, enhance and create industrial advantages, and improve the quality of human life and the environment; and the robot industry, which is closely related to the development of intelligent automation. To meet the rise of the next emerging industry and use technology to create the well-being of the people. It is urgent to train talents who are proficient in robot programming languages, so we are dedicated to teaching robot programming language.

7. References

1. "Naming the coronavirus disease (COVID-19) and the virus that causes it". World Health Organization (WHO).
2. "Novel Coronavirus—China". World Health Organization (WHO). Retrieved 9 April 2020.
3. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. (February 2020). "Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China". Lancet. 395 (10223): 497–506. doi:10.1016/s0140-6736(20)30183-5. PMC 7159299. PMID 31986264.
4. "Statement on the second meeting of the International Health Regulations (2005) Emergency Committee regarding the outbreak of novel coronavirus (2019-nCoV)". World Health Organization (WHO). 30 January 2020. Archived from the original on 31 January 2020. Retrieved 30 January 2020.

5. "WHO Director-General's opening remarks at the media briefing on COVID-19—11 March 2020". World Health Organization. 11 March 2020. Retrieved 11 March 2020.
6. Wikipedia, the free encyclopedia, https://en.wikipedia.org/wiki/Template:COVID-19_pandemic_data (accessed 2021.02.10) .
7. Oriental Institute of Technology (OIT), website: www.oit.edu.tw, accessed on December 9th, (2019).
8. A. Bicchi, Hands for dexterous manipulation and robust grasping: a difficult road toward simplicity, IEEE Trans. Robot. Autom. 16 (6) 652–662. http://dx.doi.org/10.1109/70.897777, (2000).
9. L. Righetti, M. Kalakrishnan, P. Pastor, J. Binney, J. Kelly, R. Voorhies, G.Sukhatme, S. Schaal. An autonomous manipulation system based on force control and optimization, Auton. Robots 36 (1–2) 11–30. http://dx. doi.org/ 10.1007/ s10514-013-9365-9(2014).
10. B. Siciliano, O. Khatib (Eds.) Springer Handbook of Robotics, Springer, http://dx.doi.org/10.1007/978-3-540-30301-5(2008).
11. euRobotics aisbl, Robotics. strategic research agenda for robotics in Europe. http://www.eu-robotics.net/cms/upload/PDF /SRA2020 _0v42b_ Printable_.pdf (accessed 26.05.14) (2015).
12. B. Gates. A robot in every home, Sci. Am. 296 (1) 58–65 (2007).
13. R.S. Johansson, J.R. Flanagan, Coding and use of tactile signals from the fingertips in object manipulation tasks, Nat. Rev. Neurosci. 10 (5) 345–359. http://dx.doi.org/10.1038/nrn2621. (2009)
14. J.R. Wingert, H. Burton, R.J. Sinclair, J.E. Brunstrom, D.L. Damiano, Tactile sensory abilities in cerebral palsy: deficits in roughness and object discrimination, Dev. Med. Child Neurol. 50 (11) 832–838. http://dx.doi.org/ 10.1111/ j.1469-8749.2008.03105.x. (2008).
15. M. Prats, A.P. del Pobil, P.J. Sanz, Robot physical interaction through the combination of vision, tactile and force feedback, in: B. Siciliano, O. Khatib (Eds.), Tracts in Advanced Robotics, in: Springer Tracts in Advanced Robotics, vol. 84, Springer, p. 177. http://dx.doi.org/ 10.1007/978-3-319-03017-3_3. (2013).
16. M.R. Cutkosky, J. Ulmen, Dynamic tactile sensing, in: R. Balasubramanian, V.J. Santos (Eds.), The Human Hand as an Inspiration for Robot Hand Development, in: Springer Tracts in Advanced Robotics, vol. 95, Springer-Verlag, pp. 219–246. http://dx.doi.org/10.1007/ 978-3-319- 03017-3_3. (2014).
17. R. Dahiya, M. Valle, Tactile sensing technologies, in: Robotic Tactile Sensing, Springer, Netherlands, pp. 79–136. http://dx.doi.org/10.1007/ 978-94-007- 0579-1_5. (2013).
18. Song Jian (Chinese: 宋健; Wade–Giles: *Sung Chien*; born 29 December 1931) is a Chinese aerospace engineer, President of the Chinese Academy of Engineering, and Vice Chairperson of the Chinese People's Political Consultative Conference.(1931).
19. KJ Kim, S Tadokoro- Artificial Muscles and Sensors, "*Electroactive Polymers for Robotic Applications*", https://doi.org/10.1007/978-1-84628-372-7. Online ISBN 978-1-84628-372-7. Springer, London (2007) .
20. SY King, JN Hwang - IEEE Transactions on Robotics and …,- ieeexplore.ieee.org (1989).
21. Delbert Tesar, Michael S. Butler "Generalized modular architecture for robot structures."Mechanical Engineering, Manufac-ture Review, Volume 2. Pages 91-118(1989).
22. Kevin Cleary, Andreas Melzer, "Interventional robotic systems: Applications and technology state-of –the-art", Page 101-113(2009).
23. Vertut, J; Coiffet, P. Robot technology. Vol. 3A. Teleoperation and robotics: " evolution and development " , (Jan 01, 1985).Jim Scrivener, ELT author for Richmond, C.U.P., Macmillan and O.U.P. Teacher Training Ambassador for Bell. (2014).
24. Perry Jr, William G. Forms of Intellectual and Ethical Development in the College Years: A Scheme. Jossey-Bass Higher and Adult Education Series. Jossey-Bass Publishers, 350 Sansome St., San Francisco, CA 94104. (1999).
25. Geoffrey Walford Senior Lecturer in Sociology, Education Policy, and Birmingham. *Researching the powerful in education*. Routledge. (2013).
26. Maria Liakopoulou, European Journal of Education, Vol. 46, No. 4. (2011).
27. Cheng, F. Y. The relationships among pupils' explanatory style, domain knowledge, creative life experience and their technological creativity." *Unpublished thesis, National Sun-yat Sen University, Kaohsiung, Taiwan*. . (2004).
28. Whe-Min Wang, "2017 Yadong Institute of Technology Multiple promotion and other sharing sessions." (2017).
29. MITSUBISHI, Mitsubishi Industrial Robot, BFP-A8054-HCR1/CR1B Con-troller INSTRUCTION MANUALController setup, basic operation, and maintenance(2004).