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

Judul Karya Ilmiah	:	ANFIS Application for Calculating Inverse Kinematics of Programmable Universal Machine for Assembly (PUMA) Robot
Jumlah Penulis	:	3 Orang (Hugo Adeodatus Hendarto, Munadi, **Joga Dharma Setiawan**)
Status Pengusul	:	Penulis ke-3
Identitas Prosiding	:	a. Judul Prosiding : 2014 The 1st International Conference on Information Technology, Computer, and Electrical Engineering (ICITACEE); IEEE Xplore Digital Library
		b. ISBN/ISSN : 978-1-4799-6432-1
		c. Thn Terbit, Tempat Pelaks. : 2014, Semarang, Indonesia
		d. Penerbit/Organiser : IEEE
		e. Alamat Repository/Web : https://ieeexplore.ieee.org/document/7065710
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		f. Terindeks di (jika ada) : Scopus

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Semarang, 1 Juni 2021

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Reviewer 1

Prof. Dr. rer.nat. Ir. A.P. Bayuseno, M.Sc
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LEMBAR
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2. **Ruang lingkup dan kedalaman pembahasan:**
   Prosiding ini membahas invers kinematika pada robot manipulator PUMA yang dilakukan dengan menggunakan ANFIS (Adaptive Neuro-Fuzzy Inference System). Pengembangan dan hasil dari ANFIS untuk menghitung invers kinematic dibahas dengan lengkap dan detail dalam prosiding.
3. **Kecukupan dan kemutakhiran data/informasi dan metodologi:**
   Prosiding ini mepunyai novelty yang baik pada implementasi ANFIS untuk menghitung invers kinematic dari robot manipulator PUMA 560. Dari hasil simulasi menggunakan ANFIS dalam software MATLAB, didapatkan bahwa hasil dari maksimum error posisi yang dihasilkan adalah 27,9 mm.
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Semarang, 1 Juni 2021
Reviewer 1

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Unit Kerja : Departemen Teknik Mesin FT UNDIP

LEMBAR
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g. Kecukupan dan kemutahiran data/informasi dan metodologi (30%)	7,50		7
h. Kelengkapan unsur dan kualitas terbitan/prosiding(30%)	7,50		7
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2. **Ruang lingkup dan kedalaman pembahasan:**
Paper ini membahas tentang metode ANFIS (Adaptive Neuro-Fuzzy Inference System) untuk menghitung inverse kinematics dari robot PUMA. Tiga membership function digunakan untuk meminimalkan error dari invers kinematics. Hasil perhitungan telah disajika dengan jelas dan detail serta disertai dnegan plot yang menarik.
3. **Kecukupan dan kemutakhiran data/informasi dan metodologi:**
Paper yang diusulkan mempunyai tingkat informasi yang baik yaitu menggunakan metode Adaptive Neuro-Fuzzy Inference System (ANFIS) untuk menenttukan posisi end-effector pada robot PUMA. Hasilnya menunjukkan bahawa dengan menggunakan metode ANFIS, error posisi yang dihasilkan dapat diminimalkan.
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Semarang, 1 Juni 2021

Reviewer 2

Prof. Dr. Jamari, S.T., M.T.
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Certificate

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July 25, 2014

this to certify that :

Hugo Adeodatus Hendarto

as

PRESENTER

2014 1st International Conference on Information Technology, Computer and Electrical Engineering

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2014 1st International Conference on Information Technology, Computer, and Electrical Engineering: Green Technology and Its Applications for a Better Future, ICITACEE 2014 - Proceedings
23 March 2015, Article number 7065710, Pages 35-40
2014 1st International Conference on Information Technology, Computer, and Electrical Engineering, ICITACEE 2014; ICT Building of Diponegoro UniversitySemarang; Indonesia; 8 November 2014 through 9 November 2014; Category numberCFP1489Z-PRT; Code 111714

ANFIS application for calculating inverse kinematics of programmable universal machine for assembly (PUMA) robot (Conference Paper)

Hendarto, H.A., Munadi, Setiawan, J.D.

Mechanical Engineering, Diponegoro University, Indonesia

Abstract

View references (10)

This paper focused on the robot arm's kinematics problem or the connection between angle in each joint and the end-effector's position.f Forward kinematics problem will be deduced using D-H (Denavit- Hartenberg) parameter method. The inverse kinematics problem will be solved using ANFIS (Adaptive Neuro-Fuzzy Inference System) instead of calculating the solution. ANFIS is a feature in MATLAB using ANFIS toolbox. PUMA 560 robot arm virtual model is used in this paper. Three ANFIS training conditions are made to test the influence of training conditions with the result's performance. The difference between end effector's position that using ANFIS and from calculation in forward kinematics will be calculated to test the end effector's position error. By making ANFIS solutions with three different MFs (Membership Functions), influence of MF number are known. With more MF will decrease the position's error. The most MF in this paper is 10 MFs resulting position error by 27.974mm. © 2014 IEEE.

SciVal Topic Prominence

Topic: Fuzzy inference | Soft computing | Adaptive neuro-fuzzy

Prominence percentile: 76.984

Author keywords

ANFIS | Arm robot | forward kinematics | inverse kinematics | PUMA 560

Indexed keywords

Engineering controlled terms: End effectors | Fuzzy systems | Inverse kinematics | Inverse problems | Kinematics | MATLAB | Membership functions | Robotic arms | Robots

Engineering uncontrolled terms: ANFIS | ANFIS (adaptive neuro fuzzy inference system) | Forward kinematics | Forward kinematics problem | PUMA 560 | Puma 560 robot arms | Training conditions | Universal machines

Engineering main heading: Fuzzy inference

ISBN: 978-147996431-4
Source Type: Conference Proceeding
DOI: 10.1109/ICITACEE.2014.7065710
Document Type: Conference Paper

Cited by 2 documents

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(2018) Journal of Physics: Conference Series

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Lin, H.-W. , Chan, W.-S. , Chang, C.W.
(2013) International Journal of Fuzzy Systems

Original language: English

Volume Editors: Facta M.,Eridani D.,Riyadi M.A.,Isnanto R.R.
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February

ISBN : 978-1-4799-64314

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PROCEEDINGS

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KEYNOTE SPEAKER 1
Keynote Speech : Prof. Hiroshi Ochi (Kyushu Institute of Technology, JAPAN)
Keynote Title : Multi-User MIMO Wireless System -From Theory to Chip Design
Speaker's Biography:  Hiroshi Ochi is a professor in Computer Science and Electronics of Kyushu Institute of Technology in Fukuoka, Japan.Dr. Ochi is a cofounder of Que-Wave.He received Ph.D. from Tokyo Metropolitan University in 1990.He has been engaged in researches and developments of digital communication systems and signal processing areas at an academic environment since 1986.He brings over 17 years of experience and knowledge of electronics engineering to Que-Wave.One of the reasons he founded QW is he has felt to need more useful and high-performance devices than ever. And then, he decided to focus on producing useful tools and services from an engineer's point of views.

KEYNOTE SPEAKER 2
Keynote Speech : Prof. Dr. Trio Adiono (Institut Teknologi Bandung)
Keynote Title : Challenges and Opportunities in Designing Internet of Things
Speaker's Biography:  Trio Adiono is faculty member of the School of Electrical Engineering and Informatics of Institut Teknologi Bandung (ITB) and the head of IC Design Laboratory of Microelectronics Center ITB. He obtained his Ph.D. degree in VLSI Design from Tokyo Institute of Technology (Titech), Japan. From 2002 to 2004 he was a research fellow of the Japan Society for the Promotion of Science (JSPS) in Titech. In 2005, he was a visiting scholar at MESA+, Twente University, Netherlands. He has developed several microchips for video processing, smart card, NFC, and WiMax Baseband Chip. He received the "Second Japan Intellectual Property (IP) Award" in 2000 from Nikkei BP for his research on "Low Bitrate Video Communication LSI Design".

KEYNOTE SPEAKER 3

Keynote Speech :

Adi Rahman Adiwoso
(Pasifik Satelit Nusantara)

Keynote Title :

Role of Telecommunication Satellite in Indonesia

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BSc in Aeronautical and Astronautical Engineering, Purdue University, 1974
MSc in Aeronautical and Astronautical Engineering, California Institute of Technology, 1976
Work Experience :
1974 – 1982 Hughes Aircraft Company
1982 – 1987 Rasikomp Nusantara
1987 – 1990 PT Rajasa Hazanah Perkasa as Managing Director
1987 – 1991 Board member and COO of Orion Satellite Asia Pacific in Washington DC
1991 – Current President Director of PT Pasifik Satelit Nusantara
1993 – 1995 Marketing Director of PT Satelit Palapa Indonesia
1994 – Current Chairman and CEO of ACeS
1999 – 2008 Chairman of Indonesian Institute of Corporate Governance
2005 – 2006 Expert Staff for BRR
2007 – 2012 Member of Board of Commissioner of PT Garuda Indonesia
2008 – 2012 Member of Board of Commissioner of PT Dirgantara Indonesia (Persero)
2008 – 2011 Member of Board of Commissioner of PT Perusahaan Pengelola Aset
2009 – 2010 Member of Board of Commissioner of PT Merpati Nusantara
Other :
Graduate with Honors from Purdue University
Howard Hughes Fellowship
Nominated in 1997 as The Best Satellite Executive of The Year, Washington DC
Nominated in 2001 as The Best Satellite Executive of The Year, Washington DC
Awarded in 2005 as The Best Satellite Executive of The Year in the Asia-Pacific

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Taufik (California Polytechnic State, USA)

TABLE OF CONTENTS

INFORMATION AND COMPUTER TECHNOLOGIES

ANFIS Application for Calculating Inverse Kinematics of Programmable Universal Machine for Assembly (PUMA) Robot

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This paper focused on the robot arm's kinematics problem or the connection between angle in each joint and the end-effector's position.f Forward kinematics problem will be deduced using D-H (Denavit– Hartenberg) parameter method. The inverse kinematics problem will be solved using ANFIS (Adaptive Neuro-Fuzzy Inference System) instead of calculating the solution. ANFIS is a feature in MATLAB using ANFIS toolbox. PUMA 560 robot arm virtual model is used in this paper. Three ANFIS training conditions are made to test the influence of training conditions with the result's performance. The difference between end effector's position that using ANFIS and from calculation in forward kinematics will be calculated to test the end effector's position error. By making ANFIS solutions with three different MFs (Membership Functions), influence of MF number are known. With more MF will decrease the position's error. The most MF in this paper is 10 MFs resulting position error by 27.974mm.

Keywords—Arm robot; PUMA 560; forward kinematics; inverse kinematics; ANFIS

I. INTRODUCTION

Consumer demand of products are always increasing both in terms of quantity and quality with a good price. Automated production system will be very useful to overcome this situation. In Indonesia, there are many industries that still using non automated system. This is caused by automating the production system's cost in Indonesia are still high, or man power are still not so expensive compared with automating the system.

However, non automated system still have many drawbacks in production time, stability of the products quality and quantity. Because such condition, automation developing is needed, so that the automation system will be more affordable in Indonesia.

There are a lot of automated machines used in automation. One of the common automated machine is an arm robot or a manipulator robot. This robot can be used for many tasks e.g. moving objects, welding, painting, assembling, etc. In this paper, PUMA 500 series configuration is used. This industrial robot is developed by Victor Scheinmann under Unimation robot industry [1].

PUMA 500 series' configuration can be seen on Fig. 1[2]. This arm robot has six DOF (degree of freedom), with servo motors as the actuator [2]. This robot will be modeled and simulated, so forward and inverse kinematics can be solved and proved.

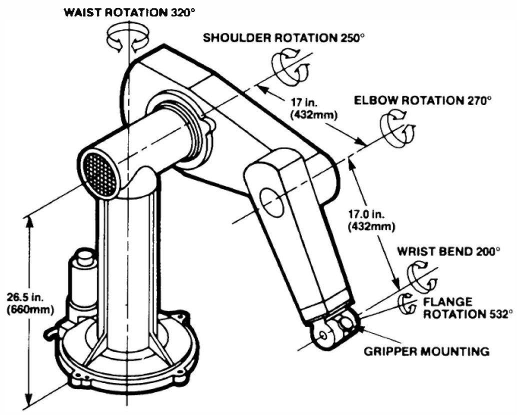

Fig. 1. PUMA 560 dimension [2].

To develop arm robot's controller, forward and inverse kinematics are needed. D-H parameter will be used for solving the forward kinematics problem [3]. However, inverse kinematics solution has always been a problem in every robot's controller designing due to its complexity and more than one possible solution for each position, whereas inverse kinematics is used in defining motor's rotation from desired end effector's position. Inverse kinematics also used to smoothen robot's movement and moving the end effector in line, circle, or another trajectory. To overcome this difficulty, ANFIS is used to solve the inverse kinematics so that there is no need to calculate inverse kinematics solution. And then, the result from those solution will be tested in the simulation.

ANFIS has been used for DC-DC step down converter [4], controlling autonomous flight system [5], ANFIS tuning of PID controller for hydraulically driven parallel robot machine [6], water flow rate [7], etc. Another uses of ANFIS is to solve inverse kinematics problem. There are some papers that use ANFIS in solving the inverse kinematics problem.

Srinivasan Alavandar, M. J. Nigam made a paper about Neuro-Fuzzy based approach for inverse kinematics solution of industrial robot manipulators [8]. The paper solved 3 Degree of Freedom (DOF) arm robot's kinematics problem. They made inverse kinematics solution with both ANFIS and calculation to test the result's performance by comparing the deduced angle with ANFIS's angle.

Enhancement of DRAMs Performance Using Resonant Tunneling Diode Buffer

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***Abstract*—DRAM industry has gained most of the interest in the memory chip industry in the last decades for its high density (due to its simple structure) and lower power consumption. As the density of DRAM chips increased, the bit-line parasitic capacitances increased and many problems appeared such as increased power consumption and larger read/write access times which gave great attention to improve the design of the CMOS sense amplifier used in the memory chip for its great effects on memory access time, overall memory power dissipation and chip density.**

In this paper, we introduce one of the most effective solutions to increase the performance of the advanced high density DRAMs by replacing the sense amplifier circuit with a specially designed logic buffer circuit based on Resonant Tunneling Diode (RTD) that can be fabricated in Nano-scale and exhibit higher operation speed with lower power consumption and higher chip density. The proposed design improves the Power Delay Product (PDP) by about 36% compared with that in conventional RTD-CMOS sense amplifier and 15% compared with that in conventional CMOS sense amplifier. The 45nm CMOS technology is used in this paper.

Keywords*—*Access time; CMOS; DRAM; Logic circuits; Power Delay Product (PDP); Resonant Tunneling Diode (RTD).

I. Introduction

DRAM cell has a very simple structure shown in Fig.1, which makes it easily implemented in arrays, this simple structure made DRAMs widely used in most of recent applications. It consists of a cell capacitance (C_s) and an access transistor (M_{access}) between the bit-line (BL) and the cell capacitance which is controlled by the word-line (WL). The bit-line is connected to a differential sense amplifier to sense the voltage stored in the cell capacitance and pulls the bit-line to V_{DD} or ground according to the value of the sensed voltage [1, 2].

Sense amplifiers are one of the most essential circuits in the periphery of DRAMs. They sense the voltage stored in the bit-line that results from the charge sharing between the cell capacitance and the bit-line capacitance. According to this value it pulls the bit-line up to the supply voltage (V_{DD}) or down to ground.

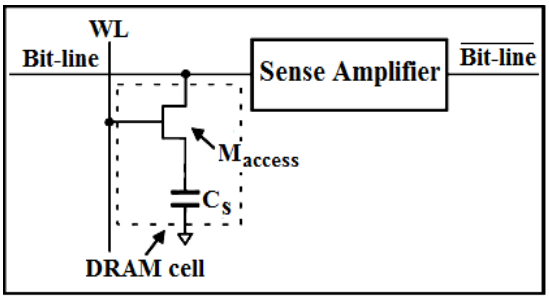

Fig. 1. DRAM cell [1].

The voltage shared must be sufficient enough for the sensing operation to work correctly; it can be expressed as follows [2, 3]:

$$\Delta V = \frac{C_S}{C_S + C_{BL}}\left(V_{CS} - \frac{V_{DD}}{2}\right) \quad (1)$$

Where C_S and C_{BL} are the cell and bit-line capacitances respectively, V_{CS} is voltage stored in the cell and V_{DD} is the operating voltage. Usually C_{BL} is much greater than C_S, thus equation (1) can be reduced to [2, 3]:

$$\Delta V \cong \frac{C_S}{C_{BL}}\left(V_{CS} - \frac{V_{DD}}{2}\right) \quad (2)$$

In this paper, the value of ΔV is assumed to be equal to 5mV as a worst case for a very small charge sharing produced. To obtain this value; the cell capacitance (C_s) will be equal to 10fF and the bit-line equivalent capacitance (C_{BL}) will be equal to 500fF.

The CMOS sense amplifier design is facing many problems that greatly affect the performance of the memory chip. One of these problems is the CMOS technology scaling; it results in a significant increase in the leakage current of the CMOS devices which increases the power consumption. Also, the increased parasitic capacitances that come with advanced high density CMOS memories increase the power consumed and the read/write access times [6,7].

Development of Microcontroller-based Stereoscopic Camera Rig Positioning System

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***Abstract*—A camera rig operator of stereoscopic camera system mostly adjusts a pair of camera manually when trying to make a 3D video that has good image depth. However, the process of this cameras positioning is cumbersome and time-consuming. In this paper, in order to solve those problems we develop a semiautomatic stereoscopic camera system; different from other works where a microcontroller, which considered low-cost and affordable, is employed to handle automation process of the system. Nevertheless, the camera rig operator is still required to carry out some manual processes such as inserting required parameters. In this system, the object distances approach is utilized; some object distance parameters, which obtained by a laser range finder, are entered into mathematical expressions in order to obtain correct positions of two cameras.. Based on experimental results, our proposed system enhances the process of the video capture process. In other words, it reduces the time required for every single scene capture process.**

***Keywords*—Semiautomatic stereoscopic camera system; microcontroller; automation process; object distances approach**

I. Introduction

Stereoscopic camera system is a method to create three dimensional (3D) video. This technique actually adopts human visual system where there are two identical cameras used to represent two human eyes. Thus, the two captured videos, which are fused, can deliver depth of perception for presenting 3D illusion to human eyes. Furthermore, the two images must be aligned properly, including with correct disparity to avoid visual discomfort that could lead to eyestrain and visual fatigue to viewers. As such, to obtain the proper 3D videos, the cameras must be placed on a holder horizontally called stereoscopic camera rig. By using the camera rig, the alignment and the disparity of the cameras can be adjusted easily.

In recent years, the demand of the 3D video format is increasing. Herein, the 3D video can be watched not only in cinema theaters like many years ago, but anywhere as a lot of consumer devices such as 3D television, monitor, handphone, etc. are able to play 3D video format. However, from 3D video production point of view, the process is still cumbersome and time-consuming. A common way to adjust the position of the cameras is manually by a camera rig operator. In this case, a skilled camera rig operator is required. Big 3D movie companies enhance the production by using 3D live monitor equipment to assess the 3D effects during 3D video capture process [1], [2]. Another way is by optimizing the video combination process in post-production step [3].

In our opinion, optimizing the 3D video production during the video capture process could reduce workloads of video editing in post-production step and reduce the time required of video capture process itself since it is very dependent on assessment result of the camera rig operator. For example, even skilled camera rig could make a mistaken perceived depth of 3D images or videos that can cause visual fatigue to the viewers. In this case, the 3D images or video must be corrected and reevaluated in post-production step. Furthermore, dependent on subjective assessment of 3D video or image quality is obviously more time-consuming instead of objective assessment. Our laboratory had already evaluated about relationship between stereoscopic camera position and 3D image quality based on several objects position [10]; thus by following the same path, subjective assessment could be omitted and reduce time consumption. Several approaches in order to optimize video capture process have been proposed by utilizing a field programmable gate array (FPGA), and a programmable logic controller (PLC) [2], [4]. In this paper, we propose an automation system for the stereoscopic camera rig positioning by utilizing a microcontroller.

Microcontroller is a combination of central processing unit (CPU), memory, and input or output that integrated into small form integrated circuit (IC). It usually has lower price than FPGA or PLC and is intended to be used for low cost electronic system.

II. Stereoscopic Camera System Overview

There are several methods to create 3D video have been proposed. The cheaper method is by reconstructing 3D video through 2D-to-3D video converter [5], [6]. 2D video manipulation is the essential technique in this method so as to extract the depth information of the video. This kind of method is very useful to remake the old time 2D movies into 3D format. However, since the 3D effects desired from the 3D movies are basically the effects that people want to feel like in real life; therefore, the stereoscopic camera system is more preferred instead of 2D-to-3D video conversion.

This research is partially supported by Ministry of Science, ICT and Future Planning (MSIP) and Institute for Information & communications Technology Promotion (IITP) in the Information Communication Technology (ICT) and Culture Technology (CT) Research & Development Program 2014.

Training Support for Pouring Task in Casting Process using Stereoscopic Video See-through Display

- Presentation of Molten Metal Flow Simulation Based on Captured Task Motion -

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***Abstract*—The work support technology using augmented reality has been researched in the field of manufacturing. It is the technology that can present appropriate instructions to a worker. Thereby, the worker performs a task requiring an advanced skill even if she/he is not an expert. In this technology, most of work instructions are presented while the worker is working. However, there are many manufacturing tasks that is difficult to be retried when it fails. In order to deal with such tasks, a training support technology that a worker can train tasks beforehand using augmented reality is proposed. This technology can present simulated task results according to the motion of the worker. As a simulation result, for example, the worker can see internal state of the work object. And she/he can train as many times as she/he wants. Therefore, her/his skills can be improved through trial and error. In this paper, a concept of task training support technology is introduced. To realize the concept, the pouring task in casting process is selected as a target task and the prototype system is constructed. Then, the evaluation results of pouring task training using the prototype system are reported.**

Keywords- Training support, Work support, Casting, SPH, Augmented reality, Virtual reality, Video see-through display, High resolution, HMD

I. INTRODUCTION

In the manufacturing field, there is a problem with shortage of experts because of aging. In order to cope with this, the work support technology has been developed[1][2]. It is a technology that a worker can perform tasks efficiently even if she/he is not an expert by presenting the appropriate instructions corresponding to the situation at that time. In this technology, the work instructions are presented while the task is actually being executed. However, there are many manufacturing tasks that can not be retried if a worker fails, or that has a risk of large loss of cost. For such tasks, it is preferable that the task training is performed beforehand. In order to realize it, we propose the training support technology so that workers can practice in advance and their skill levels are expected to be efficiently improved. Fig. 1 shows the concept of task training support. A worker is looking at a work object through an image presented from the display device such as video see-through display. And the worker can practice by seeing not only the computer graphics but also practical work objects, and work tools that are used in the actual tasks. When the task operation is carried out by using work tools, the task motion is recorded. The simulation is executed on the basis of the recorded motion.

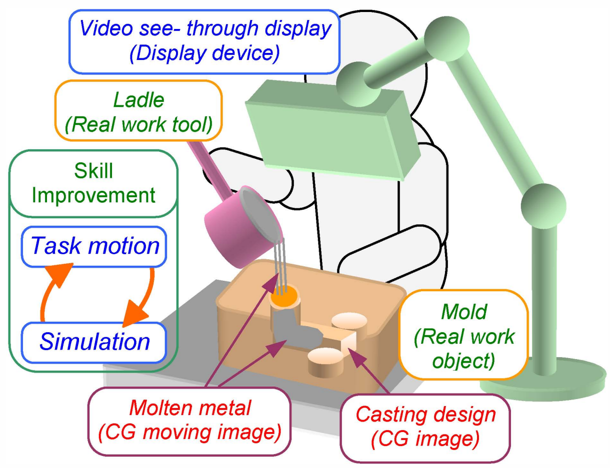

Fig. 1. Concept of task training support
Example of application to pouring task in casting process

Then, computer graphics (CG) of the simulation results is superimposed on the work object using augmented reality and the superimposed moving image is presented to the worker. As an example of the moving image, the worker is able to observe the molten metal flows into the mold as shown in Fig. 1. In this technology, the simulation result is changed according to the task motion. Therefore, through the moving image, the worker can evaluate whether the worker's previous task motion had gone well or not. Here, only simulation is performed on this training, and the actual task is not performed. Thus, the worker can practice it repeatedly through trial and error and it is expected her/his skills are improved. However, depending on the target task, it is necessary to appropriately choose the method of the motion detection and the simulation and so on.

As similar studies in manufacturing field, the assembly operation and maintenance that uses augmented reality are also studied[3][4]. They can also be used for the task training. Furthermore, the training system for the welding task is developed[5]. It can analyzed and evaluated the workers operation. However, the systems that can present the simulated task results according to the worker's motion such as the task training support we propose are hardly developed.

978-1-4799-6432-1/14/$31.00 ©2014 IEEE