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Indonesia-Germany

From Friendship to Partnership

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Strengthening the Partnership between Vocational Education and Training and Industry

Yogyakarta State University, INDONESIA

28 June 2012

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FOREWORD

This proceeding compiles all papers from the invited speakers and complementary papers in International Conference on Vocational Education and Training (ICVET) 2012. The conference is organized by Yogyakarta State University in collaboration with the German Embassy in Jakarta and the Indonesian Embassy in Berlin on 28 June 2012. It is conducted as a part of event series held to celebrate 60 Years Indonesia-Germany Partnership.

The main theme of this conference is “Strengthening the Partnership between Vocational Education and Training and Industry”. Three sub themes are covered in this conference: 1) Management; 2) Learning Process; and 3) Program and Collaboration.

I should apologize for the discontentment and inconvenience concerning both the conference and proceeding. I hope this proceeding will give deeper insights about vocational education and training.

Yogyakarta, 28 June 2012

Editor

TABLE OF CONTENTS

DEVELOPMENT OF VIRTUAL LABORATORY THROUGH HAND MOVEMENT DETECTORS IN ORDER TO IMPROVE A PSYCHOMOTOR SKILLS STUDENT OF VOCATIONAL HIGH SCHOOL

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Abstract

The students interact directly in virtual laboratory with a simulator or remote equipment, and it is desirable that the experience will be similar to a real lab. There are many ways by which a student could attain this experience -through real experimental activities or through computer human interactions. These computer based multimedia environment and cohesive with hardware. These environments offer students a means to explore, experience, express themselves, and train psychomotoric. In a Digital Electronics virtual environment, the students can posit hypotheses about a engineering concept, conduct as many experiments as they want. In this paper the virtual laboratory design based on macromedia flash (software) and hand movement detection (hardware). Have implemented a virtual lab for the user especially vocational students (SMK), making practices more interesting and interactive through user interaction with computer using a periferal with hand movement detection that provides flexibility in operating. Combination of real and virtual lab which is integrated into the course material, can enrich the learning process, increase student's interest and curiosity, enhance the ability of psychomotor with hands-on.

Keywords: virtual laboratory, hand movement detection, psychomotor

1. Introduction

Information Technology (IT) one of the branch of science in the field of contemporary give many alternative solution to development manegement process and outomation of data traffic in the various field of work. One of the implementation on information technology needs by students, teachers, laboratory, and employess of educational institution use virtual laboratory for manage the vocational students labs and practicum.

Research in virtual laboratory is more than virtual learning approach. Virtual practicum environment used the animation and simulation in the form of 2D and 3D. Student can explore the virtual Engineering laboratory, do their experiment and get the output from that experiment. Students also need to keep their experiment information such as inference and observation in the electronic experiment report and worksheet as soon as the information recorded, student are allowed to edit and print the report.

Operation Research Virtual Laboratory (V-Lab) is a virtual laboratory specially designed for supporting the practice of operations research laborarory for the student that take the course of operations research. The aims of this virtual laboratory is to provide an assistance for the students to improve their skill in laboratory practice without direct help from assistants and can be carried out without concerning time and place contraints. Virtual Lab has following featutes: tutotial, simulation and practice materials with realtime aplication using hand movement detectors.

2. Virtual Laboratories As Tools For Supporting Teaching, Learning, and Practicum Activities

Virtual Laboratories to Support teaching, Learning, and practicum Activities The virtual environments, named virtual laboratories, vary from static Web pages with didatic videos and texts, to dynamic pages with sophisticated environments, collaborative authoring [1], videos on demand, virtual meetings, and many other features. These virtual laboratories may also allow remote access to measurement instruments, video cameras.

Virtual laboratory need an interesting grafik design to keep the student stay consistent to use the electronic learning, the diversity of models and structures for virtual laboratories is large and varies according to the nature of the project under investigation, the goals, and the technologies involved. The motivations for the implementation of virtual laboratories include, but are not restricted to [2]: a) The limitation on the resources and space in the real-world laboratories. This type of limitation may cause delay in the learning activities of the students, who may face the situation in which they have to compete or wait for the availability of a given resource, in addition to the fact that one's experiment may be interrupted before it is concluded, due to the need of sharing resources; b) The possibility of sharing usually expensive equipment; c) The stimulus for the collaboration of research or work in groups independentlyof their physical distance; d) The existence of a learning environment outside the school, allowing the students to participate or develop their own projects together with other students in their spare time; e) The possibility of developing different parts of an experiment at different locations; f) The remote supervision and intervention in potentially dangerous experiments, thus helping to prevent accidents; g) The remote access and control of precision equipment; h) Facilitate the learning of a subject by allowing the distance experimentation with Engineering process, chemical reactions, biological mechanisms, physical simulations, or other subjects; h) Allow for the creation of virtual communities about a central subject, and thus result in the convergence of people with similar interests to the same virtual environment; i) Bring together resources and information related to a specific subject matter; j) Provide guidelines for the use, teaching, and learning of the subject, together with means for its assessment.

3. Hand Gesture Interaction

3. 1 Definition of Hand Gesture

"A gesture is a motion of the body that contains information. Waving goodbye is a gesture. Pressing a key on a keyboard is not a gesture because the motion of a finger on its way to hitting a key is neither observed nor significant. All that matters is which key was pressed" [3]. According to Kurtenbach & Hulteen, a bodily movement is considered a gesture if it contains information, it is observed and it is significant. Considering this definition, we define hand gestures in the context of human-computer interaction for the purpose of this thesis as follows: A hand gesture is a movement of the hand and fingers, performed by the user with the intention to interact with the computer. Hand and finger movements are significant and directly monitored, instead of monitoring the movement of an intermediary physical input device operated by the hand, such as a mouse or stylus. Each hand gesture conveys meaning to a computer. We thereby do not limit hand gestures to dynamic hand and finger movements, but also include shapes which can be adopted by the hand and its fingers. A shape is thereby referred to as a "hand posture".

3.2 The Human Hand

"With approximately 30 dedicated muscles and approximately the same number of kinematic degrees of freedom, the hand can take on all variety of shapes and functions, serving as a hammer one moment and a powerful vice or a delicate pair of tweezers the next" [4]. The broad variety of shapes and functions the hand can take on and perform makes the hand a highly valuable tool for us to interact with our physical surroundings and to communicate with other people. We can use the hand as a powerful tool to move heavy objects or crash nutshells, to perform complex high precision tasks such as tying up shoelaces or shuffling cards, as well as soft and delicate tasks such as stroking a cat. For all those tasks hands are not only used to act but also to perceive. The highly discriminative sense of touch in the fingers [5] makes it possible, for example, to perceive information on details of the surface of objects which can then be used to adjust hand movements.

Human-Computer Interaction can use the hand for input but also for output. Movements of the hand and its finger for input from the human to the computer (=hand gesture input), where "[…] the hand, which can technically be considered as a complex input device with more than 20 DOF, can become an easy to use high DOF control device" [6] and the sense of touch as a feedback channel from the computer to the human.

3.3 Hand Movements

Limbs are in general moved with a coordinated activation of many muscles acting on skeletal joints [5]. Most of the muscles for hand movements are in the forearm [7]. Power from the muscles in the forearm is transmitted into the hand by means of long tendons. Therefore most of the muscle mass used for hand and finger movements lies outside of the hand. *"This arrangement allows the hand to be light and flexible without sacrificing strength"* [8]. Furthermore, some muscles, known as intrinsic hand muscles, are located inside of the hand. The intrinsic hand muscles are responsible for minimal yet precise finger movements [9]. We can distinguish hand movements in (1) palm movements which are performed mainly in moving the palm (which also moves the fingers) and (2) finger movements which can be performed by the fingers. The following movements (described in [10] result in moving the palm, where the first four listed result from movements at the wrist, and the last two ones (supination, pronation) result from a movement of the forearm: a) Flexion: bending the hand at the wrist, toward the inside of the hand (Figure 1a). b) Extension: bending the hand at the wrist, away from the inside of the hand (Figure 1b). c) Ulnar Deviation: bending the hand at the wrist in the plane of the palm, away from the axis of the forearm, towards the direction of the little finger

(Figure 1c). d) Radial Deviation: bending the hand at the wrist in the plane of the palm, away from the axis of the forearm, towards the direction of the thumb (Figure 1d). e) Supination: lateral rotation of the hand, resulting from a rotation of the forearm (Figure 1e). f) Pronation: medial rotation of the hand, resulting from a rotation of the forearm (Figure 1f).

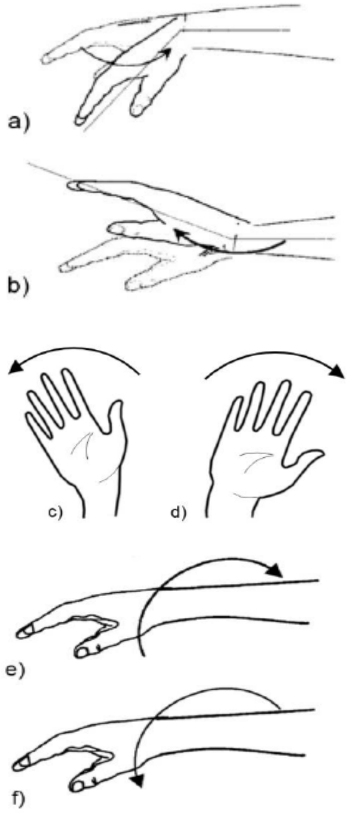

Figure 1: Palm movements, arrows indicate movement direction. (a): Flexion, (b): Extension, (c): Ulnar Deviation, (d): Radial Deviation, (e): Supination, (f): Pronation. Adapted from [10].

The fingers can perform the following movements (taken from [9],[11]: a) Flexion: moving the fingertip towards the inside of the hand (Figure 2a); b) Extension: moving the fingertip away from the inside of the hand (Figure 2a); c) Abduction: moving the finger away from an imaginary line drawn through the axis of the middle finger (Figure 2b); d) Adduction: moving the finger towards an imaginary line drawn through the axis of the middle finger (Figure 2c); e) Opposition: the opposition is a unique movement of the thumb, where the thumb is moved above the inside of the palm with the possibility to touch the tips of the remaining fingers (Figure 2d); f) Circumduction: a circular movement of a distal limb, such as the fingers, is referred to as circumduction. However, it is not a unique movement but a sequence of flexion, abduction, adduction and extension.

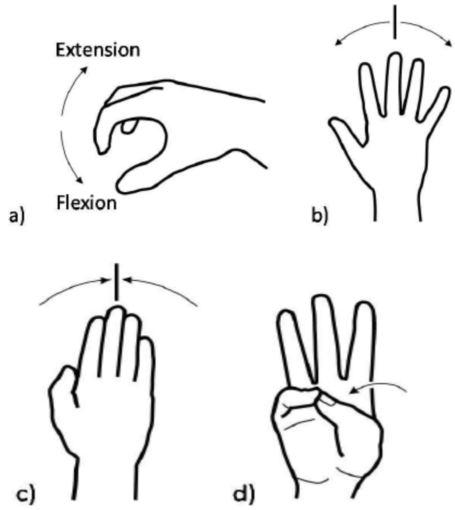

Figure 2: Finger movements, arrows indicate movement direction. a): Flexion and Extension, b): Abduction, c): Adduction, d): Opposition

Those hand movements are the biomechanical conditions given to perform hand gestures, and also describe constraints which movements are possible and which are not.

4. Tracking Hand Movements

Different approaches have been introduced for tracking hand movements to provide hand-input for human-computer interaction. Those approaches can be distinguished, according to whether objects are attached to the user‟s hand or not, into (1) computer-vision-based, non-contact and (2) glove-based approaches. For computer-vision-based, non-contact approaches, movements of the user‟s bare hand are captured with one or multiple video cameras. The images are further analyzed and processed to detect the hand. No physical objects are attached to the hand to support the adjacent processing steps. With glove-based approaches, the user either wears a dedicated data glove with build-in sensors or other physical objects get attached to the user‟s hand, which can be viewed as a minimized glove, to ease the detection of hand movements by tracking systems located distant from the hand.

4.1 Computer-Vision Based Non-Contact Tracking of Hand Movements

Computer-vision-based non-contact approaches capture hand movements with one or multiple video cameras neglecting the need to attach physical objects to the user‟s hand. Therefore users can immediately start to interact. Those approaches have the potential to provide an unencumbered interaction [6] and users cannot get disturbed by potentially intrusive hardware placed at their hand.

Capturing hand motion in real time with computer-vision-based, non-contact approaches is an active area of research (see [6] for a comprehensive review on existing solutions). Applying computer-vision, non-contact approaches to capture the real 3D motion of the hand and recover the full degree of freedom (dof) hand motion from images, is a challenging problem in the context of HCI, and "[…] several challenges including accuracy, processing speed, and generality have to be overcome for a widespread use of this technology" [6]. The design of computer-vision, non-contact solutions encounters several difficulties. The hand is a flexible object which can take on a variety of shapes. This capacity of the hand gives rise to two difficulties. The first is self-occlusion, which describes the fact that the projection of the hand onto an image plan can contain many self-occlusions, where parts of the hand overlap other parts of the hand. The second one is the difficulty that a large number of parameters have to be estimated from the derived projections, such as position and orientation of the hand itself, location of the fingertips, bending of fingers, etc. Technical difficulties are 1) uncontrolled environments, which have to be taken into account when locating the hand in the image and 2) processing speed, as a huge amount of data has to be processed [6]. To alleviate some of the difficulties, restrictions on the user or the environment can be applied by ensuring, for instance, that the palm is parallel to the image plane, which avoids overlapping of fingers, or by controlling the background in order to make the system fast and robust [12] or using only a distinct aspect of hand movements for input (e.g. 2D position of the fingertip). However, those restrictions may not necessarily be of high inconvenience for the user. For instance, if the hand is typically parallel to the image plane in a given context of use, if background conditions can be easily controlled, or the derived aspects of hand movements are sufficient for the interaction they are used for. Following this, we will describe two sample solutions which do not track full 3D hand motion but still provide a highly usable basis for hand gesture interaction. [13] describe a system which applies computer-vision to facilitate non-contact hand gesture interaction. They detect the 2D position and 2D direction of user‟s fingers and associate them with the corresponding finger. They use this information along with the number of outstretched fingers as variables for defining hand gestures. Those hand gestures are then used to interact with three sample applications projected onto a wall, to control a presentation, move virtual items on the wall during a brainstorm session and virtually paint on the wall. In each sample scenario, users stand in front of the wall and interact with the projected application. Adaptive background models are used to ease the detection of fingertips in the images even with changing backgrounds originating from changes in the appearance of the graphical user interface and lightning conditions. They report a total latency of their finger finding algorithm of 26 – 34 ms (not including time needed for image acquisition).

Segen & Kumar [1998, 2000] describe a system designed to support tasks like 3D navigation, object manipulation and visualization. Their system detects the 3D position of the index finger- and thumb tip, and the azimuth and elevation angles of the finger‟s axis1. Based on this information they defined three hand gestures, a fourth gesture is included to serve as a default gesture for all other identified hand postures. The system is used in a desktop environment with two video cameras placed above a table. In order to make the system fast and robust, a high-contrast stationary background and a stable ambient illumination is required. A limitation of the

system, which is mentioned by them, is the limited range of hand rotation due to the use of two cameras and their placement. However this can be compensated in adding video cameras for image capturing. Their system recognises the gestures and tracks the hand at a rate of 60 Hz (imposed by the video cameras used). Those two sample systems provide valuable and excellent solutions for the setting they are aimed for. However, generalizing those approaches to other settings may be difficult, as a controlled background cannot always be guaranteed, holding the palm parallel to the image plane might not always be desired, or additional features of hand movements should be utilized for hand gesture interaction, e.g. using the rotation of the palm combined with a certain hand shape as an input parameter.

4.2 Glove-Based Tracking of Hand Movements

Besides computer-vision based, non-contact approaches, there are glove-based approaches for tracking hand movements. Commonly used for tracking finger movements are commercially available data glove solutions, which build sensors into gloves to measure the bending of fingers capturing flexion, extension, adduction and abduction movements [14] [Immersion 2008] (see Figure 10, left & middle). Data gloves with build-in sensors reliably deliver data on all possible finger movements and have the advantage that the quality of the data cannot be influenced by occlusion of fingers, or changing backgrounds. However, the gloves of data glove solutions typically come in only one size [14] [15] [16] and a good fit for each hand size cannot be guaranteed. A bad fit is not only able to disturb the user but can also influence the accuracy of the measured data if the build in sensors do not reflect the actual finger movements. Data glove solutions typically provide high sampling rates, for instance 90 Hz for the CyberGlove® II or 75 Hz for the 5DT Data Glove 14 Ultra. In order to track movement of the palm commercial data glove solutions can be combined with a tracking solution capable of detecting the orientation of an object. Therefore data glove solutions can be combined with an optical (e.g. [17] [18]) or electromagnetic (e.g. [19]) tracking system. An optical tracking system uses multiple cameras to detect objects and calculates their position and orientation in reference to a predefined coordinate system. Such an object (typically consisting of a fixed arrangement of markers) has to be attached to the glove to monitor movements of the palm (e.g. at the back of the glove). Due to the use of cameras the reliability of the data on the movement of the palm is sensitive to occlusion. If the tracked object is occluded by other objects from the view of the cameras it cannot be detected. The user‟s mobility range for accurate tracking depends on the amount of cameras used and their set-up. An electromagnetic tracking system detects a sensor which also has to be placed on the glove to monitor movements of the palm. The tracking system can provide information on the orientation and position of the sensor. Due to the fact that no cameras are used for tracking, occlusion of the sensor is not an issue. Electromagnetic systems can limit the range of the mobility range of the user in order to provide accurate tracking (a diameter of 2 meters in the case of the Polhemus system). The sampling rate depends on the tracking system used, for instance 50 Hz for the Polhemus system, 60 Hz for the optical tracking system developed by A.R.T. [20] and 120Hz for the Vicon tracking system [18].

Independent from the chosen combination of a data glove for tracking finger movements and an additional tracking solution for tracking palm movements, wearing a glove can encumber user interaction and give rise to hygienic problems if the same glove is worn over a longer period of time or by different users.

Figure 3: Left: the CyberGlove II (taken from [15]). Middle: the 5DT Data Glove 14 Ultra (taken from [14]). Right: The data glove of the A.R.T. finger tracking solution. Taken from [17]

A further glove-based solution has been developed by the company A.R.T. [17] [21]. It combines a minimized data glove (see Figure 3, right) with their optical tracking system. The data glove consists of a thimble set that can be attached similar to foxgloves onto the fingertips. The thimble set, available to either cover three or five fingertips, is connected to a target (an object consisting of a fixed arrangement of markers for which the tracking system can detect the position and orientation). This target is placed at the back of the hand. Markers, actively sending out infrared rays, are placed on the tip of the thimbles and onto the target. The optical cameras detect those rays and calculate the position of the thimbles (the position of the fingertips) and the position and orientation of the target (the position and orientation of the back of the hand). Therefore finger and palm movements can be tracked. From the tracked data the angles between the joints of the fingers and the orientation of the finger tips is derived. Fingers are identified via synchronized modulated flashes which synchronize the markers of the data glove with the optical tracking system. Due to the minimized data glove which minimizes contact of the glove with the hand, hygienic problems arising for the previously described data glove solutions can be reduced. The design of the thimble sets, which are available in three different sizes, allows accustoming the data glove to a wide range of hand sizes. The markers on the fingertips are therefore always close to the fingertip whose position they measure. However, due to the use of an optical tracking system occluded finger markers or target markers can impede tracking of hand movements which is not possible if the markers are not in the field of view of at least the number of cameras required for tracking. The sampling rate for the information on palm movements (derived from the target) is 60 Hz. The sampling rate for the information on finger movements (derived from the thimbles) depends on the version (three vs. five thimbles) used: Sampling rate = 60 Hz / Number of thimbles. We are not aware that there currently is any other comparable system available.

5. System Design

This virtual laboratory detects fingertips in the real time from live video and calculate fingers bending angle. The process from the human gesture to virtual laboratory is explained in figure 4. First captured 2D image would be preprocessed and skin filter would be applied. Segmentation method is able to extract the hand gesture from the image frame even if there are skin colors like objects in the gesture background. The processed image would be cropped to get only area of interest to make further processing faster. In the cropped image, fingertips and center of palm would be detected and then system would measures distance between centre of palm and fingertips. The calculated angle for each finger could be passed as input to virtual laboratory, so that virtual laboratory can bend its finger accordingly. System is able to detect fingertips, center of palm and angles continuously without any system error. In this paper fingertip detection based gesture recognition was done without using any training data or any learning based approach.

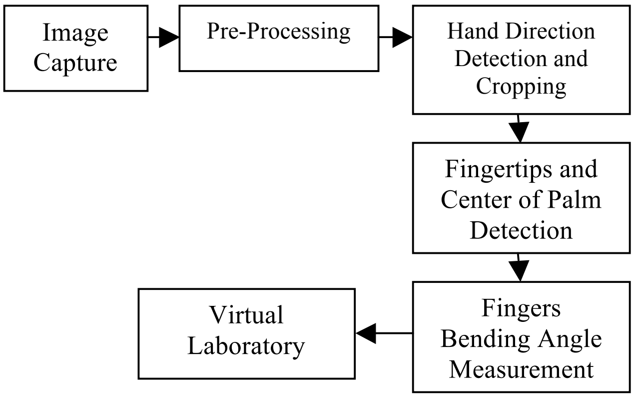

Figure 4. Block diagram flow of the system

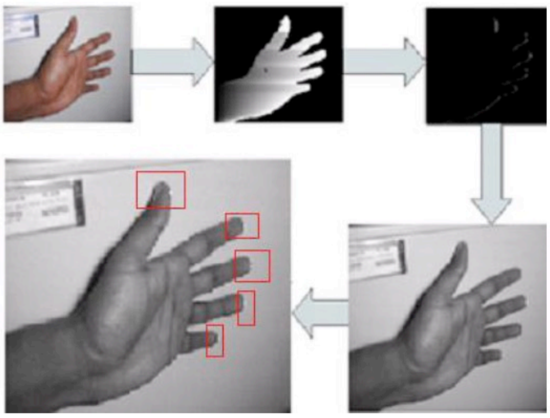

Figure 5. Fingertip detection process

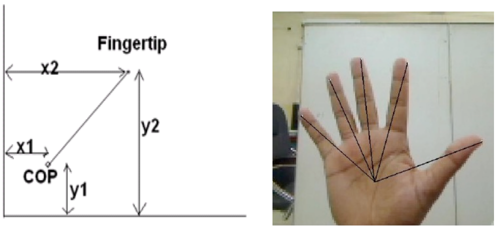

Figure 6.Distance calculation between centre of palm and Fingertips

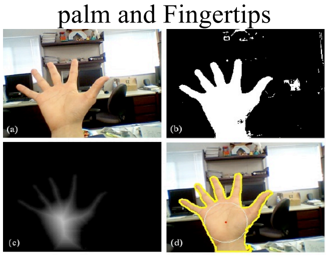

Figure 7. Hand segmentation procedure. Given a captured image (a), skin color segmentation is performed (b). Then the distance transform (c) is used to extract a single connected component of the hand (d).

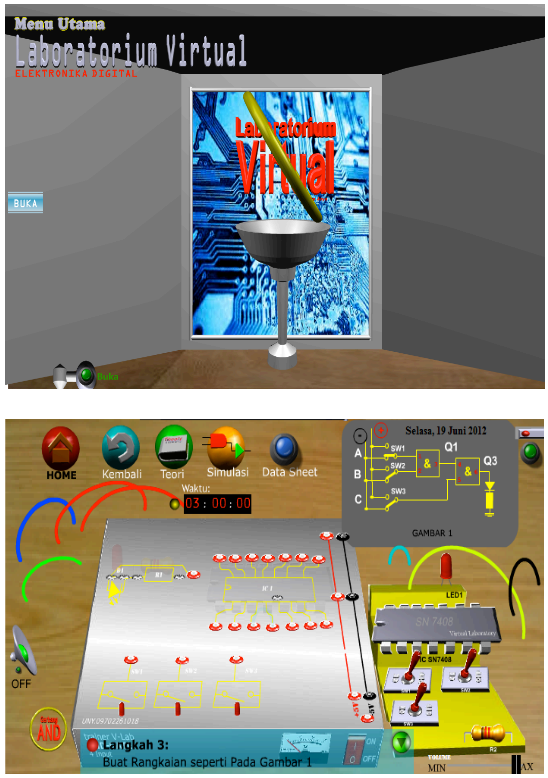

Figure 8.virtual laboratory Display using macromedia flash (software)

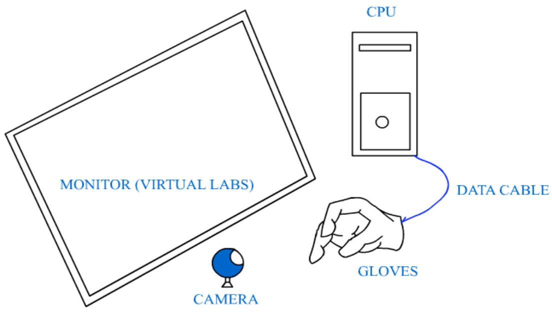

Figure 9. Human Computer Interaction with Virtual Laboratory

Figure 10. Virtual Laboratory Through Hand Motion Detectors (Hardware)

Virtual laboratory approach consist of software and hardware. This software are design by using macromedia flash, 3Ds Max for making a visualisation virtuality and swift 3D. This Hardware using sensor to detect hand movement, segmentation image by using webcam. To pick up the cable and component in the screen, user must move their hand like pick up the real component.

The Content of Virtual Lab Application such as: a) Characteristic : Applicative, communicative, interactive, compatible and develop critical thinking skill rather than just observational skill; b) Form of experiment : collaborative and interactive simulation; c) Simple navigation : User Friendly; d) Content : According to concept and syllabus, up to date, aperception, problem based learning, contextual learning; e) Completeness : user guide, trial and error, glossary, reference, help navigation.

Synergy between real and virtual lab [22] which supported by certain policies among them are about standardization of development procedure of virtual lab application and the proper usage of virtual lab for Vocational School can give the following benefits: Provide even distribution of access to science lab in Vocational School, Increase the quality and competitiveness of the science education especially in natural science, Upgrade the competence level of students and teachers, Increase the utilization of Jardiknas Reduce the gap of laboratory facilities between Vocational schools.

CONCLUSSION

In this paper the virtual laboratory design based on macromedia flash (software) and hand movement detection (hardware). Have implemented a virtual lab for the user especially vocational students (SMK), making practices more interesting and interactive through user interaction with computer using a periferal with hand movement detection that provides flexibility in operating. Combination of real and virtual lab which is integrated into the course material, can enrich the learning process, increase student's interest and curiosity, enhance the ability of psychomotor with hands-on.

Combination of real and virtual lab which is integrated into the syllabus, can enrich the learning process and increase student's interest and curiosity. Students are also benefitted from the synergies between real and virtual laboratory.

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