Augumented Reality Welding Simulator

Vijayalakshmi K [1], G.Sai Priya [2], Mojamill Jan [3], Rishma, Imroz [4]
[1] Assistant Professor (O.G.), Department of Computer Science and Engineering, SRM Institute of Science and Technology, Chennai, India.
[2, 3, 4] Student, Department of Computer Science and Engineering, SRM Institute of Science and Technology, Chennai, India.

Abstract- Circuit simulation of gas metal arc welding (GMAW) system was developed. Using a circuit equation and mass and energy balance equations for wire length and droplet length, the system is represented in state space. This makes the model inclusive and effective. The model predicts the time-variable properties of GMAW systems and the results have been compared with experiment, showing good agreement. Arc welding is a process that is used to join metal to metal by using electricity to create enough heat to melt metal, and the melted metals when cool result in a binding of the metals. They can use either direct (DC) or alternating (AC) current, and consumable or non-consumable electrodes. The welding region is usually protected by some type of shielding gas, vapor, or slag. Arc welding processes may be manual, semi-automatic, or fully automated. First developed in the late part of the 19th century, arc welding became commercially important in shipbuilding during the Second World War. Today it remains an important process for the fabrication of steel structures and vehicles.

Index Terms-- Circuit simulation, Welding, Wire, Equations, Voltage, Power system modeling, Predictive models, Contact resistance, Heat transfer, Inductance.

1. INTRODUCTION

Welding is the process in which two or more parts are joined permanently joined at their surfaces by a suitable application of heat or pressure. Often the filler material is added to facilitate coalescence. The assembled parts that are joined by welding are called as weldment. Welding is primarily used in metal parts and their alloys. Welding processes are classified into two major groups:

a) Fusion welding: In this process, the base metal is melted by means of heat. Often, in fusion welding operations, a filler metal is added to the molten pool to facilitate the process and provide bulk and strength to the joint. Commonly used fusion welding processes are: arc welding, resistance welding, oxyfuel welding, electron beam welding and laser beam welding.

b) Solid-state welding: In this process, the joining parts is taken place by application of pressure alone or a combination of heat and pressure. No filler metal is used. Commonly used solid-state welding processes are: diffusion welding, friction welding, ultrasonic welding. Arc welding and similar processes It consists of combination of different welding processes wherein coalescence is produced by heating with an electric arc, (mostly without the application of pressure) and with or without the use of filler metals depending upon the base plate thickness. The final welded joint has unit strength approximately equal to that of the base material. The arc temperature is maintained approximately 4400°C. A flux material is used to prevent oxidation, which decomposes under the heat of welding and releases a gas that shields the arc and the hot metal.The second basic method employs an inert or nearly inert gas to form a protective envelope around the arc and the weld. Helium, argon, and carbon dioxide are the most commonly used gases.

2. BACKGROUND LITERATURE

Throughout modern industry, welding is the most widely used, cost effective means for joining sections of metal to produce an assembly that will perform as if cut or formed from solid material. Welding practices can be traced back to ancient times. Although man began to pressure-weld metals such as gold more than 2000 years ago, and learned to forge-weld iron about 1000 years later, modern implementations of welding did not begin until a little more than 100 years ago. Arc welding had its practical beginning shortly after introduction of arc lights in 1881. Early experiments in arc welding provided basic theories for the development of two systems of arc welding five or six years later. Welding was used in a very limited way for manufacturing proposes prior to World War I period (1914 – 1918). From 1919 to 1925, much fundamental research work was carried out by various manufacturers. During 1926 to 1950, a desire to improve the quality of welds produced by arc welding led to the development of several welding process which combine gas and arc welding. During this period, submerged arc welding (SAW) process was developed for welding carbon steel.

a) Modern welding technology

Modern welding energy sources include general electric arc, plasma arc, resistance heating, excitation through irradiation by high energy laser or electron beams, excitation by an electromagnetic source of infrared or microwave radiation, friction, plastic deformation, exothermic chemical combustion, exothermic chemical reaction, induction etc. Energy sources which so that can produce more intense heat, enable welds to be made in metals and alloys of higher melting temperature, larger structures, thicker sections, and allows the process to be done at a greater speed. Automatic arc welding equipment involves mechanical and electronic means of controlling welding conditions.

b) General arc welding process

Fusion welding process that employ an electric arc as heat source is called as arc welding processes. Generally the arc in the arc welding processes is created between an electrode and a work piece or the weldment, each at different polarities. The arc itself consists of thermally emitted electrons and positive ions from electrode and work piece. These electrons and positively charged ions are accelerated in the potential field (arc voltage) between the electrode and the work piece, which are typically connected to the terminals of the electrical (arc voltage or arc current) source and produce heat when they convert their kinetic energy by collision.

3. AR (AUGMENTED REALITY)

Augmented reality (AR) is a direct or indirect live view of a physical, real-world environment whose elements are "augmented" by computer-generated perceptual information, ideally across multiple sensory modalities, including visual, auditory, haptic, somatosensory, and olfactory. The overlaid sensory information can be constructive (i.e. additive to the natural environment) or destructive (i.e. masking of the natural environment) and is spatial registered with the physical world such that it is perceived as an immersive aspect of the real environment. In this way, Augmented reality alters one’s current perception of a real world environment, whereas virtual reality replaces the real world environment with a simulated one. Augmented Reality is related to two largely synonymous terms: mixed reality and computer-mediated reality.

The primary value of augmented reality is that it bring the components of digital world into a person's perception of real world, and does so not as a simple display of data, but through the integration of immersive sensations that are perceived as natural parts of an environment. The first functional AR systems that provided immersive mixed reality experiences for users were invented in the early 1990s, starting with the Virtual Fixtures system developed at the U.S. Air Force's Armstrong Labs in 1992. The first commercial augmented reality experiences were used largely in the entertainment and gaming businesses, but now other industries are also getting interested about AR's possibilities for example in knowledge sharing, educating, managing information flood and organizing distant meetings.

Augmented reality is also transforming the world of education, where content may be accessed by scanning or viewing an image with a mobile device. Another example is an AR helmet for construction workers which display information about the construction sites. Augmented reality is used to enhance the natural environments or situations and offer perceptually enriched experiences. With the help of advanced AR technologies (e.g. adding computer vision and object recognition) the information about the surrounding real world of the user becomes interactive and digitally manipulable. Information about the environment and its objects is overlaid on the real world. This information can be virtual or real, e.g. seeing other real sensed or measured information such as electromagnetic radio waves overlaid in exact alignment with where they actually are in space. Augmented reality also has a lot of potential in gathering and sharing tacit knowledge. Augmentation techniques are typically performed in real time and in semantic context with environmental elements. Immersive perceptual information is sometimes combined with supplemental information like scores over a live video feed of a sporting event. This combines the benefits of augmented reality technology and heads up display technology (HUD).

fig.1 - Augmented reality

4. PHOTOSHOP FOR QR CODE

Adobe Photoshop is a raster graphics editor developed and published by Adobe Systems for macOS and Windows. Photoshop was created in 1988 by Thomas and John Knoll. Since then, it has become the de facto industry standard in raster graphics editing, such that the word "photoshop" has become a verb as in "to Photoshop an image," "photoshopping" and "photoshop contest", though Adobe discourages such use. It can edit and compose raster images in multiple layers and supports masks, alpha compositing and several color models including RGB, CMYK, CIELAB, spot color and duotone. Photoshop has vast support for graphic file formats but also uses its own PSD and PSB file formats which support all the aforementioned features. In addition to raster graphics, it has limited abilities to edit or render text, vector graphics (especially through clipping path), 3D graphics and video. Photoshop's feature set can be expanded by Photoshop plug-ins, programs developed and distributed independently of Photoshop that can run inside it and offer new or enhanced features.

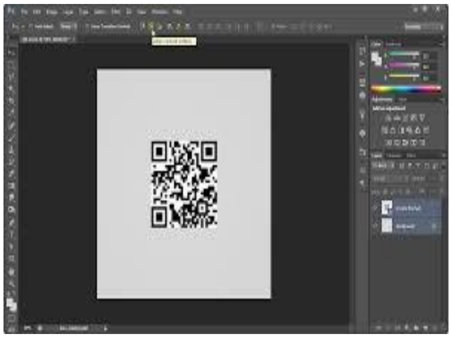

fig.2 - QR code photoshop adobe

5. ARC WELDING AND SIMILAR PROCESS

Arc welding is a method of permanently joining two or more metal parts. It consists of combination of different welding processes wherein coalescence is produced by heating with an electric arc, (mostly without the application of pressure) and with or without the use of filler metals depending upon the base plate thickness. A homogeneous joint is achieved by melting and fusing the adjacent portions of the separate parts. The final welded joint has unit strength approximately equal to that of the base material. The arc temperature is maintained approximately 4400°C. A flux material is used to prevent oxidation, which decomposes under the heat of welding and releases a gas that shields the arc and the hot metal.The second basic method employs an inert or nearly inert gas to form a protective envelope around the arc and the weld. Helium, argon, and carbon dioxide are the most commonly used gases. Shielded-Metal Arc (SMAW) or Stick Welding This is an arc welding process wherein coalescence is produced by heating the workpiece with an electric arc setup between a flux-coated electrode and the workpiece. The electrode is in a rod form coated with flux. Shielded-Metal Arc (SMAW) Submerged Arc Welding (SAW) This is another type of arc welding process, in which coalescence is produced by heating the workpiece with an electric arc setup between the bare electrode and the work piece. Molten pool remains completely hidden under a blanket of granular material called flux. The electrode is in a wire form and is continuously fed from a reel. Movement of the weld gun, dispensing of the flux and picking up of surplus flux granules behind the gun are usually automatic. Flux-Cored Arc Welding (FCAW) This process is similar to the shielded-arc stick welding process with the main difference being the flux is inside the welding rod. Tubular, coiled and continuously fed electrode containing flux inside the electrode is used, thereby, saving the cost of changing the welding. Sometimes, externally supplied gas is used to assist in shielding the arc. Gas-Metal Arc Welding (GMAW) In this process an inert gas such as argon, helium, carbon dioxide or a mixture of them are used to prevent atmospheric contamination of the weld. The shielding gas is allowed to flow through the weld gun. The electrode used here is in a wire form, fed continuously at a fixed rate. The wire is consumed during the process and thereby provides filler metal Gas-Metal Arc Welding Gas-Tungsten Arc Welding (GTAW) This process is also known as tungsten–inert gas (TIG) welding. This is similar to the GasMetal Arc Welding process. Difference being the electrode is non consumable and does not provide filler metal in this case. A gas shield (usually inert gas) is used as in the GMAW process. If the filler metal is required, an auxiliary rod is used.

6. ARC WELDING USING AR AND QR CODE

Welding Software is a general term for welding related software, i.e. applications addressing variety of topics associated with the welding industry, including base metal selection software, filler metal selection, machine welding settings/instructions, weld automation and tracking, welding code reference, welding documentation (Procedures and Personnel), welding gas distribution & supply, welding health & safety, welding inspection, welding material tracking, weld imaging / measurement, welding patterns and layouts, welding planning, welding production management, welding robotics, welding simulation and optimization, and other categories continuously being introduced.

a)For Welding Quality Assurance

Welding management software for quality assurance must include the ability to do weld mapping and provide complete traceability. Weld mapping is the process of assigning information to a weld joint to enable easy identification of its design (WPS), production (welders, their qualifications, date welded), quality (visual inspection, NDT) and traceability (heat numbers of materials joined & welding consumables). For full traceability, the final documentation produced for quality assurance must also incorporate a pictorial identification to represent the weld number on the fabrication drawing, in case the designer does not nominate a weld number. Welding is done for joining the materials which can be one through lot of processes.

fig.3 - welding simulator

fig.4 - scanning QR code for joining materials

7. EXISTING MODULE

Miller Electric Mfg. Co., has announced the availability of the new Augmented Arc Augmented Reality Welding System for welding education. Designed for use by beginner and intermediate-level welding students, the system helps students complete their training faster and instructors make more effective use of their time and resources.

Miller Augmented Arc simulates multi-process MIG, TIG, flux-cored and stick welding, blending real-world and computer-generated images into a one-of-a-kind augmented reality environment. The system is designed to combine the efficiency and economy of classroom education with the effectiveness of hands-on welding experience — for a realistic welding simulation that can be used by trade schools, union facilities and industrial training departments to optimize training efficiency and minimize material costs.

With a user experience designed to engage and motivate students, Augmented Arc helps students quickly develop proper technique — while also reducing the cost of materials used in training, such as wire, gas and coupons. Even students who have never welded before can start working with the system almost immediately, benefitting from an experience that closely resembles live arc welding and delivers immediate and quantitative visual feedback on their welding techniques.

Augmented Arc enhances what students see and hear during training by superimposing computer-generated images onto their view of the real world. Students work with real 3D objects and can see them overlaid with computer-generated images. The system's specially designed helmet uses a camera and sensor to send video and positioning data to the system computer, which processes that data and creates a realistic welding simulation and graphic information based on the student's actions. This simulation is then sent to a heads-up display panel and speakers inside the helmet. To the user, this seems like actual welding — complete with metal workpieces, weld arc and weld beads — to help them gain process knowledge and experience. Augmented aarc in welding takes a major role for joining purpose.

Using Augmented Arc, students can practice on all common joint types, including pipe, in all positions — from initial techniques to the most advanced skill levels.

Instructors can use Augmented Arc to make more effective use of their time while providing students with an immersive augmented reality experience. The system also records video for instructors to read, replay and evaluate. In addition, instructors can remotely manage AugmentedArc, customize the curriculum, develop assignments, run reports and monitor each student's performance.

8. PROPOSED MODULE

The final goal of our project is to deliver a system that can be used to teach students and trainee alike how to welid in an intelligent augmented reality environment. The main features of diffrenciation of our system are:

a)Augmented reality system

The augmented reality based system have ability to gie us a more realistic vision, hand-eye coordination and diversit of shapes of weldments, whereas in virtual reality its not so. Virtual reality trainees are trained by looking at the virtual simulation . these are created by 3D computer graphics technology.in augmented reality however, they are able to observe an actual object which is more realistic.

Hand EV coordination, in virtual rality the trainee is not able to control and see hand that easily and freely since workspace, weldments, a welding torch, and the hands of trainees all exist in virtual space.on the other hand , augmented reality systems provide high level of hand eye coordination and and higher training effect since the welding torch weldments , hand are real images in workspace.

In vitual reality the graphic designer and the developer hav eto creat a new content every time the structure of weldment changes. However, in augmenten reality system the trainee is trained on real images and actual welded parts can be used making it more cost effective.

In this project a prototype of augmented reality chamber and helmet are developed Combining camera witha video through HMD with LCD screens.a welding helmet and welding torch will be provided to the trainee .The positions and orientations can be rendered through the screen that is provided.

In addition to this markers anre attached to weldment so the vitual beads and arc can be visualised at coorect position even if the trainee changes position freely.

b)Script based training content authoring

To enable training on a variety of weldments, it is not sufficiency that only augmented reality-base system is provided. Though it augmented reality based system reduces the cost of making it is not possible to simulate welding without knowledge of structure and positioning or welding postures.

In this project we define the structure of weldment and welding posture using HTML based script, so that various training content can be written by teachers without any knowledge of programming.

c)GMA Welding Database

In order to simulate welding in augmented reality contents data measured in actual welding must be constructed in a database. The parameters set in this project are current, speed, woking angle, running angle,and contact tip to work distance. Database is create by collecting actual data of welding and changing parameters.

The result of welding for each combination of above parameters is the shapes of beads and arc. These results are captured into real image and managed in database using a 3D shape measuring device and a high-resolution camera.

d)Result estimation technique

Even if there is a DB that has accumulated a lot of welding data, it is not possible to simulate all the welding conditions that may occur.in this project we try to solve this problem by using neural network. The nueral network estimator, trained using the data obtained from dizens of experiments, predicts the welding result for new input data including current, speed , angle, etc.

9. FUTURE WORK

Augmented learning is an on-demand learning technique where the environment adapts to the learner. By providing remediation on-demand, learners can gain greater understanding of a topic while stimulating discovery and learning. Technologies incorporating rich media and interaction have demonstrated the educational potential that scholars, teachers and students are embracing. Instead of focusing on memorization, the learner experiences an adaptive learning experience based upon the current context. The augmented content can be dynamically tailored to the learner's natural environment by displaying text, images, video or even playing audio (music or speech). This additional information is commonly shown in a pop-up window for computer-based environments.

Most implementations of augmented learning are forms of e-learning. In desktop computing environments, the learner receives supplemental, contextual information through an on-screen, pop-up window, toolbar or sidebar. As the user navigates a website, e-mail or document, the learner associates the supplemental information with the key text selected by a mouse, touch or other input device. In mobile environments, augmented learning has also been deployed on tablets and smartphones.

Augmented learning is closely related to augmented intelligence (intelligence amplification) and augmented reality. Augmented intelligence applies information processing capabilities to extend the processing capabilities of the human mind through distributed cognition. Augmented intelligence provides extra support for autonomous intelligence and has a long history of success. Mechanical and electronic devices that function as augmented intelligence range from the abacus, calculator, personal computers and smart phones. Software with augmented intelligence provide supplemental information that is related to the context of the user. When an individual's name appears on the screen, a pop-up window could display person's organizational affiliation, contact information and most recent interactions.

In mobile reality systems, the annotation may appear on the learner's individual "heads-up display" or through headphones for audio instruction. For example, apps for Google Glasses can provide video tutorials and interactive click-throughs, .

Foreign language educators are also beginning to incorporate augmented learning techniques to traditional paper-and-pen-based exercises. For example, augmented information is presented near the primary subject matter, allowing the learner to learn how to write glyphs while understanding the meaning of the underlying characters. See Understanding language, below.

10. CONCLUSION

The mechanical maintenance department is responsible for the running of DLW. It ensures that the all the machinery and equipment are running at their top performance level without being affected by failure and breakdown. Working with the engineers of the mechanical maintenance department I have gained such an amount of knowledge which would not have been possible in a classroomin a similar period time. Also the practical experience I have gained here in DLW, VARANSI gave me knowledge of to what extent my theoretical knowledge learnt in my college is applicable in the field. Although the theoretical knowledge forms the base of practical knowledge required onthe field , the field job also require somedifferent set of skills which I learnt about during my training. My skills in mechanical engineering has definitely been taken to a much higher level than it was when I first joined the training program of 4 weeks back and I truly consider myself highly fortunate to get this opportunity.

REFERENCES

[1] J. Haidar, J. J. Lowke, "Predictions of metal droplet formation in arc welding", J. Phys. D, vol. 29, pp. 2951-2960, 1996.
[2] J. Haidar, "A theoretical model for gas metal arc welding and gas tungsten arc welding. I", J. Appl. Phys., vol. 84, pp. 3518-3529, October 1998.
[3] J. Haidar, "Predictions of metal droplet formation in gas metal arc welding. II", J. Appl. Phys., vol. 84, pp. 3530-3540, October 1998.

[4] J. Haidar, "An analysis of heat transfer and fume production in gas metal arc welding. III", J. Appl. Phys., vol. 85, pp. 3448-3459, April 1999.

[5] E. Haltφy, "Simulation and instabilities in GMAW and SAW", 49st Annual Assembly of IIW IIW Doc. 212-895-96, August 1996.

[6] W. Mao, M. Ushio, "Measurement and theoretical investigation of arc sensor sensitivity in dynamic state during gas metal arc welding", Sci. Technol. Weld. Joining., vol. 2, pp. 191-198, 1997.

[7] P. Xu, M. Rados, S. W. Simpson, "Circuit simulation for gas metal arc welding", Sci. Technol. Weld. Joining., vol. 4, pp. 341-346, 1999.

[8] M. Van, S. W. Simpson, "Efficient simulation of short arc welding", Australasian Welding Journal, vol. 46, pp. 40-47, 2001.

[9] T. Yamamoto, T. Ohji, F. Miyasaka, Y. Tuji, "Mathematical modeling of metal active gas arc welding", Sci. Technol. Weld. Joining., vol. 7, pp. 260-264, 2002.

[10] G. Huismann, "Contact resistance in MIG welding", IIW Doc. 212-950-99, 1999.

[11] C. Y. Ho, M. W. Ackerman, K. Y. Wu, T. N. Havill, R. H. Bogaard, R. A. Matula, S. G. Oh, H.M. James, "Electrical resistivity of binary alloy systems", J. Phys. Chem. Ref. Data, vol. 12, pp. 283-300, April 1983.

[12] H. Terasaki, S. W. Simpson, "Modelling of the GMAW system in free-flight and short-circuiting transfer", Sci. Technol. Weld. Joining..

[13] J. J. Lowke, P. Kovitya, H. P. Schmidt, "Theory of free-burning arc columns including the influence of the cathode", J. Phys. D., vol. 25, pp. 1600-1606, 1992.