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Circuit Build AR: Interactive Circuit Designing and Simulating

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Abstract – *Setting up an electric circuit can sometimes be a headache due to broken bulbs, dead batteries, damaged components or short circuits. Purchasing new kits and components are also a tedious work as some of the components may not be available or setup easily. But using this app, users can practice building circuits without actual components. This application provides a virtual environment for students to practice electric circuitry. Electric components can be printed to paper cards and can be brought to life using Augmented Reality. Real world 3d models of each component are augmented upon the corresponding paper cuttings. Users can design circuits, interact with components, customize their properties and also simulate and test their circuits easily . Engineers can test and debug their designs using this virtual lab and virtual components. They don't have to waste power, resources and money on real components for testing and debugging. This app is a much more safer and eco-friendly environment to work on*.

1. INTRODUCTION

An electric circuit is composed of individual electric components such as resistors, switches, bulbs, transistors, capacitors, inductors and diodes connected by conductive wires. The combination of these components and wires can provide us with heat, lighting, energy to drive motors and so on. Electric circuit simulation is a technique where computer software simulates the behaviour of an electric circuit. New designs can be tested, evaluated and diagnosed without actually constructing the circuit. Circuit simulation may be useful tool in troubleshooting a system to gather data before circuit level troubleshooting actually takes place. Electric circuit simulation uses mathematical models to replicate the behaviour of an actual electronic device or circuit. Simulation software allows for modelling of circuit operation and is an invaluable analysis tool. Due to its highly accurate modelling capability, many colleges and universities use this type of software for the teaching of electronics technician and electronics engineering programs. Electric simulation software engages the user by integrating them into the learning experience. These kinds of interactions actively engage learners to analyze, synthesize, organize, and evaluate content and result in learners constructing their own knowledge. Simulating a circuit's behaviour before actually building it can greatly improve design efficiency by making faulty designs known as such, and providing insight into the behaviour of electric circuit designs. In particular, for integrated circuits, the tooling (photo masks) is expensive, breadboards are impractical, and probing the behaviour of internal signals is extremely difficult. Therefore, almost all IC design relies heavily on simulation. The most well known analog simulator is SPICE. Probably the best known digital simulators are those based on Verilog and VHDL.

Augmented reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are "augmented" by computer-generated or extracted real world sensory input such as sound, video, graphics, haptics or GPS data. It is related to a more general concept called computer-mediated reality, in which a view of reality is modified (possibly even diminished rather than augmented) by a computer. Augmented reality enhances one's current perception of reality, whereas in contrast, virtual reality replaces the real world with a simulated one. Augmentation techniques are typically performed in real time and in semantic context with environmental elements, such as overlaying supplemental information like scores over a live video feed of a sporting event. Augmented reality in education will soon revolt learning as we know it. AR will fully change location and timing of study process and open additional ways and methods. Finally, AR capabilities may make classes more transformational and engaging. Educators know for sure that learning can't include just learning and reading parts. It should have creative and interactive elements as well. Meanwhile there is for no need pedagogues to become students‟ best friend to get them involved into science.

Augmented Reality Simulation refers to 3D models combined with other technologies which allow users to experience virtual objects superimposed on top of physical objects or places. As opposed to Virtual Reality, Augmented Reality is only partial 'immersive' thus allowing images from the physical and virtual worlds to appear as one. AR is typically experienced through hand-held screens, wearables, holograms and projections.

The proposed system aims to create an augmented reality environment to design and simulate electric circuits. Users can print "markers" corresponding to each electric component and can use these paper cuttings instead of actual components. These paper cuttings are brought to life using Augmented Reality. 3D models of components are augmented onto these paper cuttings when the device

is focused onto them. Users can design circuits, interact with components, customize their properties and also simulate and test their circuits easily. This system can be used by engineers to debug, test their circuits efficiently without any fear of damaging components, without setting up actual circuits, and without wastage of power. It can also be used by teachers in laboratories to train students on electric circuits. Students can also setup a virtual lab in their home to do homework and assignments. This system foster students‟ intellectual curiosity and the interactive lessons help them retain the knowledge for a long time. This system also provides a safe and eco-friendly environment for electric circuit design and their simulation .

2. SYSTEM ANALYSIS

System analysis is a process of collecting and interpreting facts, identifying the problems, and decomposition of a system into its components. System analysis is conducted for the purpose of studying a system or its parts in order to identify its objectives. It is a problem solving technique that improves the system and ensures that all the components of the system work efficiently to accomplish their purpose. Another view sees system analysis as a problem-solving technique that decomposes a system into its component pieces for the purpose of the studying how well those component parts work and interact to accomplish their purpose. Analysis and synthesis, as scientific methods, always go hand in hand; they complement one another.

2.1 EXISTING SYSTEM

Electrical circuits are difficult to understand. Novices tend to have inadequate understandings of what happens at the level of atoms and electrons, leading to difficulty predicting the outcomes of electrical circuits at the level of wires, resistors, and light bulbs. Electricity and electrical circuits have traditionally been taught through lectures and other virtual activities, which separate some of the main concepts of circuitry from the tangible realizations of the circuits. Studies show that learners can benefit more from building and debugging circuits than from schematic drawings of a circuit that can only be explained verbally. However, building a circuit is not an easy task itself, and the process of making a real circuit has many aspects that don't directly contribute to learning, which make the learning process more intimidating for novices.

One approach for substituting real laboratory investigation of electrical circuits is to use toolkits designed to teach electronics with the principles of learning-by-making. Examples of these educational toolkits include Snap Circuits, an experimental kit consisting of electric components that snap together; Little Bits, a library of pre-assembled circuit boards that can be put together to make an electric device; and Light Up, a collaborative toolkit for teaching electrics in which a set of circuit building blocks are linked to an on-screen simulated circuit. In Light Up, the electric components of the circuit are attached to each other with magnetic connectors. These toolkits are usually modular and hide many details from the learner in favor of a „plug-and-play‟ approach. Although these toolkits are effective in bridging the gap between novices and experts in circuitry, many fundamental concepts about electrical circuits remains hidden from the learner.

Another approach is to use computer simulations in lieu of real equipment. There are several computational environments and activities that simulate the electrical circuits and allow students to investigate simple circuits. Examples include the Circuit Construction Kit (CCK) from the PhET project, which simulates the behavior of simple circuits; and Light Up which uses augmented reality to project a simple representation of current flow on top of an image of the physical circuit. Computer simulations have the potential to increase accessibility to a variety of concepts by visualizing aspects that might otherwise remain hidden and can address practical issues such as providing clear visual cues that the wires in a circuit are connected or that a light bulb is on.

2.2 PROPOSED SYSTEM

The proposed system is an android application that provides users with an augmented reality environment to design and simulate electric circuits. Paper cuttings are used as substitute for real components so that users can work without having to buy expensive materials which gets damaged easily. These paper cuttings are brought to life using Augmented Reality. These paper cuttings will be converted to 3d models of real life components when watched through a device . Users can design circuits, interact with components, customize their properties and also simulate and test their circuits easily using this system. This system can be used by engineers to debug, test their circuits without damaging components and without wastage of power. It can also be used by teachers in laboratories to train students on electric circuits. Students can also setup a virtual lab in their home .This system offers interactive lessons.

The advantages of the proposed system for circuit simulations are Save money: With this app there is no need to purchase the expensive electric components to build circuits. Users will be able to print component cards for free. Realistic Simulations: The app calculates the voltage and current for each component in your circuit. This is done using the same technology as professional circuit simulation software. Eco-friendly: With AR technology, system eliminates wastage of power and protects the environment compared to physical electronics kits. Secondly, the components will never lose their charge or burn-out. No damaged components: With this system, users don't need to worry about the broken bulbs, dead batteries, and damaged components that come with using physical electronics kits. Safer: With this

system, students are working with printed paper components and a mobile device. There is no need to worry about burns from bulbs and short circuits, toxic heavy metals or other chemicals in components, and many of the other dangers that come with physical electronics kits.

3. SYSTEM DESIGN

The system has three main modules which together ensures a easeful use for users. The system contains option for new users to view and print paper cuttings as markers for each components they need. It also have an option to set default values for each components like resistance and default status of components. The main module is to start building circuits and interact live with components and simultaneous simulation of the circuit.

3.1 CIRCUIT BUILDING MODULE

This is the module which provides an Augmented Reality environment for circuit building and simulation. The primary camera of the device gets turned on. Camera is the primary sensor used by the system. Then the application waits until it identifies a marker to augment 3d models upon. The video provided by camera is continuously processed to recognise matching markers. All the markers recognised are then matched with the database and the corresponding 3d models of real life components are augmented upon them. This creates a mixed reality, which include physical real world and the virtual 3d models.

The application not only search for markers in the video, but also waits for user actions simultaneously. User actions are touch inputs. Application identifies the component which is touched by the user and displays its properties and allows user to customise its properties.

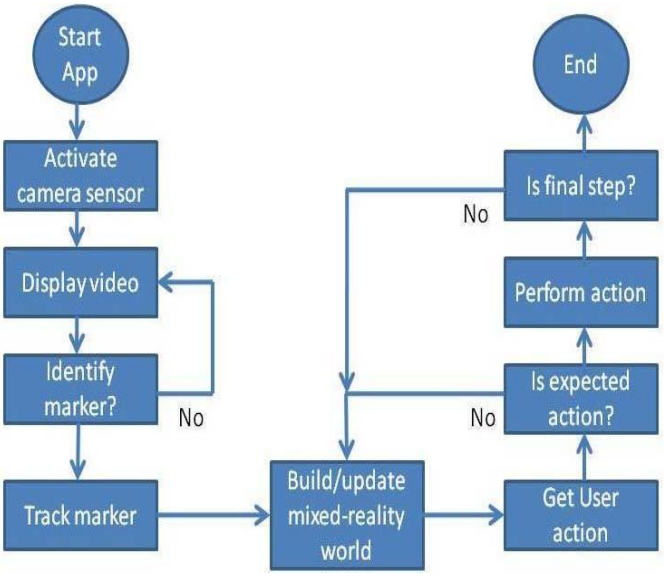

Fig - 1 Flowchart of circuit building module

3.2 PRINT COMPONENTS MODULE

This module provides instruction for novices on how the system works and also lists various markers or paper cuttings of different electric components from which the user can print whichever components he need. List of available components are :

Component	Properties
Wire	NIL
Resistor	Resistance (ohm)
Battery	Voltage (volt)
Bulb	Resistance(ohm) , Colour
Switch	Status
Conductors	Materials

Table 3.1.2 List of components

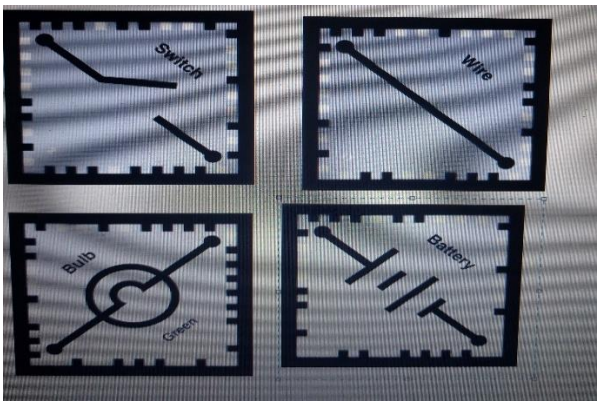

Fig – 2

3.3 CUSTOMIZE COMPONENTS MODULE

This module provides allows user to set default properties and values for each type of components. System lists all types of components and allows the user to edit their properties.

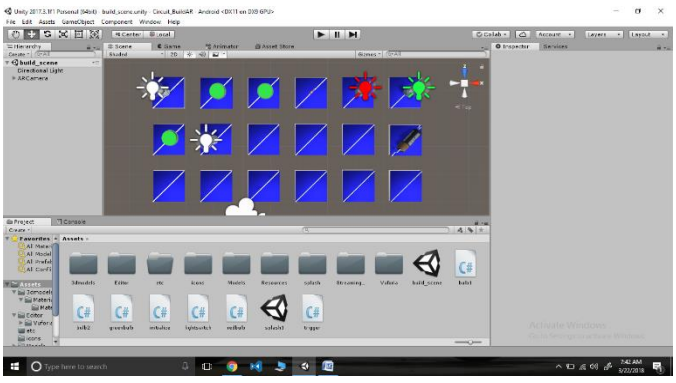

Fig -3

4. RESULT

In our experiment , we have used a set of paper cuts to demonstrate the circuit simulation.The circuit consist of different componets.The working of electric circuit using augmented reality as shown in fig 5.

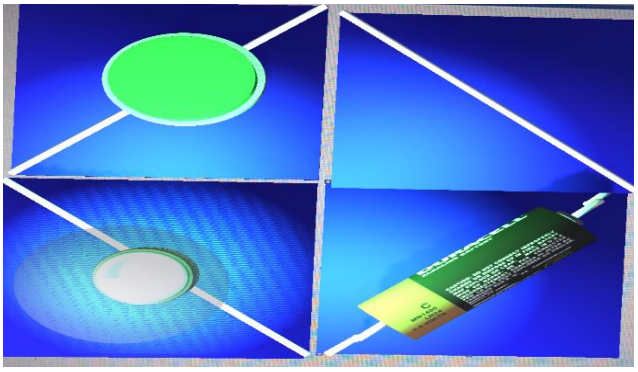

Fig -4

5. CONCLUSION

Circuit BuildAR , Augmented Reality Circuit Simulator can successfully replace a real world electrical laboratory with a much safer and eco-friendly virtual laboratories. Students can use this application to study the basics of electricity and to train themselves in circuitry. Engineers can test and debug their circuits without wasting power and damaging components. The application also offers interactive lessons for students who can get hands-on training on electric circuitry. Anyone with an android device can successfully use this virtual lab setup at their home . It also cancels the need of real components while learning. It only uses paper cuttings as substitutes for real electric components. Thus the application also offers a cheap virtual electric lab.

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