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SUPPORTING LEARNING AMONG CHILDREN USING AUGMENTED REALITY

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ABSTRACT. *ICT4D is an emerging research field where researchers from multiple domains try to support human beings by improving their life. Lack of experienced teachers and limited educational infrastructure is a major issue with low literacy rate among developing countries. In this paper, we describe the design and development of e-learning software based on augmented reality. This prototype provides an interactive, informative and fun learning environment by embedding a graphical visualization generated by the computer using real world coordinates. This enhances a person's ability to understand the surroundings better, by providing an overlay of information on real world patterns.The system will help students to interact with different objects and thus making learning fun. The availability of such systems in schools in developing countries enables teachers to motivate school going children to better learn about objects. As a next step we plan to roll out this prototype amongst school children and to understand the effectiveness of this system.*
***Keywords*:** E-learning, Augmented Reality, ICT4D, IT Support, Organizational Practices, Human Development.

1. Introduction. Advancements in computing technologies and especially the evolution of web 2.0 applications have made computers the new source of learning, fun and entertainment. Computing systems have huge potential in fostering effective learning among individuals [1,2]. There are many learning management systems [3,4,5,6,7,8,9] and virtual environments [10, 11, 12] to support learners. ICT4D is an emerging discourse where researchers from multiple domains are trying to meet the United Nations millennium development goals by employing innovative ICT applications. A prime issue in developing countries is its limited teaching staff and less educational institutions. There have been many studies to support children electronically in different geographical regions [13, 14, 15, 16], but there is a scarcity of much similar work in Pakistani context.

Keeping this knowledge gap in mind we focused on developing a software to support school children in Pakistan. In this paper, we describe the preparation of a prototype which is interactive and provides learning and fun at the same time. Young school kids are targeted as they learn more from physical interaction with the subjects due to their inquisitive nature. Our prototype allows the students to immerse themselves in an interactive study process.

The objective of this paper is to highlight the design and development process of our prototype. The remaining of the paper is structured as follows. Section 2 will discuss the design of prototype, whereas section 3 discusses the development of the system. In section 4 we discuss the system testing, which is followed by a conclusion.

2. System Design. Our proposed system E-Learning with Augmented Reality (EAR) will make use of Computer Generated 3D models which would appear on the screen of a user's device, when a marker is viewed from a camera. Every marker will hold the information of the marker under observation and the computer software will then append that information to our camera view. Core points of our proposed solution are as follows:

1. Information about topics and objects will be provided as the user comes across the markers in the book.
2. 3D Image/Text Generation upon closer inspection of a marker will reveal information regarding key interest points and items to enhance understanding.

3. Showing 3D image models where necessary to further explain the concepts.
4. Ability to manipulate the image with human interaction, making this interactive and more interesting to learn.
5. This will provide children and adults to have a very unique learning experience.

Four types of stakeholders have been identified in this case, which are users, information providers, content providers and system operators. As the application directly benefits the users, which in this case is the younger generation (children). They are the key users of this application, and the application is designed keeping in mind the best learning experience for them. The Information Providers are like teachers, who provide an outline of the information they wish to teach to the others, and based on the feedback from the users (children) the information may vary. Content Providers are the designers or people responsible for the creation and collection of relevant models outlined by the Information Providers. System Operator ensures the information is up to date, and implemented. Furthermore, this ensures System Operator makes adjustments and facilitates the other stakeholders.

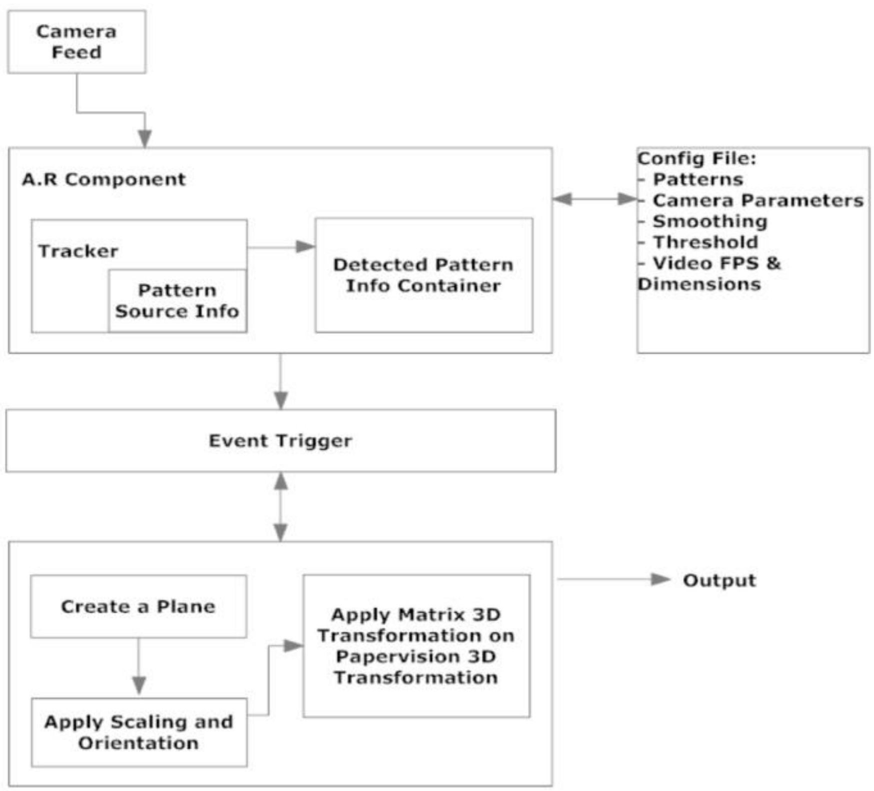

Figure 1. System Architecture

Figure 1 explains in detail how the system works. Live camera feed is passed on to the A.R Component, which reads the parameters from Config File, which defines the video settings, threshold, smoothing and other vital information on the basis of which A.R Component processes live feed down to a binary level breaking the pixel data into RGB components, it then matches it to the data bank of patterns and creates a container for that pattern as well as triggers an event. Event Triggers are of 3 basic types: 1) On Added 2) On Updated 3) On Removed.

When events Added or Updated are triggered, PaperVision 3D is called upon to create a 3D Plane, Load Model on to the plane, scale & set orientation according to the real world location and orientation of the detected marker. Then the Matrix 3D coordinates (real world location of the marker) are mapped onto the plane and in the output the model will be shown in on top of the marker. On the other hand Figure 2 describes the data flow of the system. Each frame is captured from live camera feed. Tracker library, then detects the pattern, calculates its orientation and position with respect to the main window. It compares the calculated pattern information with the stored pattern information. A virtual object to be displayed is then aligned according to the calculated orientation of the pattern. Transformation matrix is applied on the model and the scene rendered on live video stream.

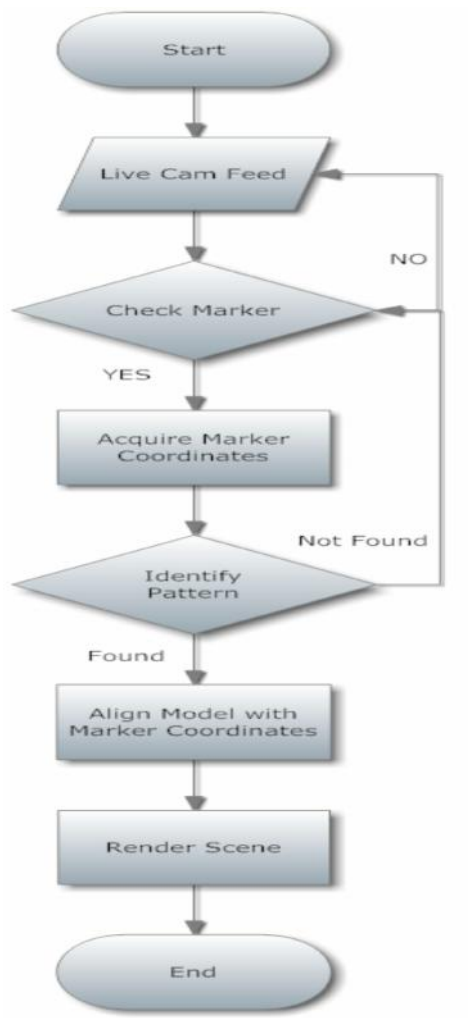

Figure 2: Data Flow Diagram

3. System Development. Our prototype will make use of Computer Generated 3D models which would appear on the screen of a user's device when a marker is viewed from a camera. Every marker will hold the information of the marker under observation and the computer software will then append that information to our camera view. This system uses a three layered architecture, which are interlinked.

3.1. Operating System Layer. Operating system layer communicates with the video devices. It provides the live video feed from the camera to the upper layer i.e. A.R Layer. The OS layer's second purpose is to facilitate the output on the user's screen.

3.2. A.R Layer. This is the core layer, which is responsible for tracking and identifying the markers, calculating the real world coordinates and projecting the corresponding 3D Models on the coordinates.

3.3. Interface Layer. This layer provides an application interface to the user in two formats, either a Web Front-end or a Visual C# Desktop Front-End.

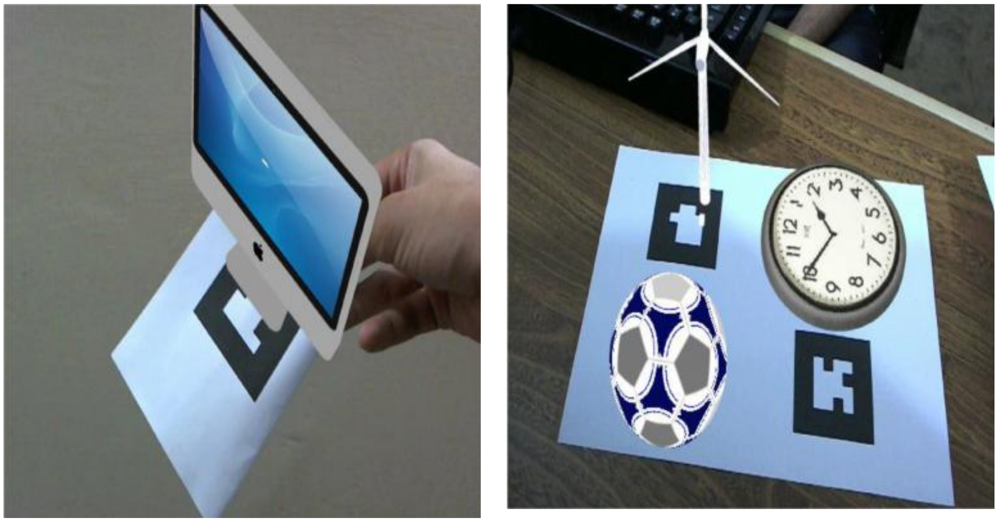

Figure 3: Multiple 3D Models

4. Conclusions. As the state of the art describes there is not much ICT4D work carried out in Pakistan so this motivated us to experiment and enhance the learning curve of school children by supporting them with an augmented reality environment. In our in-house testing, we found the system very stable and as a next step we plan to roll out this prototype in practice among school children to understand the effectiveness of this prototype.

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