SAKSHAR: An Image-projective Desktop Varnamala Trainer (IDVT) for Interactive Learning of Alphabets

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I. Introduction

Primary education is necessary for overall development of a person as well as a society. There are major improvements in social indicators when quality of education improves [1]. The traditional education system based on procedural and rote learning does not help kids to improve basic skills like literacy and arithmetic skills [2]. The use of incomprehensible books makes the children to shy away from learning and is not suitable for primary education. This might be a major contributing factor for school drop outs in developing countries [3]. In this paper, we are proposing a device which can make learning interactive and full of fun.

SAKSHAR-IDVT is based on SOI (step-on interface) concept, which uses the projected screen as a bidirectional interface, through which the information is presented from the robot to the user, and the user instructions are delivered to the robot [4-5]. In recent years, development of touch screen is getting high attention. Samsung's display table known as SUR40 [6], Microsoft's PixelSense [7] and Surface Table [8] are results of this increased interest. These devices recognize fingers, hands and objects placed on the screen, enabling vision-based interaction. Though, they deliver high quality of graphics with good interactive experience, they are expensive and not easily transportable. These are important requirements for a system to be used in fields like education in developing and underdeveloped countries.

II. Background

A device named IDAT [8, 9, 13] was earlier designed for upper limb rehabilitation by training to improve eye-hand coordination. "SAKSHAR: An Image-projective Desktop Varnamala Trainer (IDVT)" is the next generation of IDAT designed for the use in educational purposes. The device has been named SAKSHAR which means "Literacy" in Hindi (an Indian language). "Varnamala" is also a Hindi word which stands for complete set of alphabets. To lower the total costs, a cheaper sensor has been used. We feel that devices like SAKSHAR will give a boost to reading skills of children and thus improve literacy.

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III. Structure

SAKSHAR-IDVT, as shown in Fig. 1, consists of a projector, scanning laser range finder sensor and a computer. The projector renders graphics provided by the computer on a projection surface. A scanning laser range finder sensor, which is mounted on the device, provides the information about the coordinates at which surface has been touched. The URG-04LX-UG01 [10] sensor is a scanning Laser Range Finder made by Hokuyo Automatic Co. and is used for mobile robotics applications. The sensor is small and light and thus easily transportable. It has detection range of approximately 5m.

In the current model, the projector and laser range finder sensor are mounted on a stand made by aluminum alloy, which ensures strength with light weight and maximizes portability of the device. The laser range finder sensor is placed at the bottom of the stand, touching the ground. This makes the ground as the plane surface on which screen is projected. On the other hand, projector is placed inclined and focused on the ground plane.

IV. Description of the Game

A game based learning methodology is being used in SAKSHAR. The game displays a question to find out the correct image of an object. As an example, it asks find 'K' for Kettle (Fig. 2a). The game displays four available options and the player/learner has to select the correct answer. Total points of the game are displayed at the bottom side of the projective screen. The game also displays the time taken in seconds. (Figs. 2b and 2c).

The game was designed in Hindi language also. There are approximately 310 million native speakers of Hindi language around the world which accounts for 4.7% of total world population (fourth largest spoken language) [11]. In-spite of this there is no suitable library to render Hindi fonts in OpenTK. We have developed a library for rendering Hindi fonts in OpenTK. This library uses System.Drawing component from Microsoft.Net framework to generate a graphics object, in which we write the text. Finally this graphics object is converted into bitmap image and rendered by OpenTK as a texture. This library enables us to render good quality Hindi fonts. This library can be extended for various languages. We have tested it to render some of the Indian languages like Bengali (Seventh largest group of speakers in the world) [11], Malayalam and Urdu. The results are good and encouraging. Figure 2(d) shows screenshot of Hindi version in SAKSHAR.

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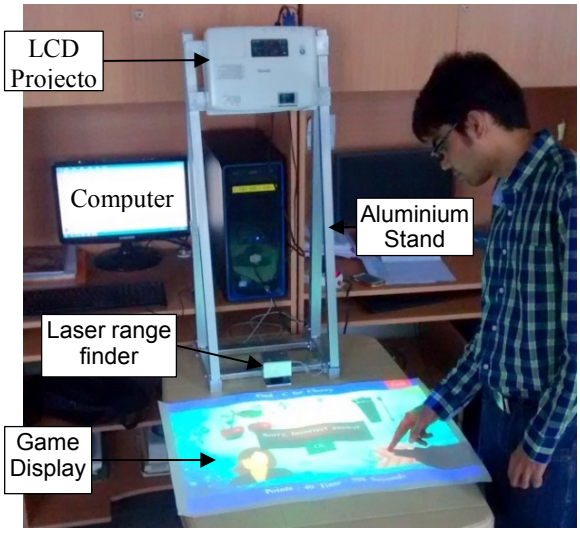
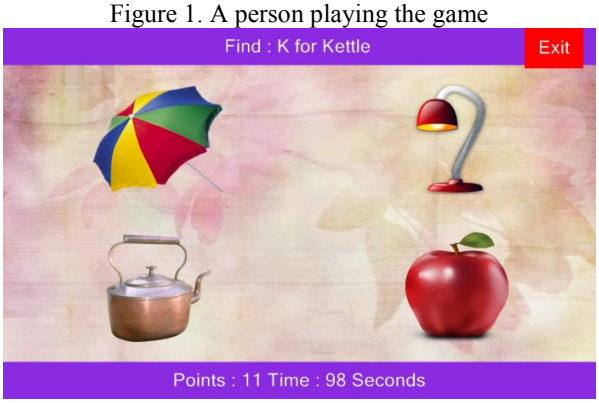
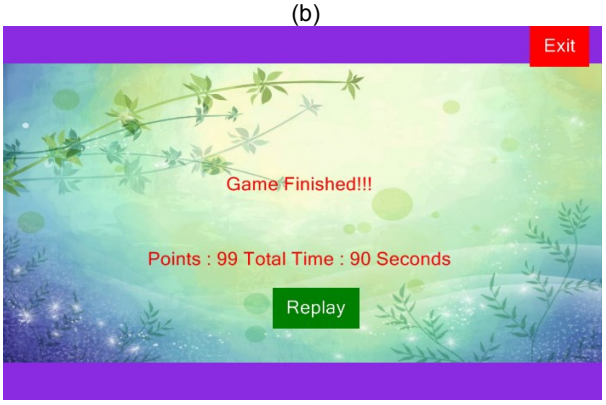


Figure 1. A person playing the game



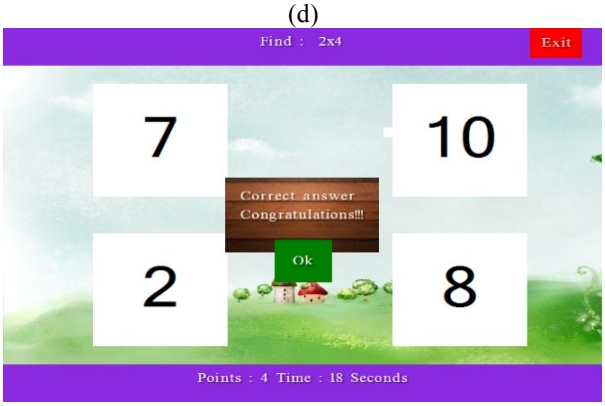
(a)

(b)



(c)

(d)



(e)

Figure 2 Display Screen: (a) Game screen for English alphabets, (b) Welcome screen for English alphabets, (c) Result screen for English alphabets, (d) Game screen for Hindi alphabets, (e) Game screen for Mathematics.

The system can be used for learning elementary mathematics as well (Fig. 2e). The game have two operating modes, which are explained next-

A. Teaching mode

This mode was designed for targeting kids, who are new to schools. Corresponding to each alphabet, this mode contains basic and well-known objects. Also in this mode, the user is given unlimited number of attempts for each alphabet. This way, a user can learn though they make mistakes.

B. Testing mode

Once user is familiar with alphabets and gets enough knowledge about alphabets, this mode is used to test his/her knowledge. Testing mode contains multiple images for each alphabet, which gives exposes the user to more number of alphabets. This mode does not provide unlimited attempts. It displays a countdown timer on the basis of which time available for making choice for a given slide is kept constant. Four points are given for correct answer, whereas each wrong answer has a penalty of one point. The total score can be used to keep track of learning outcome for each user.

V. CALIBRATION

The laser range finder provides polar coordinates, which are then converted into Cartesian coordinate. These coordinates are with respect to the sensor coordinate system. Figure 3 shows the configuration of coordinate systems of

the Projective Screen(P) and the Sensor(S). The origin of the Projective Screen coordinate is at $[x_p, y_p]^T$ at the coordinates of the detected point is represented by $[\mathbf{x}]_P$. Initially, a nominal value is used to start the calibration process which is estimated by the user. Later, the final correction values can be obtained after obtaining multiple readings from the sensor for known coordinates of the screen[12]. Once the calibration is done using a suitable artifact, it is possible to track the position of user's hand/finger accurately through appropriate visual feedback.

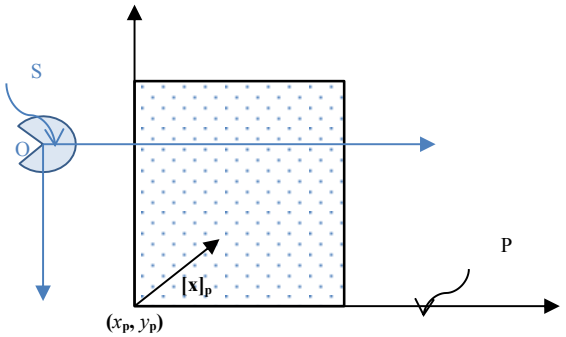


Figure 3. Transformation of coordinate axis

Till now this calibration was done as a separate step. Following is the proposed method to integrate this with the main game such that the whole system will be adaptable. We have designed a simple user interface, which is displayed by the projector on the plane. Before starting the calibration, the user will have to enter approximate maximum dimension of the projective screen, distance and rotation between two coordinate systems (Fig. 3).

The laser sensor, which is running on a different thread of the program, will be able to record reading for position of hand on the projective screen and waits for 10 seconds. Once this process is finished for all the points, the game will calculate the required calibration values and save them in a file for future reuse.

VI. Conclusion

A new device by name SAKSHAR-An Image-projective Desktop Varnamala Trainer has been built. The details of the construction have been explained. A game with audio-visual feedback has been developed to encourage learning for primary school children. The game features multiple language based user interfaces. Current version of game can be used to help learn English and Hindi alphabets. Another version aimed at mathematics learning has also been designed and implemented. A poster representing the system is available at http://web.iitd.ernet.in/~mez118352/SAkshar2_0.tif

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