SAKSHAM: A WebGL/WebHID Based Framework for Creating a Digital Twin System for Virtual Robotics Labs

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Abstract

Web browser-based applications is now rendered as a powerful tool for visualization. It can be easily accessed by users of multiple platforms. It provides rich interactive content that eliminates the need to install any dedicated software on the client computer locally. The emergence of JavaScript-based physics engines[1] have enabled complex simulations to be executed directly in web browsers. These web-based applications consume less memory space, computationally less expensive, have better graphics and program interface. Web based applications are currently gaining huge popularity among developers' community due to the aforesaid benefits. However, web-based technologies have not been amenable for hardware based systems due to its connectivity requirement with any live machine. Moreover, having dynamic visualization of a real machine remotely over web browser remains a challenge and it still a novel area of research.

The current paper proposes a '*Digital Twin*' that generate a WebGL[2] based graphics on a remotely connected client PC running a browser. In order to connect the browser based application to a real hardware, i.e., a Human Interface Device (HID) connected to the host PC, uses a WebHID Application Programmers Interface (API) to transceive data from the hardware. The paper proposes a HID device, which is now an Open Source, that can be used for any customized application which requires a real machine to be accessed over any remote device.

The paper presents the capabilities of the proposed Digital Twin System, namely, SAKSHAM, which is a combination of a HID device, as in Fig. 1, and the WebGL/WebHID based browser application using a 6-Degrees of Freedom indegeneous serial robot as in Fig. 2. Overall, it demonstrates a Virtual Lab where a 6-DoF Serial Robot is controlled remotely over internet using Internet of Things (IoT). This system is expected to increase the accessibility of virtual labs to new audiences.

Figure 1: The HID Device.

Figure 2: Physical 6 – DoF Serial Robot

Firstly, the paper briefs the design and development of a six degrees freedom serial robot followed with its kinematics. Then a simulated environment was created using *threejs* library[3], where the CAD files of the robot was loaded into the web browser. The simulated environment[4] provides joint motion control and cartesian control of the serial manipulator.

Next, the design of HID device[5] is discussed using a circuit design package, namely NI Multisim. The paper also details the firmware for the USB based microcontroller installed on the HID device, which was developed using Light weight USB Framework for AVR (LUFA).

Finally, the paper discusses the usage of Chrome based WebHID API, where the joint angles are transferred from the WebGL based graphics of serial robot in the browser as shown in Figure 3, to the HID Device. This HID device inturn controls the real actuators and thus, give the physical motion to the real serial robot.
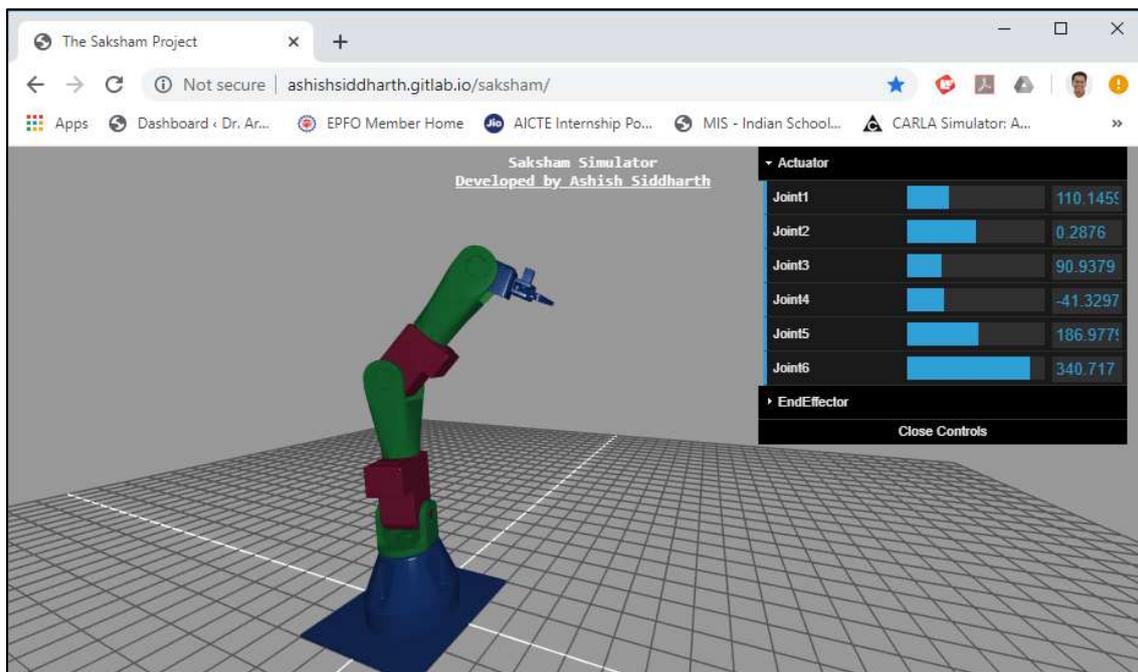

Figure 3: WebGL and WebHID Simulated Environment in Web Browser

References

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