A Review of the Construction and Performance Analysis of a Haptic Feedback Glove

Aabha P. Chaware, Dr. P. R. Deshmukh

***Abstract*—Construction of a hand glove with haptic feedback actuators attached to every finger is proposed. The actuators are to be individually controlled by a wearable microcontroller system. The input to the microcontroller is to be given over a communication link. Another microcontroller is to be employed to send visual cues to the user by means of transducers like LEDs. Both the systems have to act in synchronism to provide simultaneous visual and haptic feedback and guidance to the user's fingers. It is also proposed to employ this glove to teach Indian music.**

***Index Terms*— Haptic feedback, actuators, wearable microcontroller system, PC software, Indian music**

I. INTRODUCTION

The origin of the word 'haptics' lies in the Greek word '*haptikos*'- meaning "pertaining to the sense of touch". Haptic feedback means information input through the sense of touch. Haptic sensations are created in consumer devices by actuators, or motors, which create a vibration. Those vibrations are managed and controlled by embedded software, and integrated into device user interfaces and applications via the embedded control software APIs.

We continually absorb information from the surroundings by our senses – sight, hearing, smell, taste and touch. Almost all computers, controllers and information systems in existence today primarily rely on visual data to furnish as well as to receive information. Audio information comes next in the hierarchy. However, in the world of mobile devices, computers, consumer electronics, and digital devices and controls, meaningful haptic information is frequently limited or missing. For example, when dialling a number or entering text on a conventional touch screen without haptics users has no sense of whether they have successfully completed a task. This is where haptic feedback can make a difference to usability.

With haptic feedback, users feel the vibrating force or resistance as they push a virtual button, scroll through a list or reach the end of a menu. In a video or mobile game withhaptic feedback, the users can feel the gun recoil or the engine accelerator.

***Manuscript received Apr01, 2015*.**

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When simulating the placement of cardiac pacing leads, a user can feel the forces that would be encountered when navigating the leads through a beating heart, providing a more realistic experience of performing this procedure.

Haptic feedback enhances the user experience in different ways like improved usability, enhanced realism, restoration of mechanical feel etc.

Current applications of haptic technology are broadly classified into VR (Virtual Reality) applications and non-VR applications. The first category includes tele operators which utilize force feedback for dangerous tasks such as radioactive material handling or explosive defusing. Systems to assist the visually impaired also fall under this category. But the most prominent applications are in computer gaming. Game makers have utilized VR systems to an amazing degree to make games which not only give experience of near reality but also venture into the surreal many times. As compared to these, non-VR applications of haptics are less glamorous, but more prevalent. They are used in everyday things such as mobile phones and tactile displays. Both VR and non-VR applications of haptic technology have a very broad scope.

Benefits of haptic technology include assistance in quantitative task performance, enhancement by multimodal feedback, better user satisfaction, prospects of non-visual interaction, and possibility of passive learning.

II. LITERATURE REVIEW

Dipietro, L.; Sabatini, A.; Dario, P [1] have suggested some glove-based systems to obtain hand movement data. They have also obtained results for characteristics of devices, provided brief view for evolution of technology and limitations of current technologies. It is an excellent review of glove-based technology.

Sturman, D.J.; Zeltzer, D., [2] have discussed key hand-tracking technologies and applications of glove-based inputs.

Shin, J.H.; Hong, K.S. [3] describe smart gloves or data gloves used as input devices presented as alternatives to standard keyboards and mice - both for desktop and wearable computer. They also introduce a text input device for wearable computers using gloves to obtain performance parameters.

Gloves with distance sensors, cameras, RFID or special buttons have been used to help the blind. Peng et al. and Gormer et al. have introduced Mobile Lorm Glove as a communication device to support the communication of deaf and blind people to make them independent. This glove translates hand-touch alphabet Lorm into text. With the help of hardware prototype, deaf blind people can generate SMS messages and transmit them to the receiver side [4, 5].

Gloves with speech synthesis have been reported to help people with speech impairment [6].

ISSN: 2278 – 909X

Ring-type appliances worn on fingers to interact consistently with surrounding have been devised for appliance control. Nanayakkara, S.; Shilkrot, R.; Maes, P. have suggested a wearable interface to signal by gestures and touch to access digital information. [7].

Several systems for medical applications like devices for helping patients with Parkinson's disease have also been developed. They measure biological parameters such as heart rate, skin resistance etc. [8].

RFID techniques have been employed for object detection and obstacle detection with haptic gloves. They have used a pair of wearables, glove and bracelet to detect interaction of users with tagged inconspicuous objects. Grasp with palm or the fingertips can also be detected with the help of glove [9]. RFID Glove system consisting of glove with an integrated RFID reader, an organic micro display and a communication system has been described. It has increased the efficiency of activities and user experience [10].

Markow describes use of gloves for teaching western music [11, 12] and Braille typing [13].

III. PROPOSED WORK

It is proposed to construct a glove-based haptic feedback system to help in teaching Indian music playing and keyboard typing. The system will be based on wearable electronics. It is expected that it will assist in passively teaching Indian music and/or keyboard typing.

Another objective is to investigate the concept of Passive Haptic Learning with the help of this system. PHL is largely unexplored in our country and holds great promise in situations where good teachers are scarce.

The proposed work will consist of the following parts:

1. Construction of a haptic glove with wearable electronics
2. Making interface circuits and PCBs for providing visual cues to support the glove
3. Interfacing the circuitry with a PC which will contain the training and analysis software
4. Conducting experiments to study PHL

IV. SYSTEM ARCHITECTURE

A conceptual diagram of the proposed system is given below:

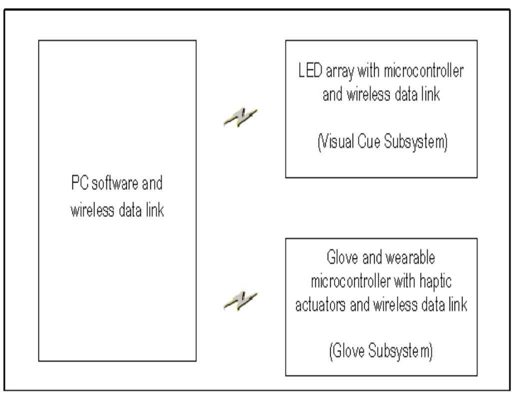

Fig.Conceptual diagram

The wearable part handles actual haptic feedback to fingers. That is why it needs to be wearable. It will also require a communication link to communicate with the PC to receive data. A wireless link is essential to avoid considerable inconvenience of wires hanging all over the user.

The block diagrams of the constituent subsystems appear below:

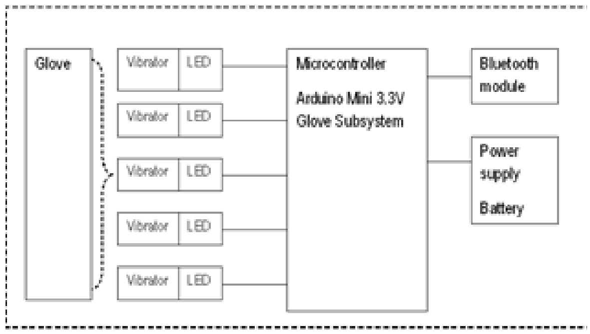

Fig. Glove Subsystem

The visual cueing system will control LEDs attached to the instrument which the system will attempt to teach. These LEDs will have to be lit in proper timed sequence to guide the user's fingers to the appropriate places. As the number ofLEDs will be quite large, another microcontroller will be needed to take care of the above requirements.

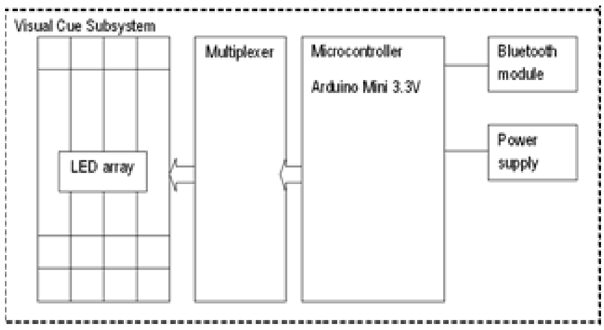

Fig.Visual Cue System

Controlling of overall system will be done by the PC software. It will also be used to evaluate the user performance. It will be interfaced with both thewearable and stationary parts through suitable protocols.

ISSN: 2278 – 909X

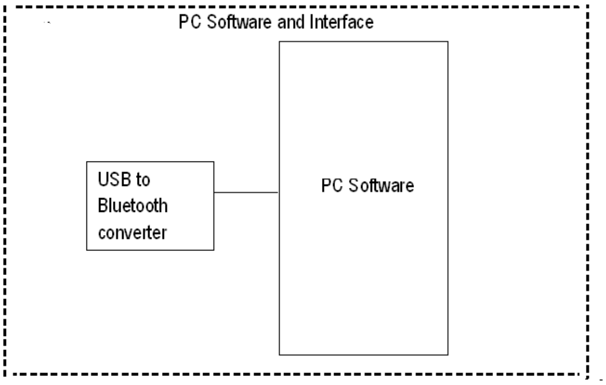

Fig. PC Software and interface

V. CONCLUSION

The proposed system is expected to yield helpful results in teaching typing and Indian music playing. Moreover it is also expected to demonstrate passive learning – in some ways similar to subliminal cueing – for doing some of these tasks. Extensions of the system to teach percussion instruments like the *tabla* - however- appear to need a lot of further work.

ACKNOWLEDGMENT

Aabha Chaware wishes to thank Prof. Dr.P.R.Deshmukh for his valuable guidance.

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ISSN: 2278 – 909X