For Consideration at the University LSI Design Contest

Sanyog: An Iconic Communication Aid for Children Suffering from Cerebral Palsy and Motor Neuron Disorders

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Area of Application: 3-d

Brief Description of the Application: Sanyog, a low-cost iconic communication system has been designed to aid people afflicted with cerebral palsy and motor neuron disorders. The system is fully portable and has been specially designed to cater to the Indian society. The biggest advantage of the system is its inherent userfriendliness achieved with the incorporation of appropriate user interfaces and specially designed accessibility devices. Sanyog is a complete embedded system solution for children who deserve special attention.

Contribution of each author: No non academic party is involved

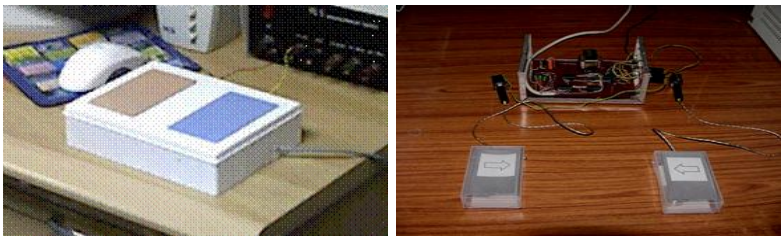
Summary

Approximately 15 million people in India, suffer from different types of motor disorders. A majority of this segment has cerebral palsy and 40% to 60% of this population is speech impaired. Though cognitively quite capable, this segment of population is deprived of accesses to modern tools for education and communication that could have alleviated their problems partially. This segment cannot avail the use of normal communication tools because of their disability. The aim of project Sanyog[1] is to develop an Alternative and Augmentative Communication(AAC) system for the aforementioned segment of the Indian population. Iconic communication tools are available abroad. But they are extremely cost prohibitive and also do not possess all the desired features. Commercially available iconic communication systems include Pathfinder Plus from Prentke Romich[2] and EZ Keys from Words Plus[3].

Salient Features of Sanyog

Sanyog is an iconic communication device that

- Accepts icons as input from the user. The icons can be selected using special access switches for those who have neuro-motor impairments and cannot use the mouse. The system seamlessly interfaces with different types of indigenously made access switches. These switches allow the user to navigate across the panel and select icons. Two different varieties of access switches that have been designed for Sanyog are shown in Figure 1.



(a) Electro-Mechanical (b) Touchpad

Figure 1: Specially Designed Access Switches

- Forms syntactically and semantically correct natural language sentences in English.
- For the preliterate children iconic sentences are also formed so that the children can understand and communicate.
- The last formed sentence is saved and can be selected for later use.
- The sentences can be spoken out using text to speech systems specifically designed for Sanyog. It is possible for a user to integrate a different text to speech system according to his/her choice.

- Allows personalization. The icon set can be modified at ease and icons suitable for a specific user can be easily incorporated.

Thus Sanyog is a complete device that can be used by users with speech impairments or multiple disorders allowing them means to form their own messages and speak them out. Special educators have also pointed out that Sanyog is an excellent device for children with Autism. To make Sanyog portable a complete embedded system for Sanyog has been designed.

Design of Sanyog

Sanyog has been developed on Innovator, a TI-OMAP 1510 [4] processor based development board shown in Figure 2. For ease of development a customized Linux kernel has been ported to the

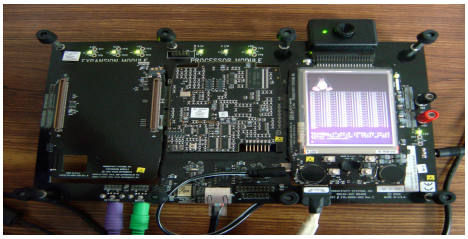


Figure 2: Innovator Development Board

Innovator board. A very small footprint filesystem has also been developed for this purpose. The Sanyog system has been developed using QT-Embedded [5] a C++ application development framework for mobile embedded systems. The choice of QT-Embedded over Java as the development framework had been necessitated by the speed, memory and cost constraints imposed on embedded systems applications. The use of the publicly available Linux framework in the development of the system has contributed hugely in making the system affordable according to Indian standards. The following subsections describe the design of Sanyog focusing on the optimizations in the different modules of the system as shown in Figure .

- **User Interface Module**: A verb directed Natural Language Generator(NLG) has been used in Sanyog. As shown in Figure the User Interface(UI) has been designed such that the user selects the icon corresponding to the verb first. After the icon selection is complete the selected Concept Icons(CI) are passed to the NLG module. There are two classes of icons one representing the different concepts as shown in Figure 4(b). The other class shown in Figure 4(a) represents different control actions such as *next*, *back*, *reset* etc. This classification is required as the UI is constrained by the 240×320 resolution of the board. The relations between the different concepts are stored in a *forest roots* data structure. This data structure has been built dynamically with the selection of each icon rather than statically at system startup. This is necessitated by severe memory and speed constraints.

- **NLG Module**: The NLG module takes the concepts corresponding to the icons as input and adds the syntactic and semantic information to generate a grammatically correct sentence as

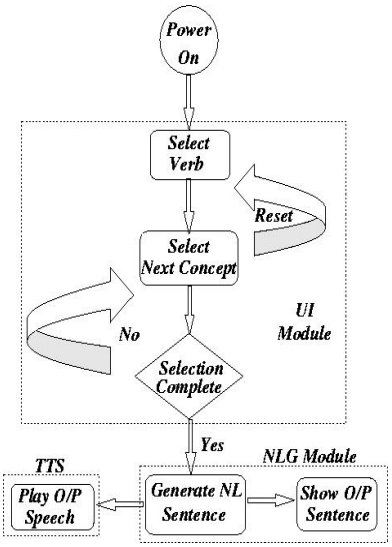
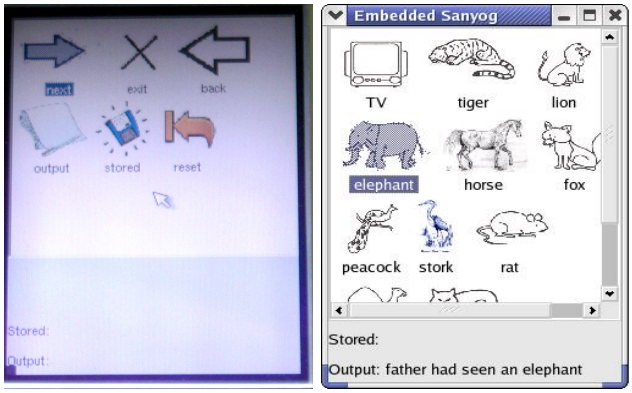


Figure 3: Operational View of the System



(a) Control Icons (b) Concept Icons

Figure 4: UI of Sanyog

output. A profile driven execution of the NLP module on the OMAP platform has shown that the NLG module performs satisfactorily under the speed and memory constraints of the platform.

- **Text to Speech Module**: To aid the communication of children suffering from speech impairments a TTS module has been added to the system to convert the generated sentence

to speech. *FLITE*, a TTS system[6] optimized for embedded devices has been used for this purpose.

- **Special Access Switches**: Children, with motor disabilities that do not allow voluntary control over the fingers or hands, fail to use direct keyboards. Thus the traversal of the icon gallery and subsequent selection of icons has been modified so that the user can exploit the functionalities of the system using only two switches serially interfaced with the Innovator board. There is a tradeoff between the number of switches used and the navigation time. The number of switches has been optimally kept at 2. These access switches come in two dispositions electro-mechanical and touch pad as shown in Figure 1.

Specialities of Sanyog
Sanyog uses a *dynamic UI* whereas commercially available products like Pathfinder[2] use a *static UI* which does not maintain any hierarchy of icons. Sanyog uses a *verb directed NLG* in place of *random selection* of icons used in Pathfinder[2]. These two features lead to significant speedup. To make it more user-friendly, Sanyog avoids *icon overloading* which is common in Pathfinder[2] where a single icon can have multiple interpretations.

Conclusion: Sanyog has been designed in a seamless manner. Thus it can be adapted to any language. The NLG and the TTS modules need to be refined for specific languages. Research work is now being carried out to adapt the system to Indo-Aryan languages. Moreover, the personalization feature of Sanyog allows the system to be adapted to individual needs. The system has been designed in a low cost manner using frameworks available in the public domain. But at no point in the design has a compromise been made with the quality of the system. Last but not the least the system has been designed keeping in mind the specific needs of the target audience. Thus a serious effort has been made to design a portable, low-cost but userfriendly and effective iconic communication system.

References

[1] http://www.cel.iitkgp.ernet.in/.

[2] http://www.prentrom.com/.

[3] http://www.words-plus.com/website/products/soft/ezkeys.htm.

[4] http://www.ti.com/.

[5] www.trolltech.com/products/embedded/.

[6] www.speech.cs.cmu.edu/flite/.