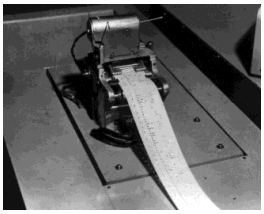


The CSIRAC Paper Tape Reader Project

Article by John Horvath

This article outlines the techniques used to archive historical computer paper tape data that was used exclusively with the CSIRAC computing system.

From a historical viewpoint, it was deemed imperative to preserve the programs and data that were stored on the last remaining paper tapes that were used with the historic CSIRAC computer and which were now deteriorating with the passage of time. It was therefore decided to convert the tape data into electronic form. The expertise of the Department of Computer Science and Software Engineering at the University of Melbourne was called upon to perform this task. The Department's in-house Technical Services Group (of which I was a member) was charged with designing the necessary hardware and software solution to this problem.

From the outset, it was discovered that the mechanical tape reading mechanism was the principle challenge and, after several prototypes were evaluated, the decision was made to utilise a spare (original) tape reading mechanism in the final design solution.

In collaboration with Jurij Semkiw, a novel solution was devised using a linear array of light emitting diodes (LED) and phototransistor detectors that were arranged in optical alignment corresponding to a row of punched hole data as occurred on the CSIRAC paper tapes to be recorded. The phototransistor detectors were coupled to the mechanical tape reading mechanism by way of short optical fibers as their physical size precluded them from being directly mounted on the tape read head mechanism due to the close spacing of the individual punch holes on the paper tapes. The LED light sources were directly attached to the original tape reading head mechanism. A parallel data latching circuit was designed to capture the sensed binary logic levels present on the phototransistor detectors as the punched paper tape traversed through the tape reading mechanism.

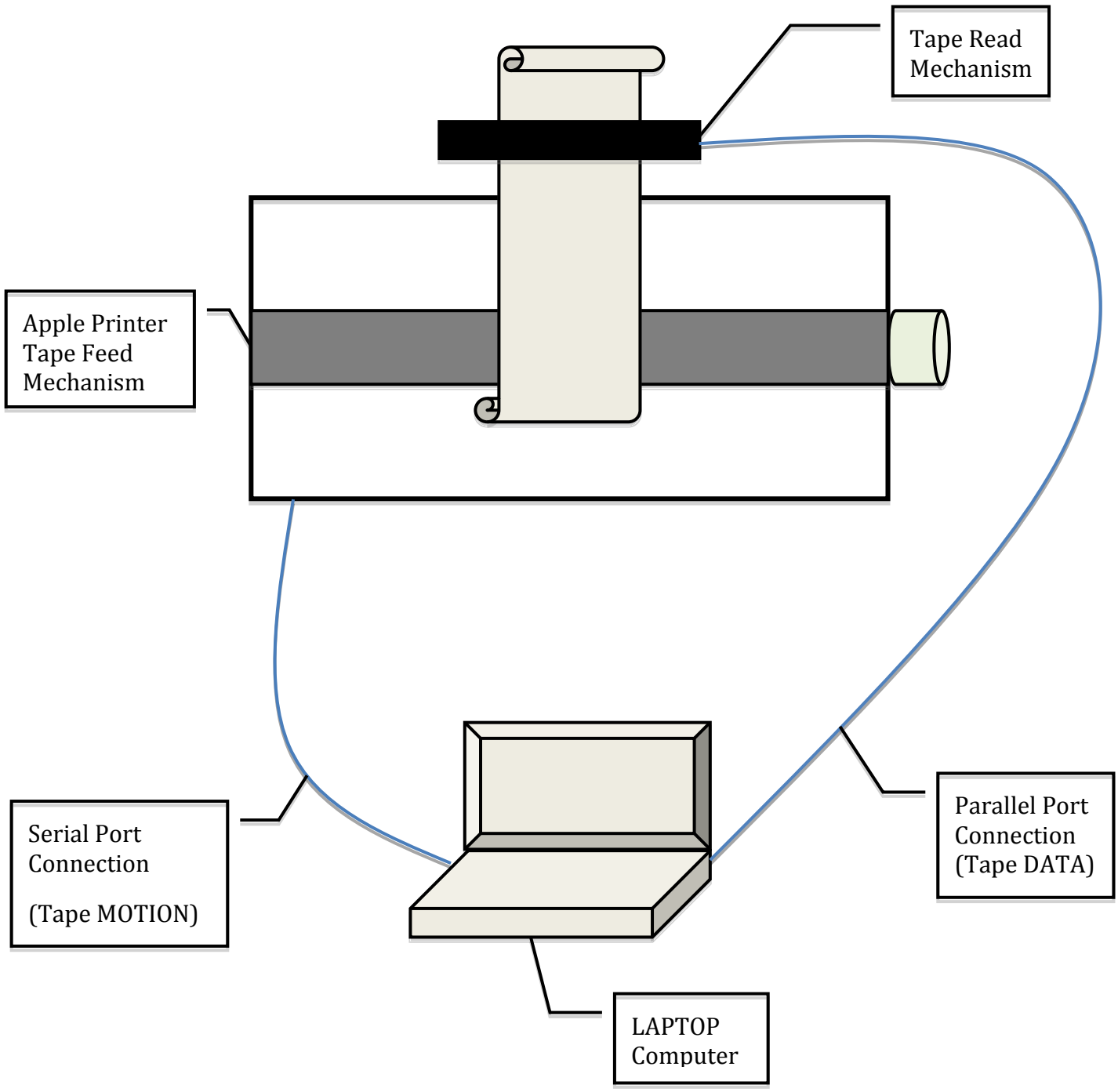
The data latching circuit was controlled by a laptop computer and featured a parallel data interface that enabled the latched (captured) data to be read and stored by the laptop computer, via its parallel printer port, a line at a time. This same computer also controlled the feed motion of the paper tape through the tape reading mechanism by way of microstepping the paper feed mechanism of an Apple Imagewriter dot matrix printer which was incorporated into the paper tape feed path in the tape reading design solution. It did this by sending special serial port motion control commands to the printer. In essence, the tape reading software optically sensed the changing state of the timing track holes on the paper tapes and controlled the printer-driven tape feed mechanism so as to position the tape "data" holes precisely under the phototransistor detectors in a rudimentary opto-mechanical feedback system.

Two programs[1] (authored in the C programming language) were written specifically for the initial capture of CSIRAC paper tape data. The first program concerned itself with controlling the tape reader electronic interface and paper feed mechanism and capturing the raw tape data as detected by the phototransistors in the tape reading mechanism. It used a memory buffering technique to improve realtime data capture performance and saved this data in an MS-DOS formatted file. The second program converted the raw captured tape data into a more convenient and human-readable form, consistent with the instruction and data formats of CSIRAC's instruction set as specified by John Spencer. This second program was manually executed on a Unix host computer and necessitated the frequent upload of raw captured data from the tape reading control laptop computer. Samples of converted data were later used by John Spencer in the development of his CSIRAC emulator software.

A sample of the decoded output format produced by this second *conversion* program is presented in file T712A_CVT.txt.

Not only did this project fulfill the primary requirements of preserving the original CSIRAC tape data for later study, it also enabled a novel visual demonstration of CSIRAC program execution to be realised by way of a CSIRAC emulator created by John Spencer. John was an original programmer of CSIRAC in its heyday and provided valuable input during the development of this project. A demonstration of his emulator can be seen at: http://www.csse.unimelb.edu.au/dept/about/csirac/emulator.html

CSIRAC Paper Tape Reading System Interconnection



[1] The tape data capture program is called **reader.exe** (MS-DOS executable) and was compiled from the source files **reader.c** and **reader.h** using Borland Turbo C++.

Note: the lookup table data in the header file **reader.h** (used by the reader program to "invert", or flip, the read binary tape data values) was generated with the program **tablegen** (UNIX executable) and was compiled from the included source file **tablegen.c** using the GCC compiler.

The second post-processing raw data conversion program is called **convert** (UNIX executable) and was compiled from the source file **convert.c** using the GCC compiler.