Mobile Hand Tracking Using FPGAs for Low Powered Augmented Reality

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Introduction

This poster describes a mobile hand tracking system that we have developed using an FPGA-based reconfigurable computer. The goal is to transfer processor intensive tasks such as vision tracking into specialised hardware, which will allow the development of miniaturised AR wearables with reduced power consumption. General purpose processors are not optimised for any one task, making them less efficient for use in wearables than dedicated hardware.

Hardware

Our system uses a Celoxica RC200, which contains a Xilinx Virtex II 1000 field programmable gate array (FPGA), random access memory, an LCD panel for debugging, video capture chip, and RS-232 serial port. The RC200 contains dedicated circuits for commonly performed tasks so only custom algorithms need to be performed in the FPGA. The user wears coloured furry markers attached to pinch gloves, which are viewed by a head-mounted PAL video camera. To provide efficient video AR overlay capability, dedicated video overlay hardware is used.

Implementation

We have implemented a custom vision tracking algorithm which uses a YCrCb colour space to find coloured markers in the environment. We have selected saturated colours which are not typically present in the environment to minimise errors. After thresholding coloured pixels, we use a centre of mass algorithm to find the coordinates of the markers. This algorithm is implemented as a series of parallel circuits in the FPGA, and the final result is sent to the host laptop via an RS-232 connection. The algorithm used was specially selected because it best suited the internal architecture of the FPGA.

Results

We measured the power consumption of the RC200 to be 4W during testing, although since it is a generic development board, the actual power used by a custom device would be considerably less. We have calculated that a board with a Virtex II FPGA and Phillips SAA7113H chip would consume less than 1W of power. Since the RC200 and video overlay device perform all vision based tasks, the laptop used for AR can now be much simpler. We plan on using these reductions to make much smaller wearable AR systems in the future.

We have successfully integrated our RC200 based tracking system with our existing Tinmith modelling system. We evaluated the tracker under a wide range of lighting conditions, particularly in outdoor environments with bright sunlight. The results were very robust, making it ideal for mobile outdoor AR applications.

Fig 6 – Schematic showing system components and the connections required to provide a video overlay AR display to the user

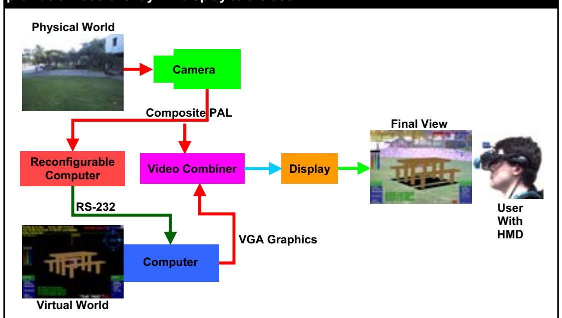

Fig 2 – Flow chart showing the operation of the software and the various processes that operate within the RC200

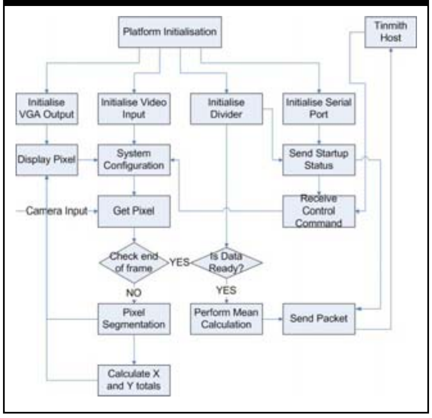

Fig 4 – Debugging image from the RC200 showing the matching pixels and a cursor at the calculated marker centre point

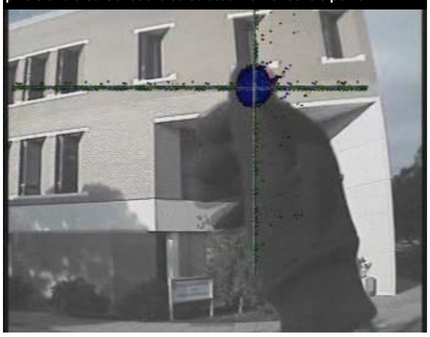

Fig 7 – Tinmith modelling software in operation with the RC200 based tracker, with 2D cursor showing the current thumb location

Fig 1 – Backpack configuration with RC200 and video overlay unit

Fig 3 – Interface gloves with coloured markers worn by the user

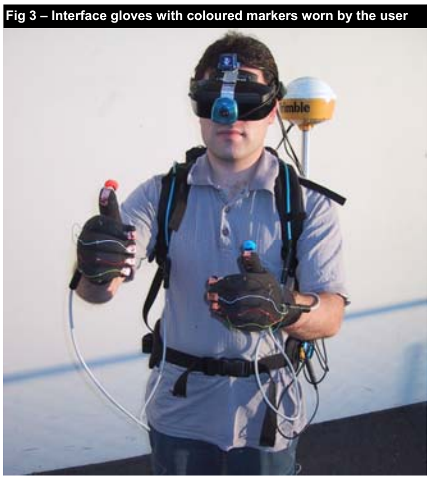

Fig 5 – Reverse view of the RC200 reconfigurable computer

Fig 8 – GrandTec MagicView video overlay device

More Info at http://www.tinmith.net and http://wearables.unisa.edu.au

Please visit the Tinmith and Wearable Computer Lab web sites to find out more information about this project, as well as other interesting projects currently in progress.

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