Laparoscopic Screen Pointer

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Objective

Current laparoscopic surgical techniques require surgeons to collaborate solely using verbal commands that can often be misunderstood. It is therefore our goal to implement a device that projects a pointer onto a video screen that can be operated from the laparoscope. This will allow surgeons to point out varying topology during both training and actual surgery without the need to move their hands.

Laparoscopic Surgery

Figure 1: Team of surgeons performing laparoscopic surgery

- Innovative surgical technique that minimizes trauma and improves patient recovery time
- Performed in the abdomen through small incisions (figure 1)
- Reduces hemorrhaging and exposure of internal organs, thereby lowering infection risk
- Reduces pain and scarring
- Surgeons rely on video screen to perform surgery
- At least two surgeons required to operate specialized instruments (figure 2)

Figure 2: Variety of laparoscopic instruments

Problem Statement

This project must superimpose a digital screen pointer on streaming video from a laparoscope to assist in the training of residents, and eventually to be used in the operating room. Specifically, the applied system must:

- Accept streaming video
- Embed a user-controlled cursor and process its data
- Output the camera view and imposed cursor on a single video signal
- Utilize a pointer controller on the handle of the laparoscope used

Compiled System

External Board System (figure 3)

- External computer unit (BeagleBoard) intercepts video from laparoscope processor
- Unit also integrates trackball data
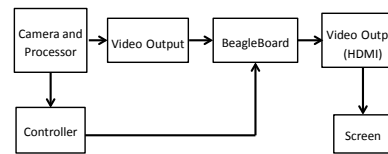- Requires a video capture device to process incoming video

Figure 3: Block diagram of the external BeagleBoard screen pointer design

Integrated Board System (figure 4)

- Video and cursor data compiled within camera processor
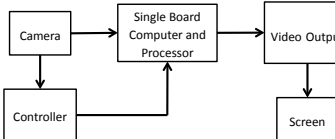- Camera then exports final rendered video

Figure 4: Block diagram of the integrated board screen pointer design
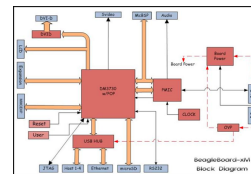
BeagleBoard XM

- Programmable single board computer
- 5V DC power supply
- Can use Linux operating system
- Boots from miscroSD card
- USB inputs
- HDMI output to transmit video to HDTV

Figure 5: Block diagram of the BeagleBoard XM

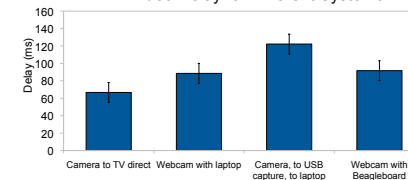## Delay Testing

Video Delay for Different Systems

Figure 6: Observed delay using various video systems

Delay Testing Procedure

1. Record blinking metronome
2. Point recording camera at display screen
3. Save video and analyze time between blinks in video software

Future Work

Improvements for training room model

- Improve upon current trackball unit (figure 7) by making it smaller and wireless
- Develop faster computer board with greater number of video input options
- Develop improved custom archetype for faster processing and easy video capturing

Figure 7: Trackball prototype that attaches to laparoscope

Figure 8: Accustream VIVO board

Design objectives for Operating Room Model

- Incorporate FPGA with DVI VIVO boards from Accustream or ATI Radeon (figure 8)
  - Process 1080p HD DVI input and maintain video quality
  - Overlay a cursor image on streaming video
  - Design sterilization technique for trackball
- Estimated Cost: $10,000 - $15,000

References

A. "BeagleBoard-xM Rev A2 System Reference Manual" July 7, 2010.
B. http://www.weightlosssurgerychannel.com/breaking-wls-news/gastric-sleeve-procedure-under-scrutiny-at-bariatric-surgery-conference.html/
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