Boeing's Laser Projectors System Proposal

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Team 34

I. Motivation

The motivation of this project is to come up with a prototype of laser projection system that would be used in factory assembly line to display instructions to workers. The system can have both the accuracy of laser projectors and the speed of optical projectors.

II. Objectives

The goal of this project is to design a prototype of projection system that uses two LPT1 laser projectors to provide an augmented reality projection that shows the actual part and where it needs to be installed. This would be used in production line to help with quality inspections and to reduce the amount of rework that could have traveled down the line. This system could then be multiplexed by using more laser projectors to increase the refresh rate.

Benefits

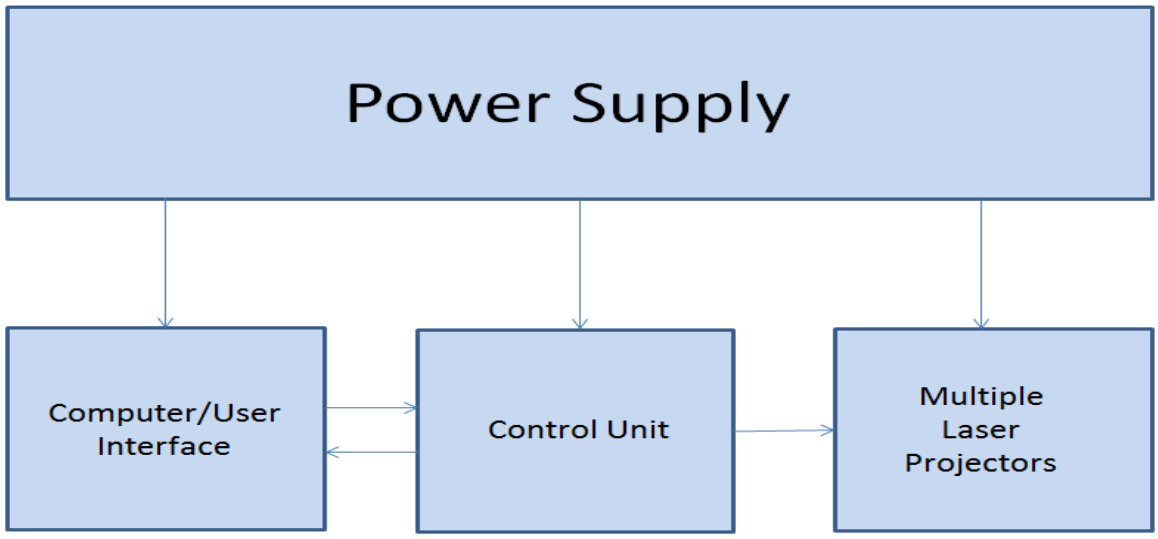
- Retain the accuracy advantage of laser projectors
- Increased refresh rate of projection system compared to using just one laser projector
- Cheap

Features

- The animation is created from a computer
- An automated system located in between the computer and the laser projectors then split the video output into two channel of output that will be routed to each laser projectors
- Control unit can allocate frames up to a maximum of ten projectors depending on the number of projectors the user want to use

III. Design

Block Diagram



Power supply

- To supply operating power into the computer, control unit and projectors
- Since the control unit requires 12 V dc input, there will be an ac/dc converter inside this module to convert a 120 V ac to 12 V dc.
- Power supply system is the power source of the whole system

Computer/ user interface

- This unit could be used to create and store the reality image of the parts. When assembling the parts, the computer can then send the animation output to the control unit. This animation will ultimately be projected on the real part to guide the workers at the assembly line.
- Computer/ user interface serves as the interactive platform of the whole system among the laser system, assembly workers, and the commander who gives instructions

Control unit

- In the prototype, this unit would split the video output from the computer into two channels of output. The basic concept here is to split the total frames into two groups and send each group to its corresponding projector. Each laser projector is only responsible to display their assigned frames which are only half of the total original frames.
- In reality, this system will be multiplexed with more projectors. If the number of total frames is equal to M, the number of projectors being used is P, then k^{th} projector (k=1,2,3….P) will continuously display a new animation which consists of frame k^{th}, $(k+P*1)^{th}$, $(k+P*2)^{th}$, …, $(k+P*n)^{th}$ until all the original frames are projected.
  By doing this, the animation speed will be multiplied by the total number of projectors used theoretically if we would ignore the processing time.
- The control unit is the processing unit of the whole system that receives, processes and sends the instructions

Multiple laser projectors

- The projectors are responsible to project the frames assigned to them to any arbitrary surface
- The laser projectors are the executing units of the whole system

Performance Requirements

- Power supply
  - Output to control unit 12 V dc
  - Output to other modules 120V ac 50Hz
- Projectors
  - Projection distance 3m – 5m
  - Projection Angular range 60 degrees
- Control unit
  - Can correctly compute the frame allocation according to the user input
  - Can assign the frames to each projector without error
- The entire system

- Can achieve about twice the refresh rate of a single laser projector
- Projected image is clear, can be perceived with human eyes
- Projected image on any arbitrary surfaces is accurate, within the smallest assembly tolerance

IV. Verification

Testing Procedure

- Power supply
  - Test the performance of ac/dc converter if it can provide 12 V dc
  - Measure the outputs of power supply module with a multimeter
- Projectors
  - Test if the two projectors can project image synchronously within a projection range of 3-5 m. A fixed distance between two projectors is determined, and the projected image is examined using bare eyes.
  - Test the angular range, image is projected onto a flat surface; the radius of projected image is then measured. Thus, using trigonometry, angular range is known.
- Control unit
  - Test if it can receive input from users. Connect a seven-segment display to the control unit and display the number received from user input.
  - Test if it can allocate frames to each projector correctly. Have the outputs of control unit connected to LEDs. The LEDs will be turned on when frame is allocated to it. If it allocates appropriately, the LEDs will be turned on sequentially. The clock speed of control unit will need to be adjusted to allow light flashes at a speed distinguishable by human eyes.
- The entire system
  - Compare the speed of the multiple projectors system and a single projector. The time required to project a set of frames using a single projector is measured. Then, the time required for the multiple projectors system is measured. Thus, the improved speed can be estimated.
  - The entire system will be tested under augmented reality. A sample set of instructions are generated from computer-aided design, the projection system will be used to project the instruction animation to a targeted component. The speed will be documented and compared with that of the original system.

Tolerance Analysis

One of the most critical parts of our design is the control unit. The control unit is responsible for allocating frames to laser projectors based on the number of projectors specified by the user. The test cases will cover all possible inputs (2-10). The goal is to demonstrate that it is possible to expand the number of projectors. In this design the limit is set to ten so that the implementation of the control unit will not be too complicated. For this unit, the clock speed is crucial to the whole system. The control unit's clock speed should be able to handle smooth allocation of frames to the projectors.

The detailed verification is described in the Testing Procedures.

V. Cost and Schedule

Cost

Parts

Items	Unit Price	Quantity	Total
Laser Projectors	$200	2	$400
Resistors, Capacitors, diodes, inductors	$0.5	50	$25
Microcontroller	$5	1	$5
120V AC/DC converter	$15	1	$15
Sample Wing Box	$20	1	$20
Computer	$300	1	$300
LabVIEW Student Edition Software	$60	1	$60
Universal Software Radio Peripheral	$170	1	$170
Motor	$50	1	$50
Grand Total			$1,055

Labors

Name	Hourly Rate	Hours	Total
Wei Keong Eiew	$50	150	$7,500
Lei Jin	$50	150	$7,500
Nan Wang	$50	150	$7,500
Grand Total			$22,500

Total Cost

Total Cost = $1,055+$22,500=$23,555

Schedule

Week	Lei Jin	Wei Keong Eiew	Nan Wang
2/6 -Proposal due	Proposal: Objectives, Cost and Schedule	Proposal: Design	Proposal: Verification
2/13	Experiment with the given laser projectors	Research laser projection systems	Research optical projection systems and other display technology
2/20 -Design review	Revise the design, schematics and flow charts	Revise the verification procedures	Revise performance requirements and tolerance of system
2/27	Control unit design	Circuit design	User interface design
3/5	Program the controller	Program the circuit	Program the user interface
3/12 -Individual progress reports	Write up progress report	Write up progress report	Write up progress report
3/19 -Spring break	Holiday	Holiday	Holiday
3/26 -Mock-up demo	Prepare design slides	Prepare control slides	Prepare test slides
4/2 -Mock-up Presentations	Modify procedure	Circuit improvement	Customize improvement
4/9 -Last day for final PCB	Presentation	Prepare the demo and document any modification	Demo
4/16 -Demo and Presentation	Final paper –design, procedure, details	Final paper –testing, verification	Final paper – introduction, cost, conclusion
4/23 -Demo	Construct measurement and verification	Construct final paper (design portion)	Construct final paper (introduction, cost etc.)
4/30 -Final paper due	Revise final paper	Revise final paper	Revise final paper