RTI Dome

Alexander Calmas, Hadrian Doromal, and John Ducham
TA: Evan Widloski
ECE 445 Team 11

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1. INTRODUCTION

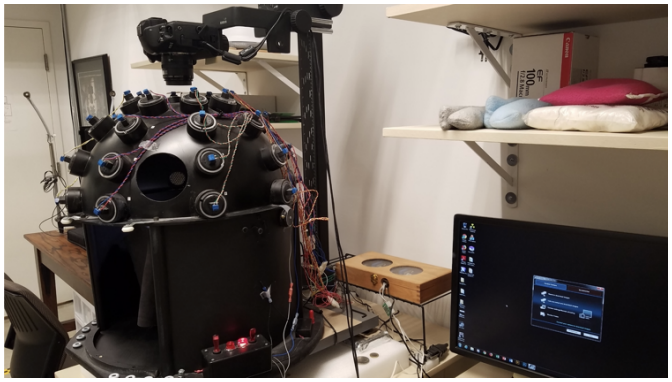
1.1 PROBLEM

The Spurlock Museum of World Cultures uses RTI photography to preserve digital records of physical artifacts so that they can be studied in pseudo-3D. This is accomplished using "the dome", an array of LED lights and a camera which photographs the artifact multiple times under different lighting conditions. The dome has begun to show its age in a few ways:

The dome's frame is bulky and the components are loose on the exterior, making transport difficult.
Several of the LEDs used for photography are unreliable.
The software used to control the camera shutter no longer works with current versions of Windows, meaning the photography process must be done manually.
The Arduino governing the dome has had reliability issues due to age.
Additionally, our sponsor is interested in a more portable RTI solution that can photograph larger artifacts and is lightweight, allowing for perpendicular setup (for example when photographing an object in a wall-mounted display).

1.2 SOLUTION

We propose a collapsible umbrella-like dome that covers an area around 1.25 meters in diameter when fully expanded. The frame will be composed of durable plastic or thin aluminum rods to save weight, with three rows of lights mounted on the interior of the dome. An opening at the top of the frame will allow the system to be mounted on the camera tripod provided by our sponsor. Finally, a control board mounted on the side of the frame will control the lights and camera, allowing for automatic and manual imaging.

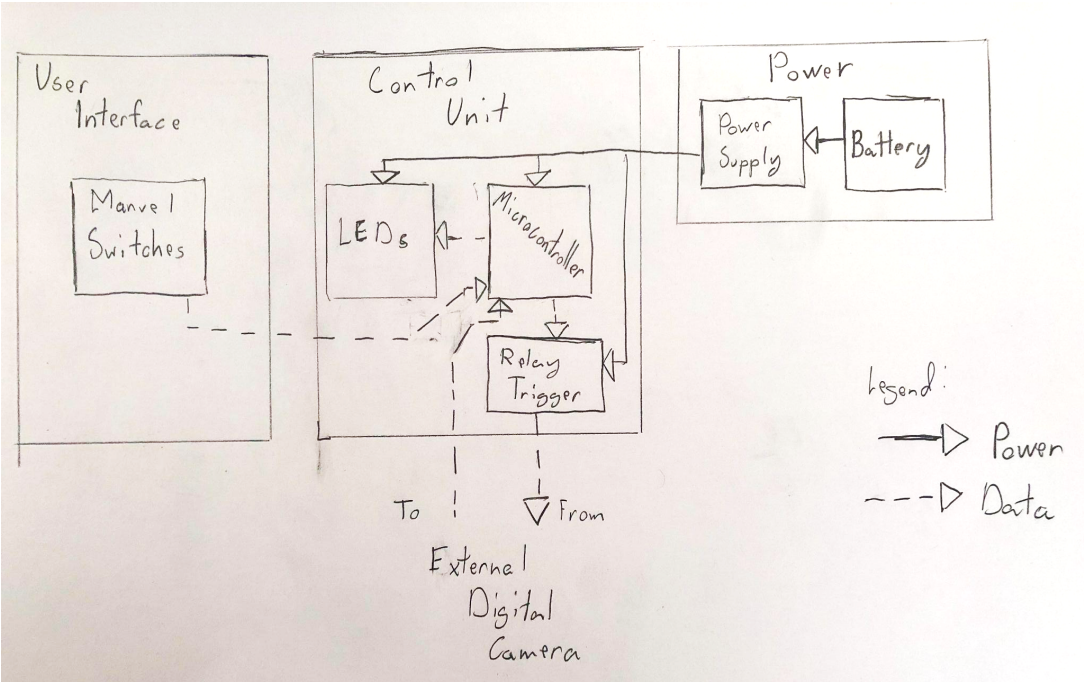


1.4 High-Level Requirements

- RTI Imaging Dome must be light, portable, and durable enough for a single person to carry and transport it in a vehicle
- All LEDs on the Dome must be equidistant from the subject
- All photos must be taken from the same position without moving the subject

2. Design

2.1 Block Diagram



2.2 Functional Overview and Block Requirements

User Interface

Our design will feature a set of switches used to control specific LEDs. This feature is necessary in the case that an image from a specific lighting angle was not taken correctly by the automatic RTI process. These switches will interface directly with the microcontroller to turn the LEDs on and off.

Requirement	Verification
LEDs must respond to switch within 100ms	Record a test flipping the switch and utilize slow motion videography to determine if response time is ≤ 100ms
Successful operation with little to no training required	Have an untrained person successfully operate the user interface

Control Unit

Microcontroller

Will properly process the user input into the device and the process the camera's external inputs into the processes so all the photos are taken properly.

Requirements	Verification
Microcontroller must respond to external input, (user and camera), within 50 ms	Record a test and utilize slow motion videography determine if response time is ≤ 150ms between the Microcontroller and a LED

LEDs MR16-42-TPW-001M Each LED will turn on and off when the microcontroller asks it to.

Requirements	Verification
LEDS must respond to given command within 100ms	Record a test and utilize slow motion videography determine if response time is ≤ 100ms between

Relay Trigger TXS2-L-4.5V-1 will relay the signal given from the microcontroller to the camera trigger to the external camera through a proper cable. **TXS2-L-4.5V-1**

Requirements	Verification
Relay Trigger must respond to given command within 100ms	Record a test and utilize slow motion videography determine if response time is ≤ 100ms, between the camera's photo being taken and a light being switched on.

Power

Power Supply must be able to divy and allocate the appropriate power levels for each device in the system.

Requirements	Verification
Power supply gives ● 12-24V to each LED ● At least 10V to the relay trigger ● 5V for the microcontroller	A Voltmeter will be used at each device's location to see if they are getting the appropriate voltage.

Battery is used to power the system

Requirements	Verification
Battery must be able to supply 15 volts to the system	Voltmeter will be used at the battery to see if it supplied the desired amount.

2.3 Risk Analysis

The component with the greatest implementation risk is the modular or portable aspect of the dome. We will mitigate this by constructing a prototype dome by the end of September that can be disassembled and reassembled without fear of dislodging wires or LEDs. If we can't successfully construct such a prototype we will scale our design back to a static dome without removable parts.

3. ETHICS and SAFETY

Due to the nature of the artifacts being photographed, we have a responsibility to ensure that our system does not risk harming the precious and possibly one-of-a-kind subjects as they are imaged.

Safety precautions must be taken to avoid electric shocks during construction and operation of the device.

Also safety precautions must be made from the portable nature of the device so it can be transported safely for both the device and the people using it.

REFERENCES

[1]H. Mytum and J. R. Peterson, "The Application of Reflectance Transformation Imaging (RTI) in Historical Archaeology", *Hist. Archaeol.*, vol. 52, no. 2, pp. 489–503, May 2018, doi: 10.1007/s41636-018-0107-x.

[2]"https://www.conservation-wiki.com/wiki/Reflectance_Transformation_Imaging_(RTI)". .

[3]"http://www.southampton.ac.uk/~km2/imaging/ptm/index.html". .

[4]"http://price.ledtronics.com/ds/Log-176-200/Log%20189%20MR16-ACDC/MR16-42.pdf"

TXS2-L-4.5V-1 Panasonic Industrial Devices | Mouser