**Laser Star Guide**

**Project title:** A Bluetooth enabled device that can point out constellations in the night sky with a visible laser.

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**Industry description and company products**:

The night sky is a constant in all our lives. The stars inspire wonder and amazement. For centuries humans have used the stars to share stories, tell time, and for direction on the open seas where no landmarks could be found. While much of what we learn about the night sky comes from literature, we also have telescopes that can focus in on one specific celestial object in the night sky, there are planetariums that educate the public and professionals that provide interactive experiences to learn about the stars, even smart phones have applications that allow people to view the constellations, planets, and stars in the night sky through their screen. But nothing exists that connects all these segments.

Laser Star guide is going to change that.

By combining existing technologies and data bases we can provide a unique user experience that does not currently exist.

**Why should students choose to be on this project:**

In this project you will take information from multiple sources and combine it with programming and electromechanical engineering in a way that has not been done before. The diverse mechanics and data will need to be combined in a coherent way so that it can function simply and effectively. Synthesis is the key to reaching the greatest audience.

This project is a new way to perceive augmented reality. Superimposing a laser on the night sky creates a new composite view and interaction with reality. And that’s not even the coolest part, This single technology not only augments a single persons reality, it is a shared augmented reality that multiple people can experience at the same time.

Some of the other fun things that this project offers are the opportunity to work with lasers, build smartphone apps, and build electromechanical machines. if you decide to take this project you will be synthesizing information in a way that no one has done before. You will be an innovator.

At the end of the project, you will have created a new tool that will fundamentally change how we learn about the night sky.

**Project background and objective:**

This concept was born from decades of leading and guiding outdoor trips all over the country. While the activities varied there was always one constant, the night sky. Wherever I went there were stars. And so, I learned about them and taught others about them. I used my laser pointer and my star books and charts to point out constellations. On many of my less remote trips and something that was becoming more common was participants telling me that they had something they used to find the stars. They would pull out their phone, open an app, put their screen up to the sky, and look at the phone saying look there’s Venus or that’s the big dipper. All while not looking at the sky but a phone in front of the sky. The laser star guide is a way to remove the phone and provide the experience of having the constellations pointed out with a visible laser. Like a combination of the phone and the guide with a laser. The best of both worlds.

This project is focused on providing fundamental understanding of the night sky and orientation to the constellations. This is done with a Bluetooth device that can point out the constellations and celestial objects with a visible laser pointer.

The number of technologies and data bases that are combined make the project particularly interesting. Much of the technology already exists. Combining the technology will be the trick. Let’s cover some of the areas:

* App
  + Content
    - Constellation name, history, lore, etc.
    - Stellarium.org
  + User interface
    - Sky views
    - Slide shows/auto features
    - Voice commands
* Device
  + Housing
    - Built for outdoors and uneven terrain
  + Device location
    - GPS
  + Device orientation and calibration
    - Polar alignment
    - level
  + Laser projection
    - Laser type and power
    - 2 mirror galvos
    - Projector programming
      * Star locations
        + Database of celestial bodies
      * Integration with smartphone
  + Safety feature
    - Find the optimal safe distance of device from user
      * Average height of user
      * Field of operation for projector
      * Automatic shut down

Now that a road map has been drawn let’s dig into the parts…

Starting with the content, I was moved by H. A Rey, the author of Curious George, and his book “The Stars: A New Way to See Them”. In this book constellations are reimagined. He took the same group of stars for a constellation, reviewed the allegorical and geometrical presentations of that constellation, and then developed a relatable graphic representation of the constellation using the same stars. What once was abstract geometry is now intriguing familiar shapes that relate to the stories behind the constellations. This information is the content for the Laser Star Guide. These are the objects that will be programmed into the application that pairs with the device.

H. A. Rey’s other book “Find the Constellations” provides the framework for a user interface for the app. In the book “sky views” are introduced. These sky views provide a window to filter out an overwhelming amount of information. Just based on the GPS location and date alone the amount of information is reduced. Add in a cardinal direction or an elevated horizon line and the sky becomes a lot smaller. Users of the app need a way to interact with the stars that they can currently see. A user interface needs to be developed that can accomplish the task of filtering and limiting information in a simple and intuitive way.

Knowing that this device is to be used at night special consideration should be taken when choosing a color theme. Another thing to consider is the use of voice commands so that one can keep their night vision. Instead of using our eyes too look at a backlight screen and press a button, why not just ask the app. Simple verbal commands can be used to transition from constellation to story to experience. Instead of reading the app could read to you. And for the experience one could auto play the constellations and even freeze them. With how rapid motors can move the appearance of a static shape can be achieved.

Now that we have content and the beginnings of some software the real work begins on the construction of a device that can point out constellations with a laser accurately and repeatedly. Size constraint for this project is that one person must be able to move and transport the device using one hand. The device is meant to be used outdoors and on uneven terrain. The device will need to be battery operated and rechargeable. Housing should be able to withstand sand, dirt, mud, and some water.

A few key things need to happen once the device is placed on the ground turned on and connected to the app. First it needs to know what time it is and where it is located. Second it needs to orient and calibrate itself. Third it will connect to the app and begin to point out constellations.

The first key component is the location and time. This can be accomplished using GPS. The GPS location and time are used in the application and user interface to reduce the amount of information to what is currently visible.

The second task is to orient and calibrate. Location is one thing direction is another. The device could have a compass in it. And if you give a device a compass it’s going to want a level too. The device needs to electromechanically level and orient itself. The device needs to create a stable platform so that the laser can be calibrated.

Calibration for a telescope is done with polar alignment. Many large telescopes calibrate using a specific know celestial body and entering that information into the software. This process needs to be redone without the telescope but a visible laser instead. Polar alignment will be implemented, and a visual calibration could be done as well. If the application has a joystick or interface to move the laser to a specific known star then that could calibrate the system. This calibration would also take into account the different perspectives people may have based on where they are positioned in relation to the device. Say you are at a distance and could be elevated or below the device. The perspective the user may have might be off from the true trajectory of the laser. This subtle adjustment or calibration may have an impact on the user experience.

The third key component is how the laser will work. Traditional telescopes use a series of motors to move the physical telescope. With lasers we are afforded the ability to have a stationary laser projector that uses mirrors to move the laser. This laser scanner is the same technology used for laser light shows. It consists simply of two mirrors operated with two motors to move the laser to a specific position. The drawback to a laser scanner is the limited field of view. So electromechanical manipulation of the laser scanner may need to take place. The goal is for a majority of the movement to come from the laser scanner. The larger movements should be made initially. These movements would be dictated by the orientation and calibration along with the sky view that the user provides. Laser light show projectors that use laser scanners come with software that may be adapted for this project. Can the celestial body database be combined with the laser scanner software and constellation content on the app? Can you adjust orientation with the programing of the laser scanner i.e., no rotation?

If these components can be combined the finer details of the project can come into view. Like how to make this thing small enough to be carried with hand.

Choosing a simple visible spectrum laser is a great place to start. My laser pointer runs on two AA batteries. Next is the laser scanner. Two small motors connected to mirrors in an X/Y mount with position detectors that would receive control input from a servo amplifier. This is then controlled by the software of the application. The field of view for the scanner needs to be taken into consideration when establishing how much manipulation of the mirror mount needs to happen with another motor.

When choosing a Galvo, the motor and mirror mount used in a laser scanner, a few things need to be considered. The torque of motor, this device does not need to move super-fast. The size of the mirror and the scan angle also have an impact. With a single laser the mirrors can be reduced in size, but they should be able to have the largest scan angle. The thermal capacity for the system needs to be considered and what kind of power source would be required.

Lastly their needs to be some sort of safety mechanism. A cover for the laser projector, that one is two fold. A proximity detector with blue tooth. Calculate the field of view for the laser and the angle at which it could project towards a person of above average height. Then program that into the app and the device. A beep or warning could go off if you get to close. And then the laser would stop after that. The device cannot be operated while moving. Warning labels need to be clear and in contrasted colors to the device

Now it’s time to put it all together! Test, problem solve, and improve upon the design. Learn about the night sky, become informed, and feel connected to our place under the stars.

**The Project requirements:**

The project must use the new diagrams for the constellations from the H. A Rey books and the correlating information about them must be included into the app and programming. Speech functions for the application need to be installed. The user interface and information presented needs to change in real-time according to the location of the device and time of night. The device needs to be rechargeable, and it must be able to be carried with one hand and have a weight less than 10 lbs. safety features for individuals need to be implemented.

**Deliverables:**

A smartphone application with constellation and stellar information that has integrated voice commands.

Design schematics and plans for the device broken down into each piece of the project.

* A laser projector that can run on a rechargeable battery
* A device that can orient and calibrate itself
* A device housing that is suitable for outdoor use

And integrated celestial database and laser projector program capable of directing a laser to specific stars.

**Skill requirements:**

* Background and/or interest in CAD and electro mechanical design
* Prefers collaborative and team-oriented working environments
* Strong aptitude for innovative electromechanical design and progamming
* Excellent communication skills, both verbal and written
* Enthusiastic about problem solving and brain storming, hands-on prototyping, testing, and design iteration
* Open-minded to constructive feedback
* Multi-disciplinary interests (e.g. mechanical and electrical engineering, mechanical engineering and computer science engineering, etc.) encouraged
* Demonstrates ownership of assignments and roles as well as committed deadlines
* Passion for bettering the community
* Critical thinker and researcher
* Innovator

**Additional information:**

[www.Stellarium.org](http://www.Stellarium.org)

This site provides free celestial body data base

The below video really helped me understand how a laser projector works. It also assured in me that if such a complex device can be created why can’t something simpler be constructed.

<https://youtu.be/4SHTdwREjRY?t=446>