MDR Presentation

StarTrack

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Daniel Willmott

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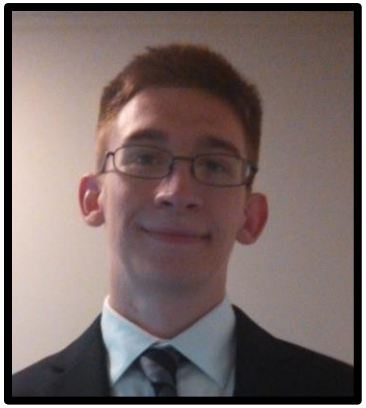
Team Introductions

Rebecca Baturin, EE

Chris Boyle, CSE

Charles Urbanowski, EE



Daniel Willmott, EE

What is StarTrack?

What is our motivation?

- We want to provide a low cost, accurate, and intuitive tool for taking photos of the night sky

Who is it for?

- StarTrack is geared toward hobbyists who already own a DSLR camera

What does it do?

- StarTrack automates the process of finding interesting targets in the sky
- Allows for wireless control of both the mount movements and the camera shutter

Concerns from PDR: Accuracy

- Test photos taken with manual tracking mount
  - 90 second exposures
  - Mount radius of ~7.14 inches meant that screw could be turned by hand at 1RPM (used a watch for reference)
  - Average star size is 25 by 30 pixels
- Goal is to produce images with stars that are circular as opposed to oblong
- The more accurate StarTrack becomes, the less distortion we will see in our final image
- During a 5 minute exposure, the apparent motion of the stars is 1.25˚
  - For 99% accuracy we will need to have tracking capabilities within 0.75 arc minutes (0.0125 ˚)

Concerns from PDR: Wi-Fi vs. Bluetooth

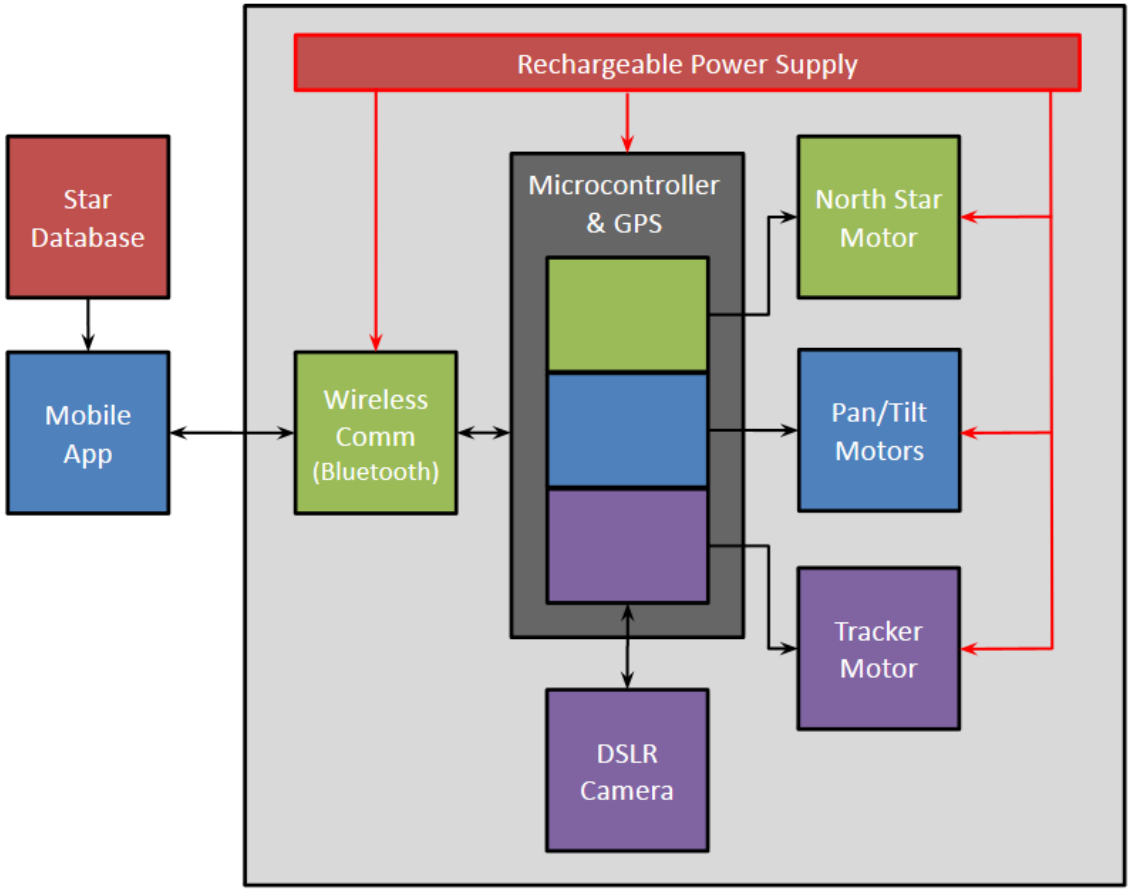
Wireless Networking in Rural Areas:

- Unreliable
- Added cost of interfacing with mobile networks

Bluetooth Low Energy:

- Has comparable range to Wireless
- Lower power consumption over time

Block Diagram



StarTrack Camera Mount

Subsystem Owners:

- Red- Charles
- Blue- Chris
- Green- Daniel
- Purple- Rebecca

General Requirements (Updated)

Wireless Control

- The mount and camera must be wirelessly controlled through a mobile application from up to 100 meters away

Mount Control

- The mount must be programmable to take a succession of at least 5 exposures of 5 minutes each at each target
- The mount must continuously operate for at least 8 hours and must also be rechargeable
- The mount must support a camera and lens of up to 2 pounds

Motor Automation

- Once placed facing North, the North Star motor must be able to align the mount with the North Star. During operation, the mount must not deviate from alignment by more than 0.75 arc minutes
- Using inputs from the Star Database, the Pan/Tilt motors must be able to position the camera so that the specified object is in its FOV
- The Tracker motor must provide accurate tracking. For each 5 minute exposure, the mount must be within 0.75 arc minutes of its ideal position

MDR Deliverables

Rebecca Baturin:

- Determine accurate tracking algorithm and program microcontroller
- Build camera interface and demonstrate control of camera settings

Chris Boyle:

- Build iOS application that can send coordinates and camera settings over Bluetooth
- Program Pan/Tilt mount to point at a specific coordinate in the sky

Charles Urbanowski:

- Build power supply to appropriately operate all components of StarTrack
- Build a compiled database of 15 noteworthy constellations

Daniel Willmott:

- Send and receive data from the microcontroller via Bluetooth
- Receive GPS data on the microcontroller
- Be able to move North Star motor via microcontroller

Star Database (Charlie)

Deliverable :

- Build a compiled database of 15 noteworthy constellations

Accomplished:

- Modular database of 15 constellations has been built to allow for rapid access and future additions
- Each object includes their name (and possible nickname) and their ICRS coordinates, including right ascension points and declination coordinates

Mobile Application (Chris)

Deliverable :

- Build iOS application that can send coordinates and camera settings over Bluetooth

Accomplished:

- Built iOS app that can connect to a Bluetooth peripheral and send the parameters and a message to start tracking
- Built OS X app to act as the peripheral for testing and demonstration

Wireless Communication System (Dan)

Deliverable :

- Send and receive data from the microcontroller via Bluetooth

Accomplished:

- Able to enter configuration mode on Bluetooth module via an Android phone
- Able to send data to the microcontroller to turn on and off an LED
- Able to receive data from the microcontroller confirming the action

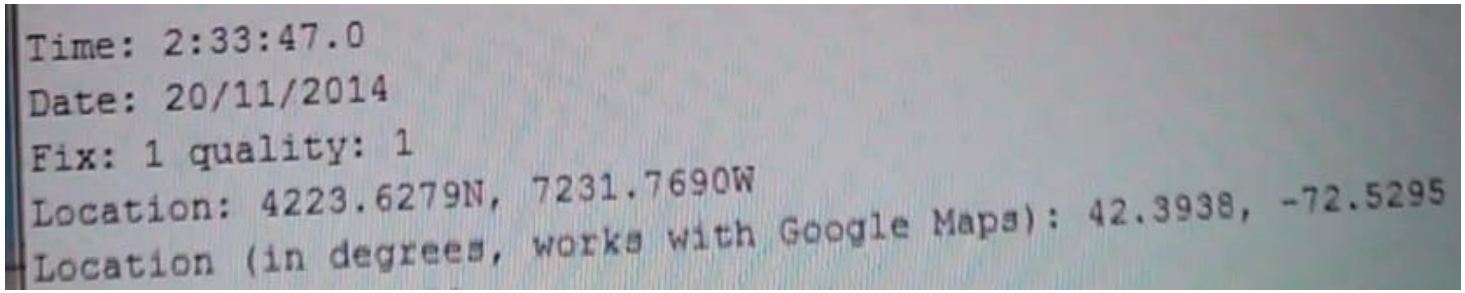
North Star Motor and Control System (Dan)

Deliverable :

- Receive GPS data on the microcontroller
- Be able to move North Star motor via microcontroller

Accomplished:

- Able to receive and parse GPS data on microcontroller



- Google Maps Confirmation Link

North Star Motor and Control System (Dan)

Deliverable :

- Receive GPS data on the microcontroller
- Be able to move North Star motor via microcontroller

Accomplished:

- Able to send real time serial data to a stepper motor and control the number of revolutions

Tracker Motor and Control System (Rebecca)

Deliverable :

- Determine accurate tracking algorithm and program microcontroller

Accomplished:

- Able to change stepper motor speed for set time intervals
- Tracking algorithm has been determined, and will be tested once the physical mount has been built

Pan/Tilt Motor and Control System (Chris)

Deliverable :

- Program Pan/Tilt mount to point at a specific coordinate in the sky

Accomplished:

- Able to move pan/tilt mount to desired points in a spherical coordinate system

DSLR Camera Interface and Control (Rebecca)

Deliverable:

- Build camera interface and demonstrate control of camera settings

Accomplished:

- Control of camera shutter is provided by the microcontroller at a user specified interval
- All other camera settings are static and are initialized by the user while setting up the mount

Rechargeable Power Supply (Charlie)

Deliverable:

- Build power supply to appropriately operate all components of StarTrack

Accomplished:

- Power supply is built and outputting near-ideal voltages
- Portable components have been researched for future testing

CDR Deliverables

Demonstration of Entire System

- iOS app initializes StarTrack mount
  - iOS app sends command to microcontroller to align mount
  - Microcontroller gathers GPS Data and uses North Star Motor to align StarTrack mount with the North Star
- User specifies desired sky target via iOS app
  - Star coordinates are sent to the microcontroller via the iOS app
  - Pan/Tilt mount moves camera to desired coordinates
- User specifies desired operation parameters
  - iOS app sends command to microcontroller to begin tracking
  - DSLR receives shutter commands from the microcontroller to take images at specified intervals (using pre-set exposure lengths)
- Tracker returns to ready state, and continues with the script
  - Tracker motor returns StarTrack mount to a closed position
  - iOS app notifies user that StarTrack is ready to image another target
- Once script is completed, the North Star Motor returns to a closed position

Gantt Chart

Activity	October	November	December	January	February	March
Design and Build North Star Subsystem						
Design and Build Comm Subsystem						
Design and Build Tracker Subsystem						
Design and Build DSLR Subsystem						
Design and Build Pan/Tilt Subsystem						
Design and Build iOS App						
Design and Build Power Supply						
Design and Build Star Database						
Subsystems Complete (MDR)						
Build Physical Mount						
Functional Manual Mount						
Integrate North Star Subsystem w/ Mount						
Integrate Tracker Subsystem w/ Mount						
Integrate Pan/Tilt Subsystem w/ Mount						
Integrate Power Supply w/ Mount						
Integrate DSLR Subsystem w/ Mount						
Functional Wired Mount						
Integrate Comm Subsystem						
Integrate iOS App						
Functional Wireless Mount						
Integrate Star Database						
Complete Autonomous Mount (CDR)						

Subsystem Owners:

- Red- Charles
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- Green- Daniel
- Purple- Rebecca

Demos