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MyPear AstroImageJ Plugin

By: Tyler Nourai, Dylan Tivnan, & Evan Williams

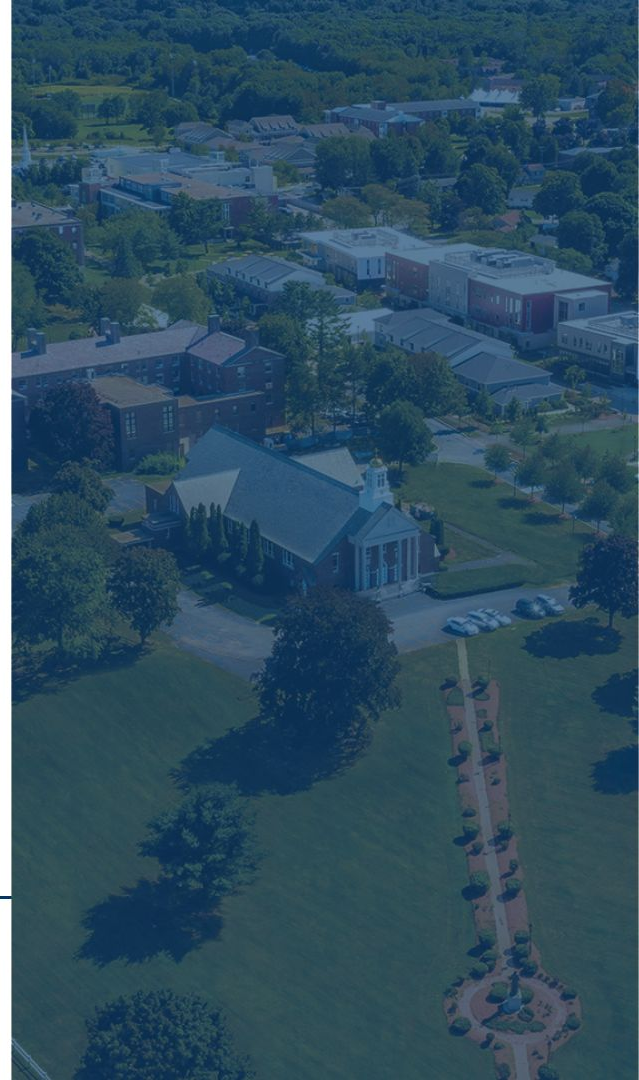
Objectives

- Introducing MyPear Team
- Introducing the Client
- Team Qualifications
- Project Proposal
- Background on AstrolImageJ and contour lines
- Other Available Solutions
- Project Management

Continued on next slide



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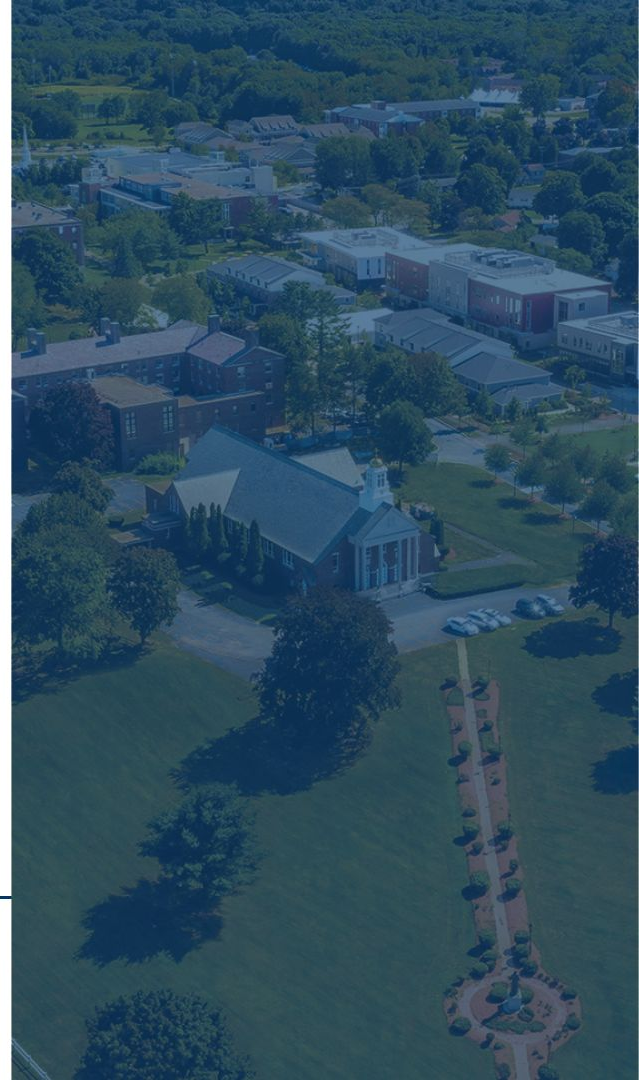


Objectives (Continued)

- Design Choices
- Algorithm Implementation
- Design Diagram
- Initial and Technical Challenges
- Live Demo
- Download the plugin
- Future Work
- Conclusion
- Questions



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Introducing MyPear Team

MyPear is a group of senior computer science students participating in the Computer Science Capstone course with **Professor Stueztle**.

The team consists of:

- Tyler Nourai - Team Manager, Spokesman, Developer
- Dylan Tivnan - Developer
- Evan Williams - Developer



Introducing the Client

- The software client for MyPear Project is **Professor Christopher Duston**.
- Prof. Duston is a faculty member in the Physics department at Merrimack College.
- Member of the Merrimack College Astronomical Research Group (MCARG).
- The proposed plugin is of an immediate need to the research group.



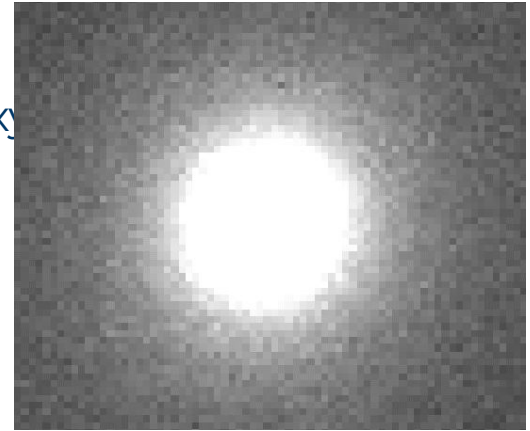
Team Qualifications

- 3 ½ years of software development experience as Merrimack College Computer Science students.
- Experience with java programming.
- Experience with bitbucket and source code control.
- Experience working in teams, in CS courses such as Computer Graphics, Network Security, and Web Development.



Project Proposal

- Our Client and the MCARG have been taking pictures of the active galaxy M87.
- They want to measure how the shape of the galaxy has changed over time.
- The proposed project will help making the measurements of the objects.



Project Proposal (Continued)

- The proposal was to develop an add-on plugin for an existing software called AstrolImageJ.
- The plugin would be called Contour Lines and Area Measurement.
 - It would add contour lines to a selected star.
 - Then, it measures the area of each contour region.
 - And displays the resulting data.
 - User can save the data.



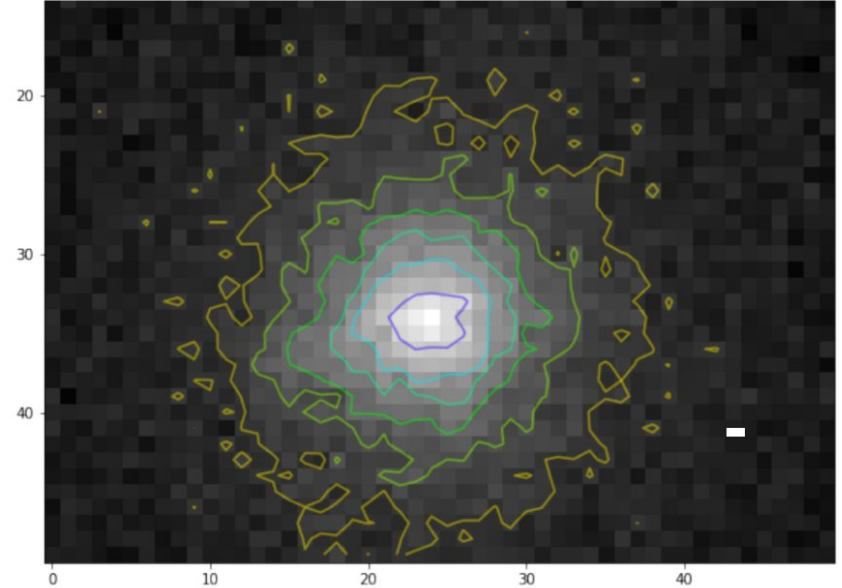
Background on AstrolmageJ

- AstrolmageJ, is built with ImageJ as its framework.
- ImageJ is an image processor application.
- It is a research-grade image analysis software.
- Built utilizing the Java programming language with GUI interface.
- It is a primary tool used by our client and MCARG.



Background on Contour Lines

- An outline, one representing or bounding the shape or form, of equal heights, in our project, pixels.
- In our clients case, contour lines and areas of its region would show a change in shape.



Other Solutions Available

- There is a plugin called Contour Plotter.
- And another plugin called Contour Lines.
- Both have stability issues, such as crashing.
- Neither had functionality to calculate areas of the region.



Project Management

- We used Bitbucket for managing, tracking changes in source code, and documenting the project as a whole.
- Including utilizing its task tracker.

ntlyer22 / myPear / issues — Bitbucket

bitbucket.org/ntlyer22/mypear/issues

Tyler Nourai / SeniorCapstone / myPear

Issues

Filter by: **All** Open My issues Watching

Advanced search

Create issue Export

Issues (1–25 of 91)

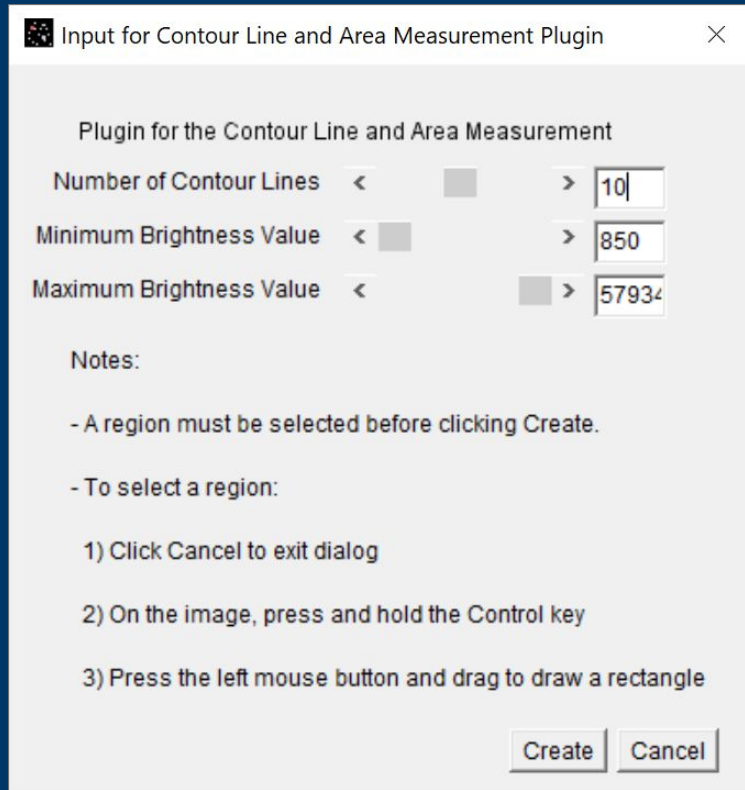
Title	T	P	Status	Votes	Assignee	Created	Updated
#88: Create .jar file for Plugin Release	✓	✗	RESOLVED	10	Tyler Nourai	2021-12-06	4 hours ago
#97: User Manual: Update How To Install for .jar	✓	✓	RESOLVED	10	Tyler Nourai	5 hours ago	5 hours ago
#47: Add gnu Licensing to plugin and files	✓	↑	RESOLVED	10	Tyler Nourai	2021-10-07	yesterday
#36: Add image restoring functionality to the Contour lines and area measurement's "do you want to save" window	✓	✓	RESOLVED	10	Evan Williams	2021-10-05	yesterday
#44: Test Case #CONT02: The user must be able to define the minimum and maximum brightness value for the contours.	✓	✓	RESOLVED	10	Evan Williams	2021-10-05	yesterday
#45: Test Case #CONT03: The spacing in-between contour lines must be linear.	✓	✓	RESOLVED	10	Evan Williams	2021-10-05	yesterday
#83: Minimum brightness input	✗	↑	RESOLVED	10	Evan Williams	2021-12-02	yesterday
#89: Create and plan presentation. (Slides + Guide)	✓	✗	NEW	10	Tyler Nourai	2021-12-06	yesterday
#95: Technical Specifications Document: Common Issues for Future Developers	✓	↑	RESOLVED	10	Tyler Nourai	3 days ago	yesterday
#96: Email Client: Meeting Request To Deliver Plugin Product	✓	↓	RESOLVED	10	Tyler Nourai	2 days ago	2 days ago
#43: Test Case #CONT01: The user must be able to select how many contour lines will be present in the measurement.	✓	✓	RESOLVED	10	Dylan Tivnan	2021-10-05	2 days ago
#92: Test Case #02: Plugin compiles and runs on mac	✓	✓	RESOLVED	10	Dylan Tivnan	3 days ago	2 days ago
#42: Test Case #01: Plugin compiles and runs	✓	✓	RESOLVED	10	Dylan Tivnan	2021-10-05	2 days ago



Design Choices

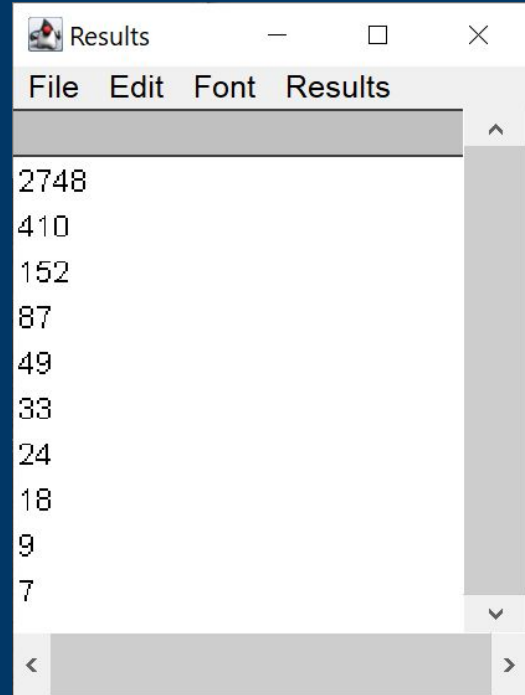
We designed our plugin software to seamlessly incorporate into AstroImageJ.

It consists of several GUI components for customization of settings to enhance the algorithm.



Design Choices (Continued)

- An additional feature that the client asked during our development, was to display the area data.
- Hence, we implemented the results functionality.

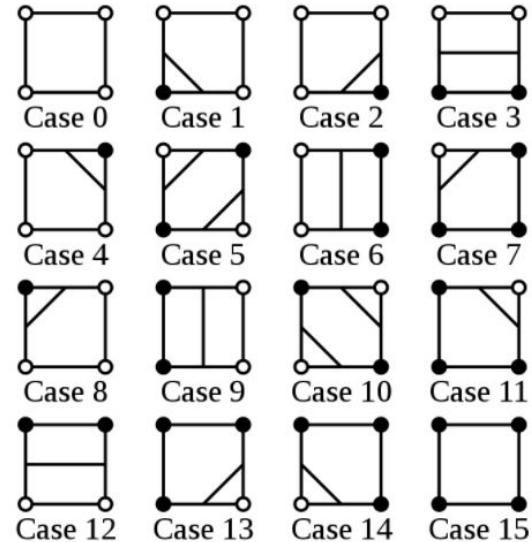


Algorithm Implemented

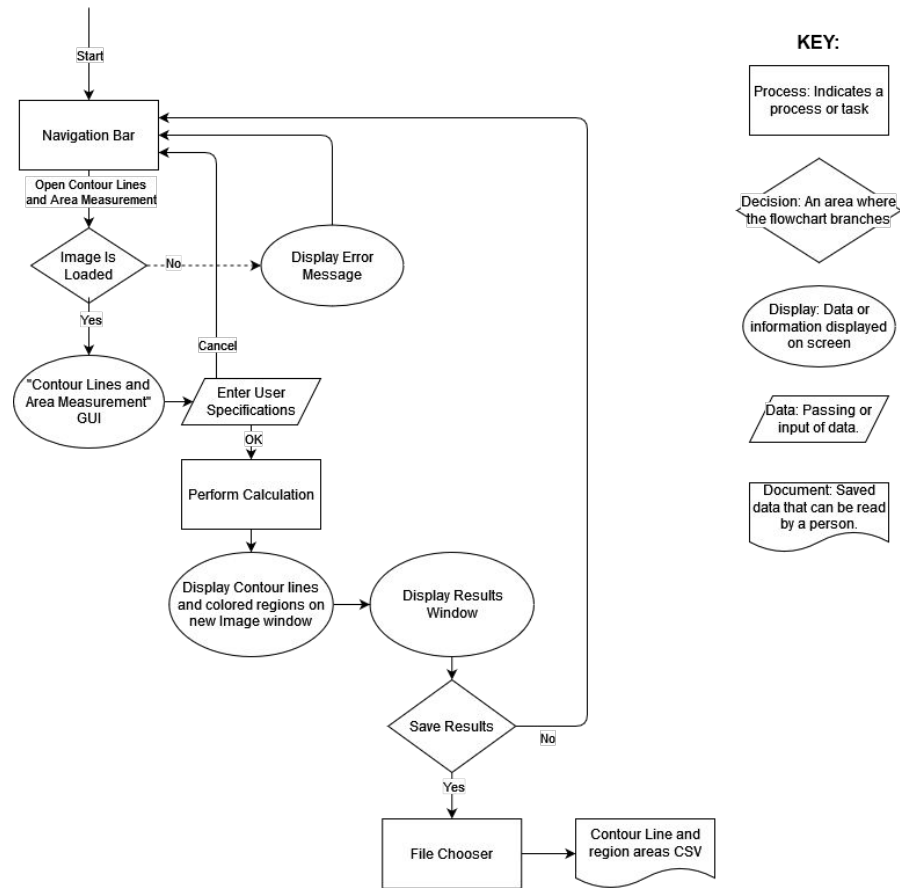
Marching squares algorithm was implemented to draw the contour lines on the image.

Divider: 200

100	200	100
200	300	200
100	200	100

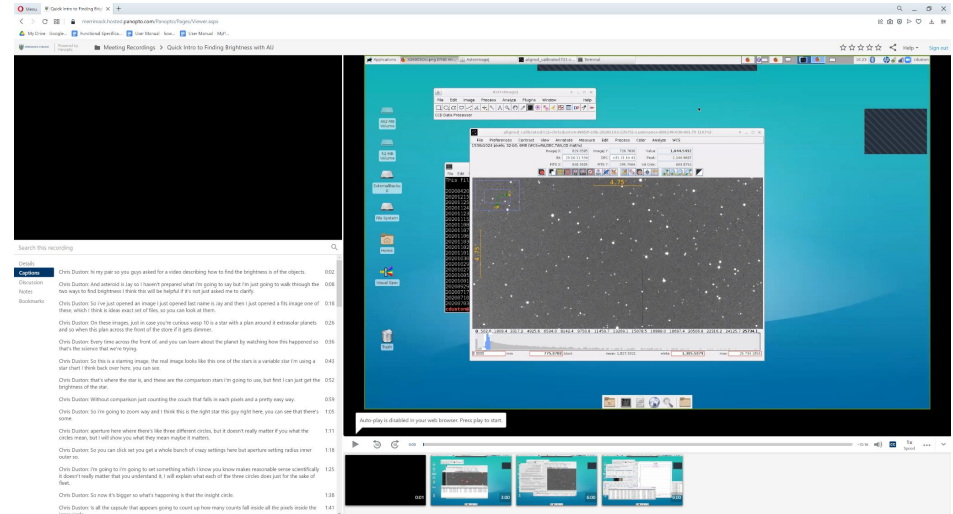


Design Diagram



Initial Challenges

- AstrolmageJ software and astronomy was new to us.
- We did not know how the tool was used for the astronomy research.
- We had no sample images.
- Client helped out by providing video and test images.



Technical Challenges

- AstrolImageJ, is built off an older version of ImageJ.
- AstrolImageJ and ImageJ uses various versions of Java 1.2 - Java 7.
- Current version of Java is 17.
- We developed our plugin using Java 7.

Version	Release date
JDK Beta	1995
JDK 1.0	January 1996
JDK 1.1	February 1997
J2SE 1.2	December 1998
J2SE 1.3	May 2000
J2SE 1.4	February 2002
J2SE 5.0	September 2004
Java SE 6	December 2006
Java SE 7	July 2011
⋮	
Java SE 17 (LTS)	September 2021



Technical Challenges

How we identified challenges of compiling errors:

```
Astronomy_Tool.class X
 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
00000000 CA FE BA BE 00 00 00 32 00 73 0A 00 17 00 3F 09
00000010 00 16 00 40 08 00 41 0A 00 42 00 43 0A 00 44 00
00000020 45 0A 00 44 00 46 0A 00 44 00 47 0A 00 44 00 48
```

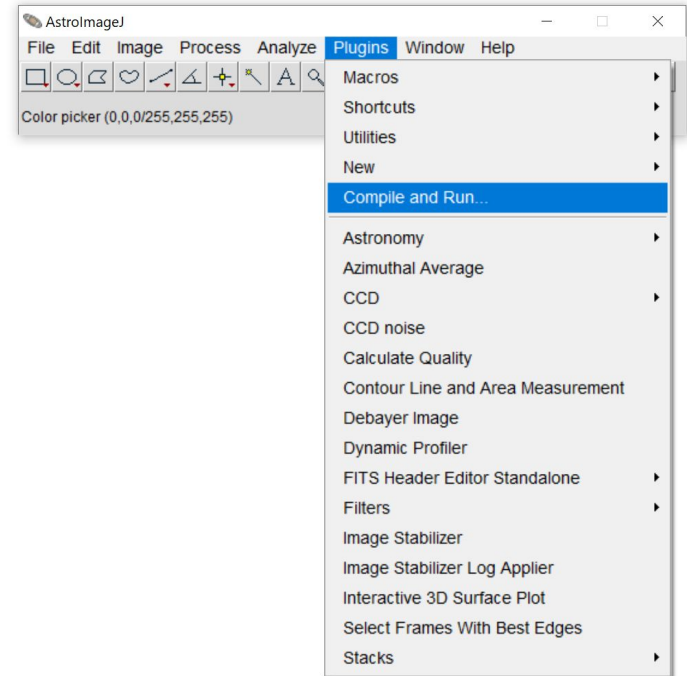
```
CCD_noise.class X
 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
00000000 CA FE BA BE 00 00 00 2E 00 DB 0A 00 4C 00 58 0A
00000010 00 59 00 5A 08 00 5B 0A 00 5C 00 5D 07 00 5E 0A
```

- Java SE 17 = 61 (0x3D hex)
- ⋮
- Java SE 8 = 52 (0x34 hex)
- Java SE 7 = 51 (0x33 hex)
- Java SE 6.0 = 50 (0x32 hex)
- Java SE 5.0 = 49 (0x31 hex)
- JDK 1.4 = 48 (0x30 hex)
- JDK 1.3 = 47 (0x2F hex)
- JDK 1.2 = 46 (0x2E hex)
- JDK 1.1 = 45 (0x2D hex)



Technical Challenges

- The ImageJ built-in “Compile and Run” uses Java 1.2, and due to changes in Oracle’s licensing, it has not been updated.
- Since some AstroImageJ later components used Java 7, we decided to use that as well.
- As a result, the new plugin needed to be compiled outside of the AstroImageJ.
- This required JDK development environment to be setup with Java 7.



Technical Challenges

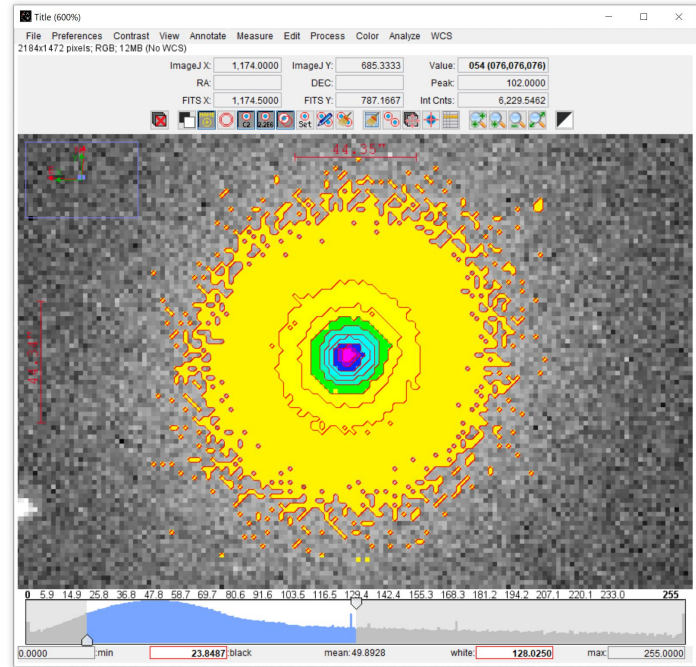
- We had to learn the existing libraries and capabilities of AstroImageJ.
- We built this into our development schedule.

Name	Date modified	Type	Size
gui	3/15/2021 2:50 AM	File folder	
io	3/15/2021 2:50 AM	File folder	
macro	3/15/2021 2:50 AM	File folder	
measure	3/15/2021 2:50 AM	File folder	
plugin	3/15/2021 2:50 AM	File folder	
process	3/15/2021 2:50 AM	File folder	
text	3/15/2021 2:50 AM	File folder	
util	3/15/2021 2:50 AM	File folder	
CommandListener.class	3/15/2021 2:50 AM	CLASS File	1 KB
CommandListener.java	3/15/2021 2:50 AM	Java Source File	1 KB
CompositelImage.class	3/15/2021 2:50 AM	CLASS File	17 KB
CompositelImage.java	3/15/2021 2:50 AM	Java Source File	18 KB
Executer.class	3/15/2021 2:50 AM	CLASS File	7 KB
Executer.java	3/15/2021 2:50 AM	Java Source File	6 KB
IJ\$ExceptionHandler.class	3/15/2021 2:50 AM	CLASS File	1 KB
IJ.class	3/15/2021 2:50 AM	CLASS File	51 KB
IJ.java	3/15/2021 2:50 AM	Java Source File	69 KB
IJEventListener.class	3/15/2021 2:50 AM	CLASS File	1 KB
IJEventListener.java	3/15/2021 2:50 AM	Java Source File	1 KB
ImageJ.class	3/15/2021 2:50 AM	CLASS File	25 KB
ImageJ.java	3/15/2021 2:50 AM	Java Source File	26 KB
ImageJApplet.class	3/15/2021 2:50 AM	CLASS File	2 KB
ImageJApplet.java	3/15/2021 2:50 AM	Java Source File	2 KB
ImageJListener.class	3/15/2021 2:50 AM	CLASS File	1 KB



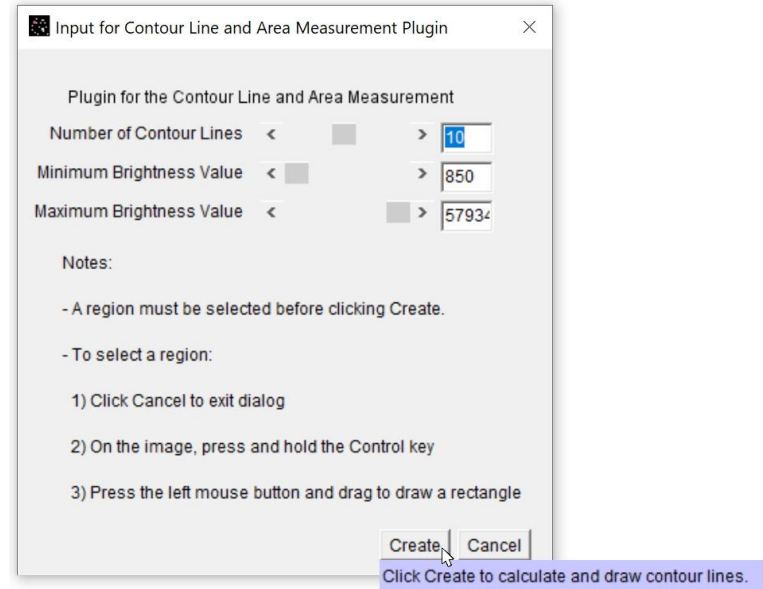
Technical Challenges

- The FITS images that we used were in greyscale, thus did not support color.
- We open a separate window with a new image that does support color.



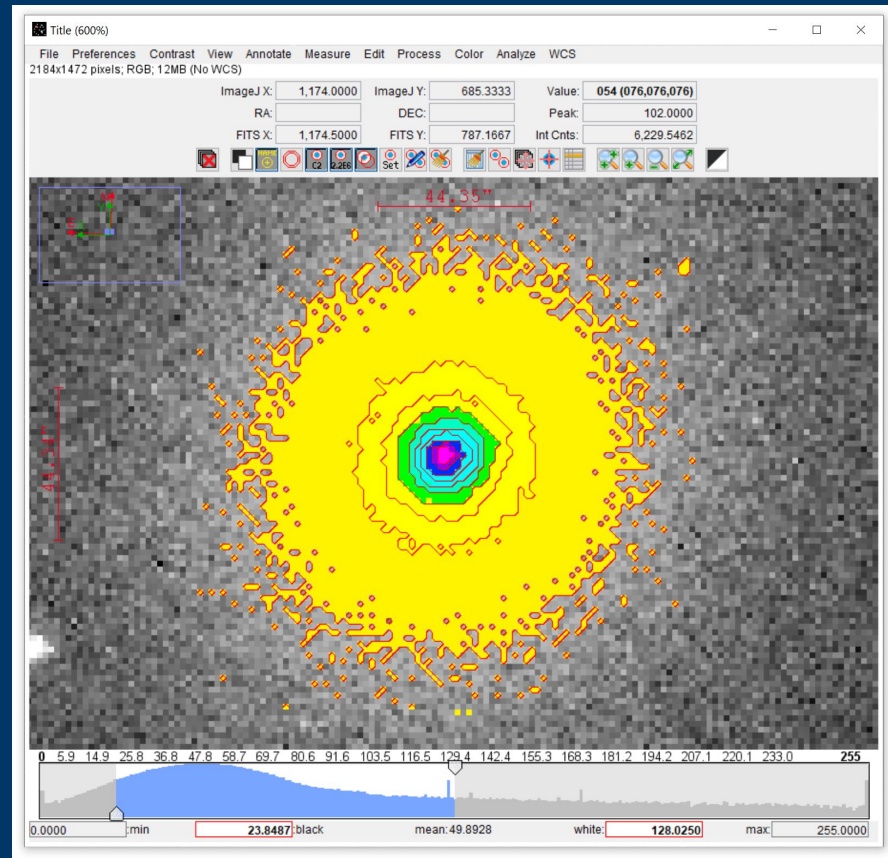
Technical Challenges

- Tooltips, is not supported for AWT.
- Researched how Tooltips can be added.
- We implemented the Tooltips functionality using an external example.




Plug-in in Action

- This image is an example of a star with our plugin running to calculate and create contour lines.



Live Demo

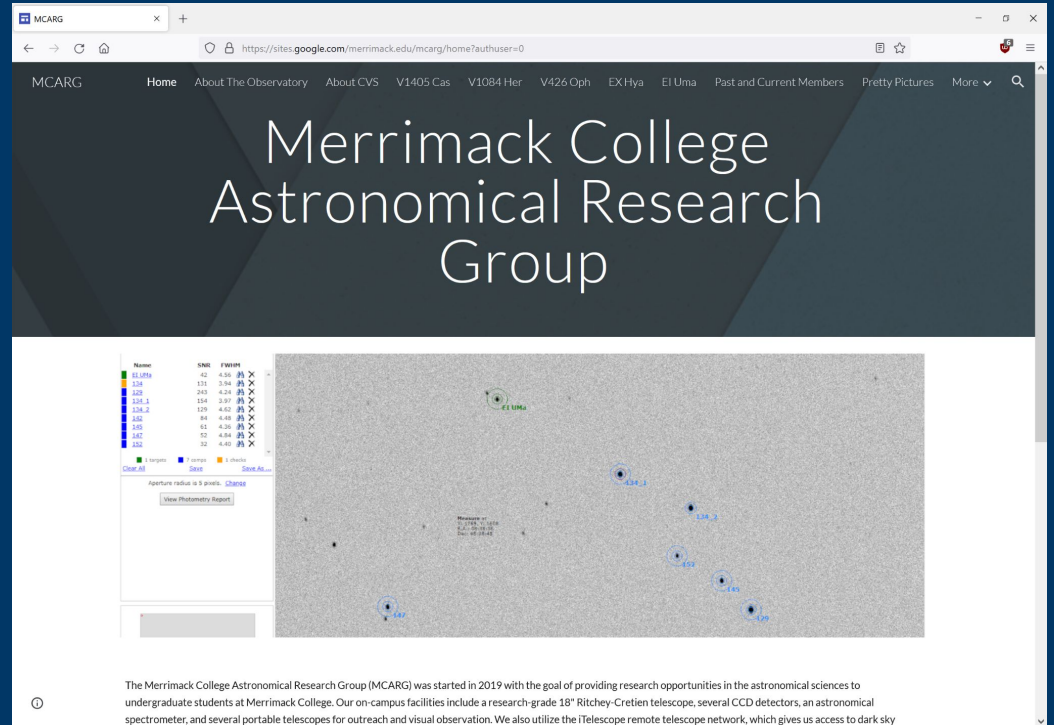
Inputs:

- Image:  calibrated-T05-noahkravette-M87-20200717-214947-I-BIN1-W-300-001.fit
- Number of Contour Lines: **10**
- Minimum Brightness Value: **850 (Default)**
- Maximum Brightness Value: **3651**



Download the plugin

- GNU Licensing
- Publicly available via download as a .jar file.
- Professor Dustons Github
- Merrimack College Astronomical Research Groups Site.



The screenshot shows the MCARG website interface. At the top, there is a navigation menu with links: Home, About The Observatory, About CVS, V1405 Cas, V1084 Her, V426 Oph, EX Hya, El Uma, Past and Current Members, Pretty Pictures, and More. The main heading reads 'Merrimack College Astronomical Research Group'. Below this, there is a table of objects and a large astronomical image.

Name	SNR	FWHM
ELUMA	42	4.96
1318	111	2.94
225	243	4.24
225.2	124	2.97
225.2.1	129	4.63
225	94	4.89
225	81	4.98
242	12	4.84
242	52	4.69

The astronomical image shows several stars with labels: ELUMA, 1318, 225, 225.2, 225.2.1, 225, 242, and 242. A 'View Photometry Report' button is visible below the table.

The Merrimack College Astronomical Research Group (MCARG) was started in 2019 with the goal of providing research opportunities in the astronomical sciences to undergraduate students at Merrimack College. Our on-campus facilities include a research-grade 18" Ritchey-Cretien telescope, several CCD detectors, an astronomical spectrometer, and several portable telescopes for outreach and visual observation. We also utilize the Telescope remote telescope network, which gives us access to dark sky



Future Work

- The contour lines are jagged and we would like to add a feature to smooth the contour lines.



Conclusion

- We overcame the challenges in this project.
- We learned how researchers work with astronomy software tools.
- We learned how to develop software with an existing software platform.



Conclusion (Continued)

- We learned the developmental process.
- We satisfied the project proposal specifications.
- We developed a functioning plugin that did not exist.
- We delivered the software to our client.



Thank You

- We would like to thank Professor Stueztle for his guidance, direction, and feedback.
- We would like to thank our client Professor Duston for the collaborative effort with MyPear.





Questions?



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