NEOSSAT

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JOINT MISSION FOR SPACE SITUATIONAL AWARENESS & SPACE ASTRONOMY

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ABSTRACT

AT THE CSA, I'VE HAD THE OPPORTUNITY TO CONTRIBUTE TO PROJECTS FOR THE NEAR EARTH OBJECT SURVEILLANCE SATELLITE (NEOSSAT) MISSION. DURING MY WORK TERM, I'VE FOCUSED ON TWO MAIN PROJECTS:

1. PRODUCTION OF CODE FOR EPHEMERIS DATA PROCESSING AND DATA EXCHANGE WITH THE NEW CSA OPEN DATA SERVER.
2. IMPLEMENTATION OF AN AUTOMATED PROCESS FOR TRANSFORMING NEOSSAT'S IMAGE DATA INTO ANIMATIONS.

OBJECTIVE

- UNDERSTANDING THE SCIENTIFIC (I.E. ASTRONOMY AND PHYSICS) ASPECT OF THE TECHNICAL TASKS APPOINTED.
- APPLYING SKILLS OBTAINED FROM EDUCATIONAL AND WORK EXPERIENCE TO ADVANCE NEOSSAT PROJECTS.

1. EPHEMERIS DATA PROCESSING

1.1 INTRODUCTION

PREVENTING SATELLITE COLLISIONS IS A VITAL PART OF SPACE SITUATIONAL AWARENESS. EPHEMERIS FILES PROVIDE CELESTIAL COORDINATES OF NEOSSAT AT SPECIFIC TIMES. THE PREDICTED EPHEMERIS FILES CONTAINING THE EXPECTED LOCATIONS OF THE SATELLITE IN THE NEAR FUTURE, SHOULD BE UPLOADED TO A TRACKING SYSTEM CALLED SPACE-TRACK THAT WILL DETECT THE ORBITS FOR MAN-MADE SATELLITES NEAR EARTH. SPACE-TRACK REQUIRES THE EPHEMERIS FILES TO BE IN ORBIT EPHEMERIS MESSAGE (OEM) FORMAT AND THE GENERATED NEOSSAT EPHEMERIDES ARE ORIGINALLY IN SYSTEMS TOOL KIT (STK) FORMAT. THE PROGRAM I'VE WRITTEN FOR THIS PROJECT HANDLES THE CONVERSION OF EPHEMERIS FILES FROM STK TO OEM FORMAT, ALONGSIDE FILE DATA EXCHANGE WITH CSA'S NEW OPEN DATA SERVER.

1.2 METHOD

- SCRIPTING A PERL PROGRAM TO READ IN DATA FROM STK FORMATTED EPHEMERIS FILES AND REWRITING INTO OEM FORMAT.
- PYTHON SCRIPTS FOR UPLOADING AND DOWNLOADING EPHEMERIS FILES .
- WRITING AND SCHEDULING BATCH FILES TO EXECUTE THE PROCESS FROM START TO END.
- PREPARING DOCUMENTATION FOR REVIEW AND DEPLOYMENT ON OPERATIONAL SYSTEMS.

1.3 RESULTS

THE SCRIPTS HAVE BEEN GENERALIZED TO WORK FOR NEOSSAT AND OTHER MISSIONS (E.G. SCISAT). THE FULL PIPELINE WORKS IN AUTOMATION BY RETRIEVING EPHEMERIS FILES FROM THE OPEN DATA SERVER, PERFORMING FORMAT CONVERSIONS AND UPLOADING THE NEW EPHEMERIS FILES TO SPACE-TRACK AND THE OPEN DATA PORTAL.

2. FITS IMAGE PROCESSING

2.1 INTRODUCTION

ANOTHER PURPOSE OF NEOSSAT IS TO CATALOG NEAR-EARTH ASTEROIDS AND COMETS, AND EXOPLANETS TO ADVANCE CANADIAN ASTRONOMY. THE SATELLITE IS SCHEDULED TO PURSUE SPACE OBJECTS AND CAPTURE IMAGE DATA IN FLEXIBLE IMAGE TRANSPORT SYSTEM (FITS) FORMAT. THE EXISTING IMAGE PROCESSING PROJECT PRODUCES RAW IMAGE FILES, THEN SORTS AND CLEANS THE DATA TO EXTRACT MORE INFORMATION. MY CONTRIBUTION TO THIS PROGRAM IS TO GENERATE CLEAN, FALSE-COLORED IMAGES AND ANIMATED GIFS WHICH SHOW THE PROGRESSION OF MOVING TARGETS, ALL IN AN AUTOMATED PROCEDURE.

2.2 METHOD

- SORTING TARGETS USING DBSCAN CLUSTERING ALGORITHM.
- IMAGES WITH THE SAME RIGHT-ASCENSION (RA) AND DECLINATION (DEC) COORDINATES ARE:
  - ALIGNED TO AVOID ASYMMETRY CAUSED BY INACCURACIES.
  - STACKED TOGETHER TO REDUCE NOISE IN THE DATA.
  - ANIMATED AS GIF FILES.
- IMAGES WITHIN CLOSE RA AND DEC RANGE ARE STITCHED TOGETHER TO PRODUCE A MOSAIC-LIKE ANIMATION.

2.3 RESULTS

THE FINAL OUTPUTS ARE ANIMATION FILES FOR THE TARGET AT THE SAME CELESTIAL POSITION (FIGURE 1) AND THE FULL MOSAIC DEPICTING THE MOVEMENT OF THE TARGET ACROSS A SMALL SECTION OF SPACE (PRODUCTION OF THESE MONTAGES ARE IN DEVELOPMENT).

CLICK ON IMAGE TO SEE ANIMATION!

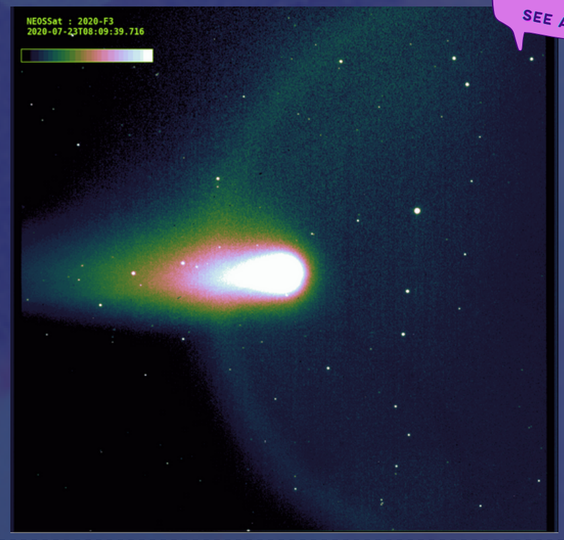

FIGURE 1. STILL OF ANIMATED GIF FOR "COMET NEOWISE." TAKE A LOOK AT THE FULL ANIMATION ON CSA'S NEOSSAT WEBPAGE.

CONCLUSION

THESE NEOSSAT PROJECTS WILL TAKE MEASURES TO PREVENT SPACE OBJECT COLLISIONS AND PROVIDE USERS ACCESS TO CSA'S OPEN DATA PORTAL AND VISUALIZATIONS OF COMET/ASTEROID DATA. I AM GLAD TO HAVE THE OPPORTUNITY TO WORK ON MISSIONS THAT WILL ADVANCE CANADA'S SPACE SECTOR.

MOVING FORWARD

- I WILL BE RETURNING TO UNIVERSITY TO COMPLETE THE LAST TERM OF MY BACHELOR'S DEGREES.
- I WILL CONTINUE TO WORK PART-TIME AT THE CSA.
- ONE OF MY TASKS WILL BE TO REFINE THE MOSAIC-LIKE ANIMATIONS AND COMPLETE THE AUTOMATED IMAGE PROCESSING PROGRAM.