A Response for

“Call for White Papers: Soliciting Community Input for Alternate Science Investigations for the Kepler Spacecraft” from NASA

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In a response for NASA call for white papers I decided to share this proposal solution for Kepler's Mission.

The problem as described in the call sheet can be broken into two main topics :

1- **Astrophysical Problem (or actually mechanical problem) that involves about the two gyroscopes 2 and 4 that had been malfunctioned, and my solution isn't talking much about it.**
2- **Software and Measurements problem , my solution is involving about this topic.**

As written in the call sheet , due the problem in the gyroscopes , the spacecraft became unstable , and it changes its position automatically upon the wrong numbers that comes from the gyroscopes , so , the images that the Earth station receives isn't precise and contains problems like brighter stars or wrong star positions.

So, I suggest this solution, and I hope it helps you to complete Kepler's mission:
Now , we know some approximate measurements for the spacecraft drifting , also I'm sure that the mission's team knows the old precise measurements , and also the team has the old good images from Kepler, so , we can gather all of that in a helping earth-station applications that recalculates the right measurements, which contains these parts :

1- A Kepler simulator :
the work of this simulator is to take the current position of Kepler in the orbit and converts it to the right measurements of the gyroscopes with a help from the two running gyroscopes.
2- Get the error percentage in the Kepler's images :
This can be done by comparing an old image from Kepler and a new image for the same place , this will help to calculate the exact drifting and the wrong pixels in the Field of View.
3- Developing a subsystem or filtering layer for the current earth-station system which takes the measurements from the last two parts and apply them to the image which coming from Kepler.

- **How to Apply the Solution :**
Kepler is very sensitive , Kepler as we know is using the star vibration due the gravity of planets to find planets in the habitable zone , so that , the solution must applied in a way that keeps the accuracy of Kepler.

***The simulator :**
As said above , the simulator must simulate the actual measurements of Kepler.
The 4 gyroscopes of course have a trigonometric relation , that relation can be used to calculate the actual measurements of each gyroscope , but to

be honest , I couldn't figure out such relation , but I am sure it is there , and also, we can use the old good numbers from Kepler to find that relation. After finding it , the simulator must take the numbers from the two running gyroscopes and apply them to the calculation function that extract the measurement of the remaining two.

***Getting the error percentage in the image:**
Let's take a look at Fig1 and Fig2:

Fig1 : An Edited image for Kepler's Field of View , source : NASA 'cutout_kplr201309811 5308_ffi-cal.fits[42]_sci'

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Fig2 : An Edited image (by adding a star) for Kepler's Field of View , source : NASA 'cutout_kplr201309811 5308_ffi-cal.fits[42]_sci'

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Those two images are the same , but in the second image I've drawn a medium star in the top left, and using a drawing application (Paint.Net) I've opened the first image and pasted the second image above it as a new layer , after that I changed the new layer's mode to 'difference' , I got Fig3:

Fig3 : The difference between Fig1 and Fig2

Then from that image we can get the error percentage in images , and then try to remove the errors in new images.

***The Filter:**

From the last two parts, it became easy to build the filter, but we still have a problem in Kepler's drifting, the filter should take the numbers and the error percentage from the last two parts and apply them to

the final image , but we must care about: The wrong part of the image , even that Kepler is taking one image in multiple shots.

Say that we took two images for a cloud like in Fig4:

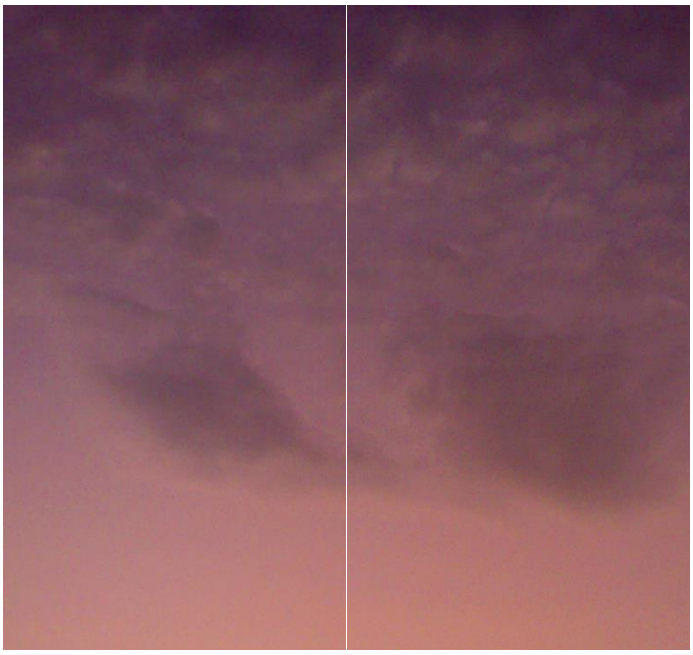

Fig4 : Two images for a cloud.

You can see that they are good , but there is a very small part from the image is repeated , this can give wrong images if we are working on a mission like Kepler, so using Paint.Net as described before , I could figure out which part is repeated , Fig5:

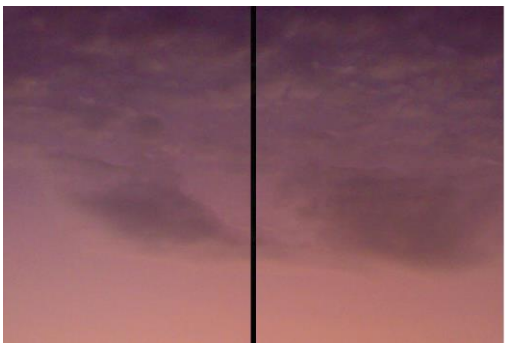

Fig5 : The repeated part from the two images is the black line.

Then, we can drop the repeated part from an image and leave it in the another image then join them to get the right image.

But now, if the two images are missing a part from the sky due the spacecraft drifting, it is a very possible problem, but there is a proposal answer for it : we can check the position of the spacecraft , and see if it moved from its position more than the width of the previous image, if that, we have lost a part from the sky.

Let's say that the X,Y of Kepler was 0,0 and took an image with width 800, so for the next image Kepler must be position 800,0 if the position is greater than that , so, we have lost a part and we should take the image again, and if it was less , so we should correct it as the previous part, or using these coordinates to fix the error.

I hope this solution helps NASA to get Kepler back to work.

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