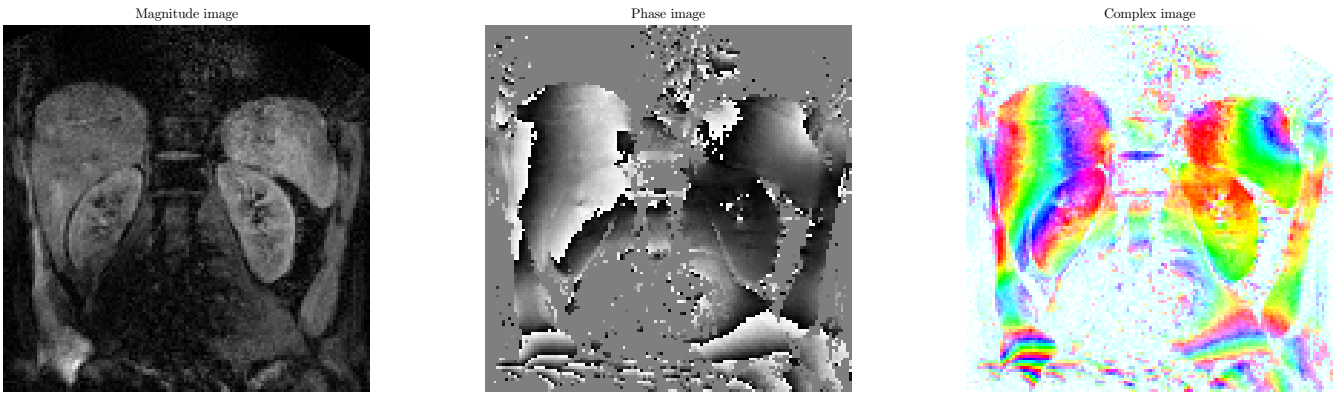
ECE 188 – Project

First of all, clone the following `git` repository:

```
git clone https://bitbucket.org/charles_deledalle/ucsd-ece188-project.git
```

and run the Matlab script called `displaydata.m`. Check that you get something like:



The variable data contains information that you will have to analyze, understand and eventually improve.

Subject

The purpose of this project is to apply what you have seen in class to a realistic scenario of image restoration. Pretend these data have been given to you by a medical practitioner, and the only information that she/he gave you is that it is MRI (Magnetic Resonance Imaging) data. The practitioner asks you this simple question: "How well can you improve the quality of my images?". You have one month to answer this question in a 5 to 7 page report (including at least 3 figures/graphs/images) together with the code. The deadline is 03/21/2017.

Note that you are free to define your own objectives. You may want to consider only restoring one frame of the video, restoring the full video, estimating a single image that summarizes the full video content, etc. You can focus on denoising only, super-resolution, and/or removing some artifacts of your choice. You can use all of the data, only a single frame, only the magnitude, etc. But try to make relevant choices, your final goal is to convince the practitioner to buy your product.

The report should contain six sections:

1. **Objectives (about a 1/2 page):** Describe what your objectives are. What are you trying to reconstruct? and what part of the data are you going to use? In short, describe what your input and your output will be.

2. **Data analysis (maximum 2 pages):** Make a diagnosis about what the image suffers from (not the patient!) For instance, it can contain a study of the noise statistics (histogram, expectation versus variance), of the spectrum (mean power spectral density) in space or in time...

3. **Model (about a 1/2 page):** From the previous study, propose a mathematical model linking the observation with your chosen object of interest. At this step, you may want to make some approximations to simplify the maths. Give justifications and explain what the limits of your degradation model are if any *(ex: "As the noise will be assumed to be Gaussian, the larger fluctuations observed on the left will not be taken into account").*

4. **Validation framework (maximum 1 page):** Propose a methodological way to perform simulations for validation. Choose/draw/generate data representing your object of interest, and use them to simulate observations according to your degradation model. Describe to which extent your simulations are faithful with the real observations. Based on this simulator, propose a quantitative measure to assess the quality of your restoration technique. Explain what the limits of your validation approach are if any *(ex: "This validation framework does not include the motion of the patient in the MRI machine. It will thus be in favor of techniques assuming frames to be stable and unfair for the other ones.").*

5. **Comparison (maximum 3 pages):** Choose three techniques. Give a short description of them and explain why they are relevant for this study. Your are free to use/adapt techniques seen in class, reuse codes of the assignments, use the Matlab image toolbox or even codes found online.

   Compare the performance of these three techniques using your simulator and validation framework. Compare them when run on the real data. Compare their execution time and theoretical complexity. Describe their pros and cons together with some justifications *(ex: "this filter is good at removing noise but degrades the resolution, since it mixes pixels from both sides of the edge").*

6. **Perspectives (about a 1/2 page):** Describe what is missing and what should be done to improve your study. *(ex: "This study should be completed by adding into the comparisons techniques based on sparsity and wavelets. Such techniques seem indeed to be suitable for this problem since... ").*

Evaluation

- Respect of the specifications: 40%
  you wrote a 5 to 7 page report containing and respecting the 6 sections as described
  section 1 (5%), 2 (10%), 3 (5%), 4 (5%), 5 (10%), 6 (5%)
  not respecting the page range leads to 0%
  bad writing and bad layout can modulate the grade
  graphs without legend, axis labeling, title can also modulate the grade
- Code: 20%
  you have provided three functions, easy to use, each of them implementing one of the methods
  you have also provided the scripts used to produce the illustrations of your report
- Soundness of the study: 20%
  your study does not have flaws – how much the foundations make sense
- Originality and relevance of the study: 20%
  your choices are relevant, non trivial and give a valuable answer to the question

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Advice

Don't be lazy, but don't be too greedy either. A simple but deep and complete study will be more convincing than an ambitious but superficial and unfinished study.

My advice will be to first pick three simple methods developed during the assignments, do the analysis, the simulations, comparisons and write everything. If done perfectly, without flaws, you will reach 80%. Next, see how much time you have left to improve or change one or two of them.