

Image Signal Processing
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Lecture 01: Course Introduction

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Image Signal Processing

Strong Lab component:

Books: A.K. Jain: Fundamentals of digital image processing
Gonzalez and Woods: Digital image processing
A.L. Bovik: The essential guide to image processing.

Topics from different papers will be covered.

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(Course Introduction)

Today that we are starting is called Image Signal Processing. (The) That is the name of the course. And I am Rajagopalan. I am supposed to be taking this course for you. There will be, as far as this course is concerned, it has a very strong lab component, it has a strong lab component, which means that, which means that you will be actually required to actually implement some of the things that I talk about here. Because this is one thing to simply teach here, but then the other thing is that you go back and actually do this by yourself, implement the whole thing by yourself that actually helps a lot.

So books, A. K. Jain, this is a very old book but (actual) but I still like it. Some of the, it is a very solid book, Fundamentals of digital image processing. Fundamentals of digital image processing. All these are, all these the Indian editions are available. So these are not, they are not expensive at all, but then I am saying you do not need to purchase them. And there is Gonzalez and Woods and this is again a good one. But then our sort of course content is going to be spread across. So, so it does not mean that whatever I say is all there in these books and so on.

It is just like I said, just if you want to have some kind of a mental comfort, digital image processing. And then there is a reference book which is a good one. This you do not, do not even dare to buy this, it is too expensive. Al Bovik: The essential guide to image processing,

essential guide to image processing. So one of the things that will happen is, I will cover topics from, from various areas, topics from these papers, from different papers will be, will be covered. Topics from different papers will be covered.

And wherever I can, I will actually tell you the paper so that, so those of you who are interested you can go back, read the paper and just in case you want to know more, you can always read those papers. And yeah, so with that, that sort of thing sets the tone. So now if you ask yourself why, why should I be doing a course like this or what can this course do for me at the, at the end of the semester, if you have, you claim that you have done this course in image signal processing, what does that mean for you in terms of what you can do. What it can actually do for you is that you will have, now you will have a working knowledge of, of ISP. Let me just shift to the next page.

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What will it do for you?
You will have working knowledge of IP, along with a firm grounding in fundamentals of IP.

- Will you know all about IP? No. But you would have learnt enough to confidently read papers and understand them.
- Also, you would have learnt many relevant topics and their interconnections.

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So, so what will it do for you? So what will it do for you? So, so the idea is that, that you will have a working knowledge. Working knowledge in the, in the sense that you should be able to read a paper, implement things and so on. So that initial psychological barrier, let us say that students have that what is this paper and how do I implement and so on, after you have kind of, after you have done this course, you should feel absolutely at home being (ab) being able to having, being able to having a working knowledge.

So have, you will have working knowledge, working knowledge of ISP. ISP is image processing or IP, not intellectual property, IP along with a firm grounding, a firm grounding in fundamentals of ISP. So it is not just the, just the implementation part, you also want to

understand. So in fundamentals of, in fundamentals of again image processing. Now the next thing that you might ask is, will this, will this mean that I will know all about image processing. Will I, will you know all about image processing?

What do you think the answer is? Obviously no. No, but you would have learnt enough, but you would have learnt enough, learnt enough to be able to confidently read and understand. So you see, the idea is that one, this is simply a basic course, of course there are (advance) advances, these concepts and all that. But the whole idea is that once you do this course, you should be, you should be able to go there, take a journal, some like transactions on image processing or transactions PAMI or something, or a CVPR level conference paper, and be able to read it and feel that you do understand it. That is, that is what it will give you.

So it is impossible to cover the entire thing under, this is a big umbrella. Image processing is a very very big umbrella, so it is impossible to cover all the things under that. But then what we will do, we will give you enough expertise in order to be able to pick any paper of your liking in (the) in this area and be able to read and understand. So confidently read papers and understand them. Because eventually, one should be able to read papers and all. And that is why it is a, it is a kind of advanced elective, it is not like a core. That is the whole idea, behind an elective, is that you should be able to understand and read advanced papers, papers and understand them, and understand them.

Then also, the other thing that I actually like to do is when I actually teach, I would also love, I would also like to give you the interconnections. Something you read somewhere, like for example, if you are doing an, doing an SVD, then what kind of interconnections that it might have with respect to let us say, photometric stereo or, or with respect to filtering, noise filtering and all those interconnections also wherever appropriate, I will try to explain, so that you also understand the, understands the, understand importance of why you are learning these things.

And some of these things you will also do by the way. And also, you would have learnt, also you would have learnt many relevant topics in there and their interconnects, and their interconnects. Then going on to the next thing which will be like why study this subject, I mean, so what is the importance of this subject as of today?

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Why study image processing?

Computer vision → Deep Learning → Google, Amazon, Facebook, ...

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So the first class, I always, always try to, try to give people an idea as to where all it is being applied today because it is not true that all of you would have already know, already know probably where image processing gets applied and so on. But then these days with the kind of cell phone usage that I see around, I am sure now the camera is one of the things that is probably most used and so when I guess, but then if you think that it is only the camera that this will be whatever be, sort of consumer camera, that is what probably gets used the most in image processing, that is where it gets used the most, that is not correct.

So the idea is that things go beyond that. And of course many of those are important today because if you can translate something onto a consumer camera, it makes a lot more sense. Because so the company where it means, it means a huge take, something like a face finding. Now it is been there for a long time now. Earlier and all, it was, it was simply, simply a theory that we would, but then just took a few years for that to be available on a phone and so on.

So similarly, any idea that you feel, that these people feel will get, can get engineered and can be transported to a cell phone, means a lot for these companies. So, why study image processing? So you heard about the top four guys. What are those big guys? Google, Amazon, Facebook and the fourth one could be Microsoft, Intel or whatever. So all these big guys you know that these are the people which are actually making waves in terms of this area. And there is image processing by which I mean it shares a kind of a blurred boundary with a computer vision.

Because the, because the sort of things that these people do right, lies at somewhere the intersection of IP and CV. There is a computer vision which is like, which is like high level thing in image processing which is typically considered to be a low level thing but then many of these, many of these vehicles that you used to do image processing, that directly feed into, into a sort of vision pipeline, which is why you find that Google, Amazon, Facebook and all, they are all actively doing this. You have this shopping market straight away where they feel that Amazon on the Go or something, what is that called?

Amazon Go I think, where you could simply walk into a shop and then you can shop around and you come out. Nobody, you do not have to interact with any one. So just find out what all you took and, and then you are on your way out. And Facebook for example, they tag and all that it does, so very automatically knows who it is actually looking at and so on. So all these things we know that there are these big guys that actually use all these. And there are the cell phone companies that want to, that want to keep increasing the kinds of apps that they want to have on these, on these phones and so on.

Now as far as, as far as we are concerned, now one thing which you should, which you should realize is the all those, all the kind of blowing up which has happened in the last 5, 6, maybe 10 years, that is all, that all has to do with ML, machine learning, deep learning and so on. So for those of you who have already done a deep learning course, some of this might look actually elementary. Elementary in the sense that you might wonder oh, can I not implement the same thing now that I have learnt, deep learning and therefore why cannot I simply use sort of a deep network to do the same job?

The answer is true but then the point is deep network should be invoked only when you really need them. It is like saying that when there is a nice mathematical construct to a problem, you would rather solve it in that manner, rather than go, hope for some black bucks which you, for which you will do some training and all that. So the idea is that, in fact I always suggest that it is good idea to first do this and then do a, do a deep learning course.

But then in this institute we cannot really enforce that. So we get people that do deep learning and then they do, they do image processing. So for such people they, it could actually come into their minds as to, can I not, could I not have, could I not have done this with simple deep network and so on, that is all true. But at the same time, we have to, you have to actually

realize that a traditional way to, way to actually examine image processing is still very nice and there are so many nice things that I think you should be aware of.

A deep network can do whatever it can do, but then there is already, already the kind of (see) physics, physics of image formation is so fundamental and that physics you cannot really afford to not know. And the idea is that people who have a background of deep learning as well as who have done a traditional image processing, will be able to use a deep network much more effectively. Than somebody who simply uses the deep network without even having any knowledge about what the physics of image formation is.

So the whole idea behind this course is that we will not, we will not go the, go the deep learning way. That is not a goal at all. We will, we will go with the fundamentals of image processing. And in the process the hope is that even if you have done, done something like deep learning, you should actually be thinking about, how do I bring all this physics into play. Now that I know deep learning, can I actually bring some of this physics into play, in order to maybe reduce my training or whatever, make things more say efficient computationally whatever, reduce the number of variables that I, the number of unknowns in my say in this one, deep network and so on.

So in that sense, there is still, there is still an essential component. It does not mean that just because deep learning is a wave and all, it does not mean that we need to, we need to forget the past. It is all the more important that we understand that we are firmly grounded in the, in the fundamentals of image processing.