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RAMESH RASKAR: So some of you have already started contacting me about project topics. And that's great. In fact, we decided a couple of projects or we started a direction over email. So I encourage all of you to start doing that.

User interaction is a lot of fun, so you're welcome to do a project in that space. But avoid the list of boring [INAUDIBLE] topics that I presented in the class. Using some intelligent lighting, this one is a lot of fun. I think if you can convert the photodetector of a flatbed scanner, and do something really clever with it, because it's like a 2000 Hertz camera with 4,000 pixels.

So Matt is doing something with it. [? Ankit ?] it has a lot of experience ripping open flatbed scanners, and [? Masai ?] is also playing with it. Think of some cool projects in that space. Tomography--

STUDENT: I actually have a question for that. It seems like almost everything you can do with a flatbed scanner has been done. I had some ideas, and people have done so much stuff. Is it possible? I mean, if there is a project out there that I would like to do, but it's already been done by somebody else, is it still possible to pursue it? Or is it useless, then?

RAMESH RASKAR: I hope by the end of the class you'll always say, people have done a lot of things, but they're very boring.

STUDENT: I mean, there's always a little twist on it, but it's not like fundamentally--

RAMESH RASKAR: But what we'll do will be radically new because we are combining hardware with computation. Even on cellphones today, you can buy a simple app that will do panoramic stitching. It's mind blowing, because it requires some computation.

All the apps I have downloaded so far don't allow me to do panoramic stitching. It's just amazing. They charge a couple of dollars for it.

And people just don't do computation. People are really good at hardware hacking. It's like I told you-- there was the era of fixing cars, and there was an error of building electronics, and now is the era of computation.

So I think you'll be able to find lots of cool things you can do by taking hardware and applying new methods to it. But send me your ideas and we'll refine them. Talk to [? Ankit. ?] Talk to other people who are here to help us and [INAUDIBLE].

Yeah, don't go with the flow. Don't follow the hype. Tomography for internals-- Doug was just talking to me. He's interested in thinking about that, always a fun project.

And Doug, who's going to talk next week with this really cool project on an array of lights, putting an object in the middle, capturing photos of that, and from that, creating 3D models. But you can talk to Professor [? Mukagawa, ?] who's back there. And he's very interested in this kind of project.

STUDENT: Are the pictures taken in front or from the back?

RAMESH RASKAR: The picture's taken from the back.

STUDENT: But there are cameras--

RAMESH RASKAR: It's just one camera looking at-- let's see if there's a picture. No. There's a camera that's looking at the screen, basically.

STUDENT: But it seems that there are several cameras above and below the light source, right?

RAMESH RASKAR: No, these are all lights. There are no cameras. That's also lights.

STUDENT: Oh, also lights, OK, I see.

RAMESH RASKAR: So we have this set up downstairs if anyone wants to play. And there's a single photo. From that you can recover 3D models. But you can do this for tomographic reconstruction.

[INAUDIBLE] for 3D scanning is always a lot of fun. And in fact, Doug, again, has all the notes on different ways you can scan objects in 3D. So you can just look that up.

Using fluorescence or transparent material, adding some objects-- so think about scanning 3D objects to start from. Cameras using other spectrum, maybe a camera using Wi-Fi. So maybe you saw this project called "Wi-Fi camera," where basically in that case, they just took a tube, metallic tube, and put a Wi-Fi detector in it. And they just scanned the whole world, just scanning it-- kind of a boring project, but fun.

But maybe you can just create that as a light-free camera. That could be a lot of fun. Visible and thermal-- a lot of interesting things you can do with it. Mike might be able to give us some thermal cameras to play with, depending on how things go.

You can use thermal IR and visible thermal segmentation. For example, you know that glass is completely black, but invisible is not. And things look different in thermal versus visible, so you can combine the two to do something interesting. Thermal IR, your human face looks very different. So you can do some interesting things there.

Multispectral camera, which we will talk a lot about color, and wavelength, and spectrum. And we might be able to create cameras, for example, that can distinguish camel from sand. And I'm sure Michael has other more motivating applications of distinguishing color.

Some other simple projects-- let's say you want to create a six-color camera. You can just take an ordinary RGB camera and put two filters in front of it. Filter one, take a photo, filter two, take a photo. And from those two photographs, you can create possibly a different spectral response camera. This is a fun project, also, to do.

Polarization is the under water, or fog, or freshness of skin, or vegetables, and so on. You can convert ordinary camera into multispectral camera. So we're going to see this particular toy you can buy for $2.

Imagine if you can put something like this in front of your camera phone, and convert your camera into multispectral camera. And Roark is interested in doing that. So we can work with him. Multiflash camera-- you're doing it for an assignment, but instead of one camera and four flashes, maybe you have multiple cameras and multiple flashes, and multiple cameras and one flash-- again, some interesting things you can do there.

Flare photography-- you can look at thermal effects. And we saw it earlier. Again, lot of fun there.

Let's see if there's an image. So creating this is a-- I believe it's a soldering gun here. And you can see the changes in temperature.

So Mike, for example, is going to explore flare photography with thermal IR cameras. I thought that was just a great combination.

Strobing and color strobing-- you can do a lot of crazy things. You may have seen waterfalls. If you strobe the light just at the right rate, the waterfall becomes steady. And if you start strobing at a slightly slower rate, the water actually starts going up-- all kinds of interesting effects.

And if you do color strobing, then the waterfall looks like it's a rainbow. And if you do faster color strobing, the waterfall looks like it's moving up in a colored rainbow-- all kinds of [INAUDIBLE]. We just had a SIGGRAPH paper looking at waterfalls, using an electro endoscope using strobing.

And if you're interested in playing in this space, so we use compressive sensing with strobing [INAUDIBLE]. In the light table photos, it's a Holy Grail of compression photography. How can I take a photo and then change the lighting post capture? So we saw the above extent was your first assignment. But maybe there's something more we can do in that space.

Non-imaging sensor, and combining that, so combining the gyro, or the GPS, or online photo collections-- lots of cool ideas there. Also some cool ideas in what if two cameras actually talk to each other? So Kevin has been exploring a little bit of that. If two cameras at the time of capture communicate with each other-- optically or some other mechanism-- we can have more information there.

Any questions on all this topic so far? Optics is just wide open-- light film, [? score and ?] [? exposure, ?] [INAUDIBLE], aperture. Again, I had this project on placing interesting apertures that had different colors and different shapes. So here is a traditional blur, but here, the aperture is shaped eight, so all the highlights have a little eight in it.

Bioinspired vision-- trying to mimic some of the biological imaging, whether it's optics or sensing. We did a project where we used-- this is Professor [? Hera-- ?] using compound eyes. These are fill eye with multiple lenses here.

But you can think of trying to imitate the biological vision of any creature. So mantis shrimp, for example, it's been the news-- it's always in the news, because it uses polarization and mirrors. Maybe we can create a camera that mimics a shrimp, or a lobster, or a scallop. The three of them have completely different mechanisms for sensing an image. So that'll be cool.

Some dreams, like how can you change room without moving parts-- you can talk to [? Ankit ?] about that. What can you do if you are allowed to move sensor while the photo is being taken? So [? Ankit ?] had this project where you can take a picture with like a cellphone camera, very tiny aperture. But by shaking the sensor and the lens while taking the picture, you can create a shallow depth of field.

So it starts behaving more like an SLR. So how can you create a SLR-like image quality from a tiny aperture? This is achieved by using shift of sensors.

And then at CSAIL, they used sensor motion for supporting motion deploying. Time-lapse photos-- always fun. We saw this project where you can take a nighttime photo and convert back. But there are many, many other groups that are doing really fascinating work with time lapse.

Displays-- so displays are definitely part of computational photography because after all these great photos we create, are we going to experience them just on a flat, 2D screen? So maybe a display that's aware of temperature, aware of-- can blow out the candle, lower density, shake aware, going beyond what Matt did for his [INAUDIBLE] screen. How can you convert a big screen LCD into a camera that does even more?

Scientific imaging, microscopy-- so a new trend is that instead of trying to build a microscope, you can just take the sensor of a camera. And because the pixels are shrinking down to 1 micrometer now, they're approaching a resolution of a traditional microscope. So you can picture it directly on the sensor.

You can just put an object directly on the sensor and shine light at it. And I can take a picture on the flat sensor. First of all, it's very large area. It's very cheap, very fast, very simple optics.

So there are very interesting things you can do in that space. So think about all the light field, and all the lighting tricks we did. And today, we're learning about color.

How can you combine that with microscopy? Because it's a completely new regime, doing microscopy without a lens, microscope using smarter lighting. Confocal illumination-- we'll study that next week. For looking at samples layer by layer, and scattering-free or scattering-aware imaging. If you have a sample that scatters light, how do you image without the scattering effects?

And then listeners, you should pitch your ideas. So we have a lot of ideas floating in the air. So you still have two or three days to propose your three ideas. They could be any one of these or something that you're thinking about on your own.

And talk to me or Professor [? Mukagawa, ?] Professor [? Oliveira ?] [? Ankit, ?] and [? Ashok. ?] He's not here, but-- and other people I mentioned here, like Roark, and Doug, and others. Sounds good.