Advanced IOT Applications
Dr. T V Prabhakar
Department of Electronic Systems Engineering
Indian Institute of Science, Bangalore

Lecture - 44
Cargo monitoring for tamper detection – Part 2

As, we come to perhaps the last part of this module on logistics or let us call it, Cargo monitoring very specifically. We discussed the one technique of trying to find out if there is a tamper on that cargo and how to do continuous monitoring and so on right. And, we were by enlarge using camera sensors for doing it.

The question really occurs to you is that the only way one should do a you know cargo monitoring, are those the algorithm only I algorithms that are useful. I do not think that is an answer. Here is why I want to show you another example of the same thing, but done differently ok.

So, at least in any solution today in the IoT world you should try out minimum 3 possible solutions; one solution which by enlarge is a default is use machine learning, artificial intelligence methods of detecting. Whether, it is speech to text, or whether it is tamper detection, or any one of them this is something that is a default way of doing things.

But, you cannot be doing a machine learning artificial intelligence even for very trivial thing it does not make sense. Because, if you want to do any of that you needle humongous amount of data right, and that may not be a feasible option if you want a quick immediate solution to a problem. Also, IoT devices today can do lot of processing, DSP is inside a microcontroller. So, what stopping you from doing matrix operations right, dot product for instance is a very straight forward thing with the multiply and accumulate instruction, which is doable on most microcontrollers.

Therefore, it is important for you to look at not do not look at everything from the ML and AI perspective look at algorithms mainly. And, those which are effective and which were very effective for a given solution; with that in mind here is a second way of doing it.

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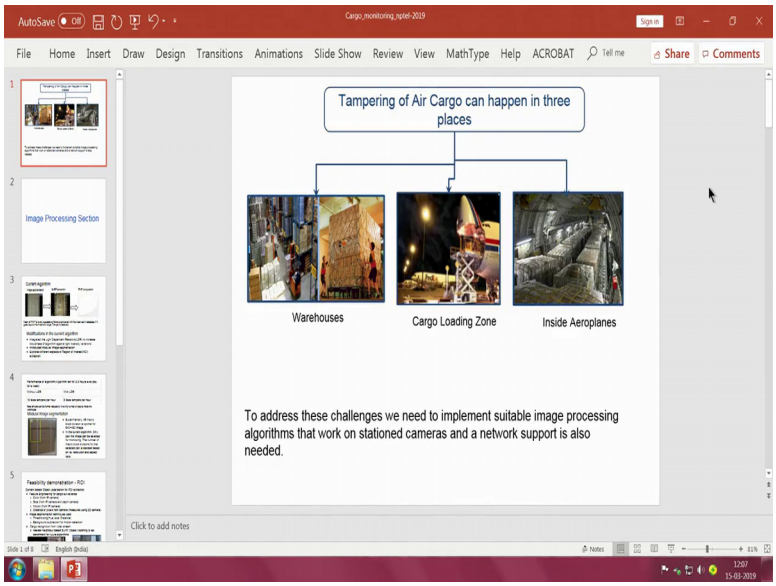

Look at this slides. This is tamper detection the same problem of cargo can happen in 3 places we have taken an airport as a scenario. You have ware houses, you have the cargo loading zone, and inside aeroplanes all 3 has the same problem that will looked at the last time. So, you need to implement a suitable image processing algorithm using cameras essentially right.

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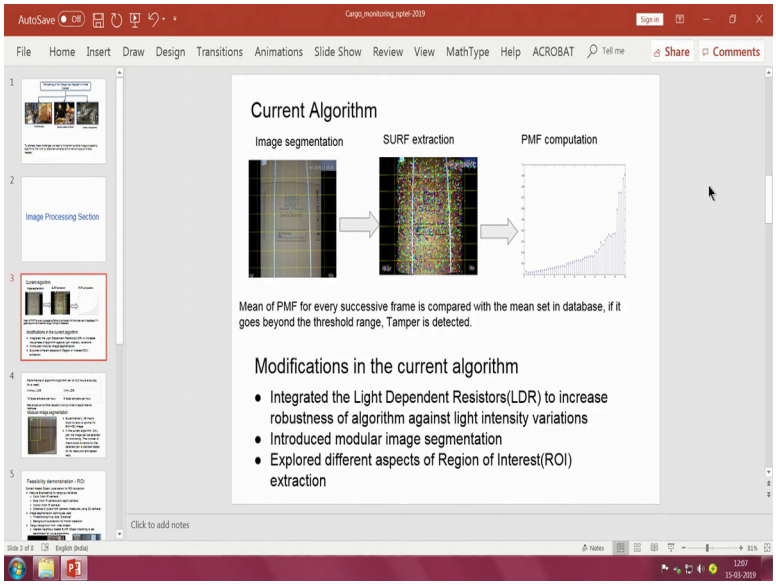

So, what is the image processing that we can look at? So, in this algorithm, you look at how to segment this image into several macro blocks, and do the speeded up robust

features extraction interest points. You see that in the middle that you see the surf extraction on that image, and then you end up with a you come and compute a probability mass function computation, this is how it should look right.

This is your basis this is your I would say reference for no tamper kind of situation. Now, this PMF computation once you set a side, mean of PMF for every successive frame is compared with the mean set in database, if it is goes beyond a certain threshold you say that it is a tamper. So, this is another way of doing it correct.

So, one can again if you do image based processing image based thing one thing is you have to be your do it light is an very important thing for an image, when you have to acquire the image because under extreme low lucks of operations, you have if you have done a reference with coloured images and under good lighting condition, if you do not put that back. Then, you are going to not going to get a consistently a good results.

Therefore, how to detect the amount of light that is a rounded? So, again you go and instrument another sensor for finding out what is the light intensity. And, what we did was we integrated it with a light dependent resistor, to increase the robustness of the algorithm against light intensity variations. And, we did further modifications are not taking a full image, but dividing it into smaller blocks and the modular segment image segmentation is a very important thing.

And, within a given large image you now start looking at the region of interest extraction and just concentrate on a sub set or a small portion of the image rather than worrying about the complete image that is seen by the camera. So, region of interest extraction, modularization of the image we do a modular image segmentation, use light dependent resistors for calibrating it correctly against light, all that essentially means you want to reduce false probabilities that is all ok.

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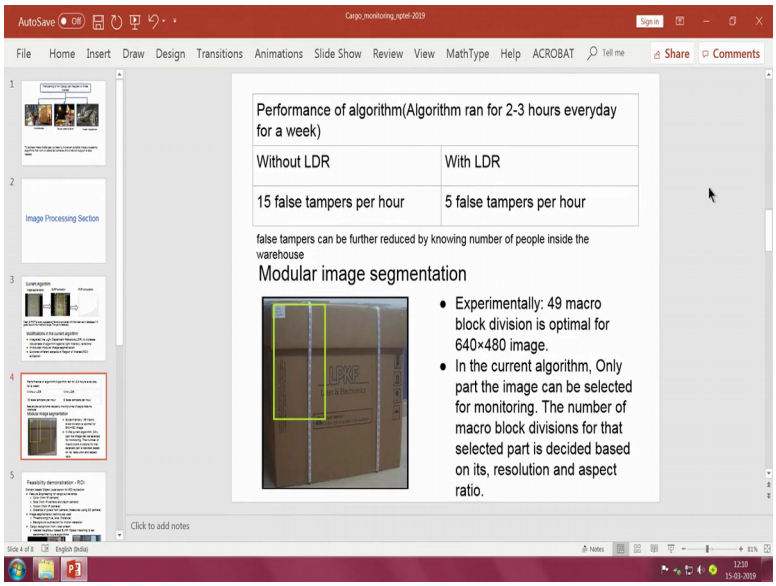

So, next slide essentially is talking about those false tampers, you see without LDR the performance was 15 false tampers per hour, but once we put in the LDR we got 5 false tampers per hour. So, this is typical of what kind of performance you can actually do. So, false tampers can you can further reduce, if you know the number of people inside the warehouse and you can somehow estimate what is likelihood of you know getting these false tampers. So, that is also something that you may want to explore, when I referred to the modular image segmentation.

Look at what I did we took a portion of the cargo the bounding box that you see there. And, experimentally forty 9 macro block divisions was found to be optimal for a 640 cross 480 image. And, only the image can be selected only that part you select now, and since it is now there are number of macro blocks of the selected part, then you basically look at the only that selected part and you decide it based on it is resolution and the aspect ratio. So, what we got essentially that I will show you the nice result there.

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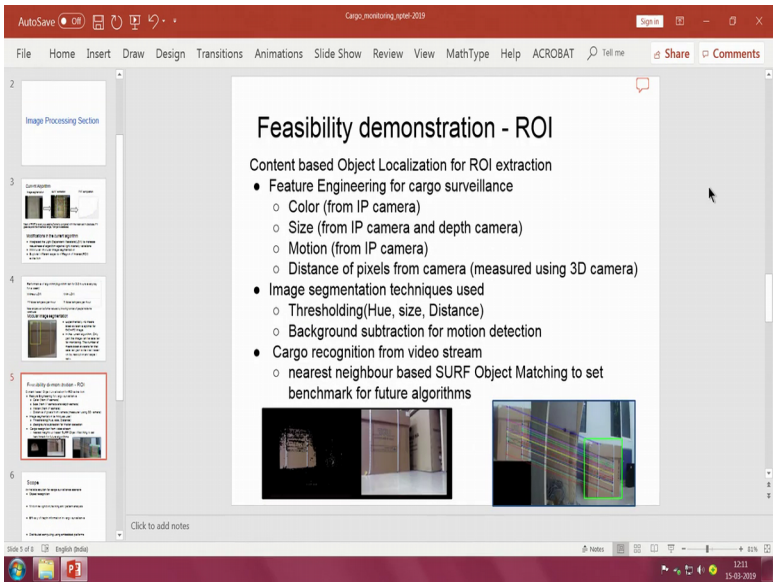

So, here is a feasibility demonstration of the region of interest extraction, you do lot of feature extraction content based object localization for a region of a extraction, you look at feature engineering for cargo surveillance colour, then size, then motion, all of them coming from the IP camera, which you have captured the images that are coming through the IP camera, depth of the camera also you will get distance of pixels from the camera measured using 3 D camera, you can also use that if you have one.

And, then you do image segmentation, usual thresholding, and then background subtraction, for motion detection and then cargo recognition from video stream. Neighbour nearest neighbour based surf speeded up robust features object matching to set the benchmark for all feature algorithms.

So, surf is the algorithm that you can use for object matching and then you can say whether there is a tamper or no tamper. As, you can see on the right side this is doing exactly that, you have those lines connecting to your reference, and then you just see how well the objects are actually the reference image that you have and the existing image that you are got through the camera, how well this matching is actually happening and if it if the match goes beyond a certain threshold you declare that it is a temper?

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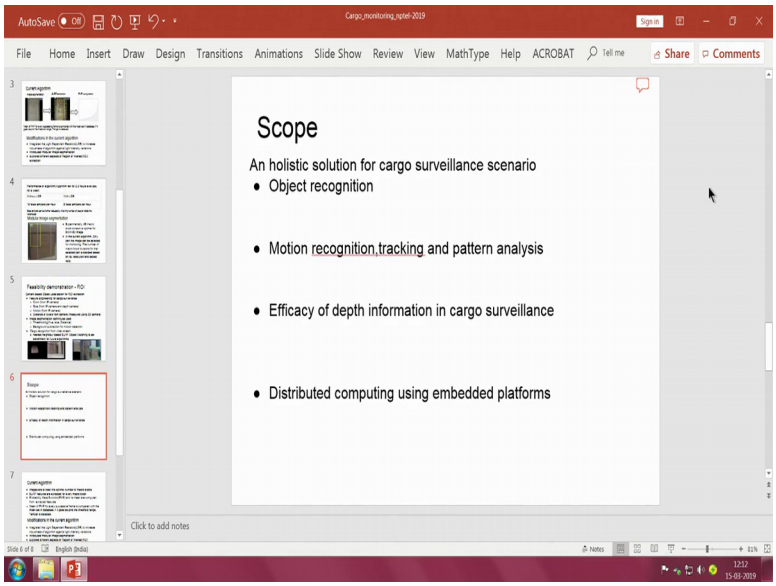

So, this is the essential idea a holistic solution for cargo surveillance scenario is a very important thing, you have to do object recognition, you have to do motion recognition tracking and pattern analysis and a lot of interesting things can be done.

You have to look at the efficacy of depth information in the cargo surveillance, and distributed computing is also another thing using the different type of embedded platforms is something that you can pull off today.

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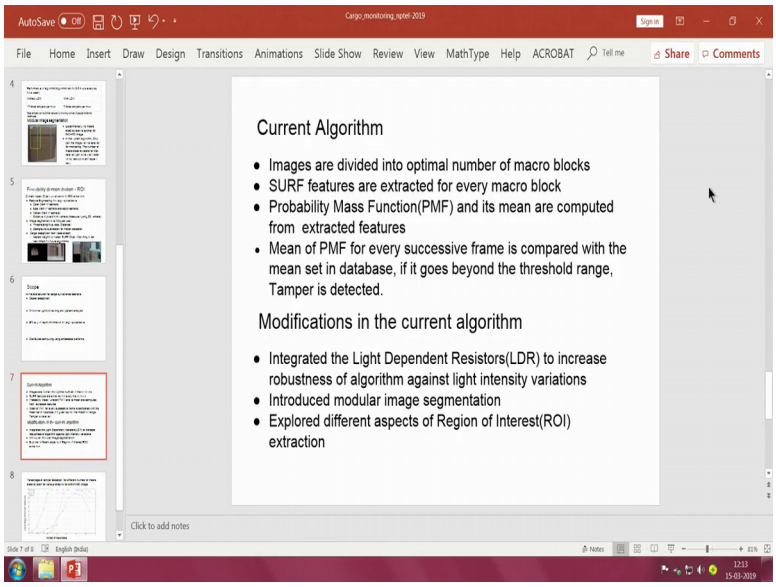

So, finally, if you look at all the algorithms that we looked at the existing algorithm and the correction that we did with LDR and all that this actually captures the big summary of everything. So, we had this PMF and it compared with the mean, we did we went a step ahead with that method and then put in the LDR to simply reduce the number of false positives. And, also we did further modular image segmentation we brought in ROI right.

So, you do all that is up here on top, that is essentially all the things in the current algorithm, you do all of it here right you do all of this part, but you also do this part bring in this part and append this lower portion to the upper portion and together, you will get a outstandingly good solution essentially. So, you still do PMF if you wish one way, then you get the key keep looking at the mass function across successive frames ok. You put the threshold methods add the LDR do a region of interest subtraction, and then you modify the algorithm suitably and also check for robustness.

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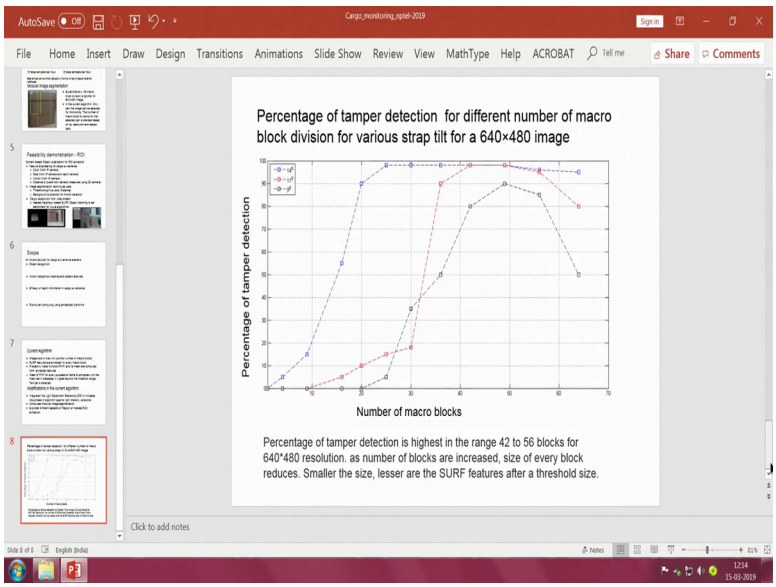

So, this is a very interesting result that we could finally, get from all of it because little bit of engineering that is associated with it. This is percentage of tamper detection for different number of macro block division, you can see that X axis is the number of macro blocks, and the Y axis is percentage of tamper detection. You can see that the result is quite intuitive the percentage of tamper detection is highest in the range 42 to 56 blocks

for this 640 480 resolution, as the number of blocks are increase size of every block reduces right.

If, you increase the number of blocks size each size of the each block will reduce smaller the size lesser are the surf features after rest threshold size right. And so, that is you must look at how to strike this compromise between the number of macro blocks, that would be required. So, of course, this is what I wanted to cover in this module I hope you had a good time going through all the modules of this course. And, we will be very happy to take questions on the forum and I sincerely hope you have learnt something and you can try implementing these things because they do not need any infrastructure.

The course has by enlarge looked at giving you a overview of the different algorithms that you can try with open source tools. Like all what I have said here can easily be tried with the open CV, if you have your lap top and open CV installed on it, you can try these little things. And, that will perhaps give you experience on working with image processing, simple webcam can be used to begin with, remember camera calibration that part you have to look at. Then, LU LDRS are available at low prices you can buy LDR as an instrument there. Simple lab setup at homes can be done with all that I mentioned and run very sophisticated algorithms to do detection.

So, that is the real highlight of this courses algorithms are e very high and, but can be tried out on very simple systems. And, perhaps the way IoT would go is essentially this mix of high performing, high performance algorithms running on extremely low end systems, and you know giving you very reliable solutions to very hard problems.

Thank you very much and please be on touch over the discussions forum and if there are questions we will be very happy to answer.

Thank you.