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Teleprompter Script for Dr. Brian Leininger, Program Manager, Information Exploitation Office

Exploiting Sensor Data

» **BRIAN LEININGER:**
I am here to talk about finding things.

We do it every day.

You typically find your car keys in the morning,
and you no doubt found something interesting in the Exhibits here.

It seems intuitively very easy.

All we have to do is "look" and "pay attention".

However, even when we have perfect sensor data, sometime this can take a lot of time.

How do we find the Bad Guys in this and what constitutes the Bad Guys?

I will argue that we
Must develop perceptually aware intelligent systems.

Perceptually aware intelligent systems will be capable of finding things that are interesting in a manner similar to the way that an analyst might find things that are interesting.

I believe that this is possible based on the advances in the algorithms and massive parallel hardware.

In modern warfare, both counterinsurgency and conventional operations, we need to find SMALL things in BIG areas
IN TIME to do something about it.

Going beyond the cartoon representation of the problem,
here is an aerial shot of a subset of a big city.

It is about 30 square km and has about
100 thousand people and about 10 thousand vehicles.

Almost all of them are doing what they should be doing.

How do we find the
“Bad Guys” in this?

And what constitutes a “Bad Guy” anyway?

Well, the first thing we have to do when finding things, is to look.

Warfighters today have more sensor platforms than ever.

The sky is not yet “black with swarms of UAVs”,
but it is getting there.

That gets us over the target area.

But now we need to get enough pixels of the target to actually SEE something.

We are rapidly developing sensors that produce images more than

2000 times the size of an HD TV.

These sensors produce more than twenty-five thousand million pixels per second.

THIS IS A HUGE NUMBER.

This may still not be enough though.

The Bad Guys believe that the US has at its disposal every sensor that Tom Clancy, the writers of 24 and their friends have ever dreamed of.

The Bad Guys,
most likely are hiding.

Given this situation,
no single sensor may find enough of him to let us truly see him.

So what do we do?

We add even MORE sensors!

So now we have multiple sensor domains of EO, radar, IR, multi-spectral, LIDAR, MTI, acoustic, AND seismic.

We now have much more than 25 billion pixels per second to look at.

The Bad Guys are
in there somewhere.

Now that we have “looked”, to find something all we have to do is “pay attention”.

What does that mean?

The sensors are producing masses of data that inherently contains the information that we want.

Somewhere in that 25 plus billion pixels is our “target”.

We could make video streams of all this data and ask warfighters to look at them.

If we did that though,
it would take more than 200 trained and dedicated operators looking at video screens.

This does not seem practical.

Clearly we need automation to extract the relevant information from the mountain of data.

Let’s talk about the algorithms to do that.

The good news is that this dense sampling of time and space actually makes automated image interpretation easier,
not harder.

Instead of trying to make difficult determinations from isolated pieces of data, we can use more complete sets of data to ease the exploitation tasks.

Here are some examples:

* Tracking versus searching.

This lets us track vehicles rather than repeatedly search for them - continuous tracking is easier than searching for vehicles over broad areas, especially in the face of camouflage and deception.

We can now connect dismounts going from buildings to vehicles to buildings.

* Determining ID.

As we maintain tracks over longer and longer times, we can invoke many different classes of algorithms to determine target ID, even manual.

When we are clever or lucky enough to have recognized the class of a vehicle, let's maintain that ID over time --
we only need to recognize each target once!

* Detecting change.

With these sensors and system we can continuously monitor for change over closely spaced intervals.

Watching a delivery to a chemical munitions plant is a lot easier than trying to infer that it happened after the fact.

Before we get too optimistic about finding things, we don’t really know what “The Bad Guy” looks like.

Yesterday’s targets were tanks, ships, and aircraft that were easy to tell apart.

Today’s targets include dismounts that are often indistinguishable from non-combatants.

We need to be able to separate our target Bad Guys from all of the things that aren't Bad Guys.

We may be able to discover patterns of activity that are
"not normal" rather than specifically "Bad Guy like."

Dense space-time sampling helps here too.

Large collections of repeated observations open the door to algorithms that learn.

In attempting to determine behavior that is not normal, context plays an integral role.

An example is, that an individual digging in a garden is normal and probably not threatening.

However an individual digging along a roadside is potentially threatening behavior.

Both the activity and context need to be simultaneously analyzed to determine if a behavior is potentially threatening.

With the ability to observe wide areas at high resolution for extended periods of time,
can we discover the purpose of buildings by observing vehicle and dismount traffic in and out of the buildings?

If this is possible then we can utilize this information to augment our geospatial understanding of an area.

The activity will enable us to determine geospatial context, the context

can then assist us in determining if the activity is normal.

IXO is exploring approaches to create perceptually aware intelligent systems for Precision ID.

Rather than search broad areas for camouflaged targets, we can monitor those areas for changes.

Rather than attempt to detect and recognize targets in unfamiliar terrain, we can track them so we know where they are at all times.

Rather than build rigid systems that look for specific targets we can develop systems that discover interesting events though experience.

Today we build an exploitation system in the factory, deploy it, and use it until we ship a new version from the factory.

Tomorrow, our exploitation systems will add target types
on-the-fly, they will adapt through experience,
and their performance will improve over time.

Our automated systems should never make the same mistake twice.

To accomplish this level of exploitation,
the processing demands are staggering.

To exploit imagery coming in at 25 plus gigapixels per second requires a phenomenal amount of processing.

Currently, hardware approaches exist for providing hundreds of terraopps to petaopps of performance.

The approaches all have one characteristic in common, they are

massively parallel.

To be able to build real time exploitation systems, we must think of how the algorithms can be implemented utilizing massively parallel hardware versus “desktop style” implementations.

When we do this, we can turn the ever-increasing ability to sense the battlefield into the key that solves the warfighter’s situation awareness problem.

Together with our partners in government and industry, we are working to make the rapid effective engagement of elusive surface targets a reality.

I am looking for your ideas on how to discover interesting events and give our adversaries no place to hide.

Thank you.

You heard me mention "patterns" as one of several ways to find
Bad Guys.

Well, let me tell you,
our next speaker,
Kendra Moore, knows even moore about patterns!