"Fuzzy" Data Compression (FDCMP)

(A micro-summary introduction)

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ABSTRACT

UNICON's recent participation in the DOD *Small Business Innovation Research* (**SBIR**) program has enabled us to envision how very large and fast artificial neural networks can be constructed. We believe that our patent-pending *CogniMax® pattern recognition technology* [2] allows us to employ very large neural networks in a way that enables us to employ a concept we call "***exhaustive learning***" for the benefit of certain types of challenging and computationally burdensome pattern recognition problems. This paper explores one such application.

"This slide set presents a brief overview of a compression method we call **Fuzzy Data Compression (FDCMP)**. Our idea is based upon an unusual idea that we first observed a few years ago in a 2003 NASA-CMU paper that showed how high LIDAR image compression ratios (>99%) could be achieved if one is willing to trade a small amount (<3%) of compression imprecision (fuzziness) to achieve a high compression ratio. In some ways this capability appeared to us to be a similar idea to the "image quality" feature of JPEG image compression. The NASA-CMU paper showed how they were able to achieve outstanding compression results, but their compression speed was very limited due the tools they had available to implement their solution (now obsolete IBM ZISC chips). We believe that UNICON's CogniMax® pattern recognition technology might enable the NASA-CMU compression approach to be more effectively implemented and thus broadly applied."

1 MOTIVATION FOR EXPLORATION

We initially decided to explore this problem area and develop our full paper (a slide set) to more fully describe our preliminary ideas for extending the prior work of NASA-CMU. As shown in Figure-1, the NASA-CMU team was able to **demonstrate** some phenomenal compression results by using their feature-indexing method (**2000:1**). Our initial thought was that enhancing this method might enable many new applications to use such an approach. We recognized that the slow compression speed that the team encountered was likely due limited capabilities of the IBM ZISC® pattern recognition chips they employed. We further recognized that our *CogniMax® pattern recognition technology* might enable the NASA-CMU compression method to be greatly enhanced and thus broadly applied.

- Paper's reported *error-rate* (**ER**) versus *compression-ratio* (**CR**) was impressive

ER	→	CR	
.031	→	99.95%	(2000:1)
.029	→	99.68%	(312:1)
.028	→	99.17%	(120:1)

- NASA-CMU method was not very fast: 0.78 sec/operation or ~13Hz)

Figure-1

2 SUMMARY

Our paper starts by describing roughly what the NASA-CMU compression method is, how it works, and the remarkable **2000:1** compression-ratio results that they obtained. We describe why we believe that their ZISC chip based implementation suffered from low pattern-recognition speed. We then describe why we believe that their compression method might be ***greatly*** enhanced through the use of our *CogniMax® pattern recognition technology*. We suspect that with our technology we can modify the NASA-CMU compression method to:

- *Achieve even higher compression ratios with equivalent compression-imprecision, or*
- *Achieve similar compression-ratios with higher compression-precision, and*
- *Greatly enhance compression-speed (always)*

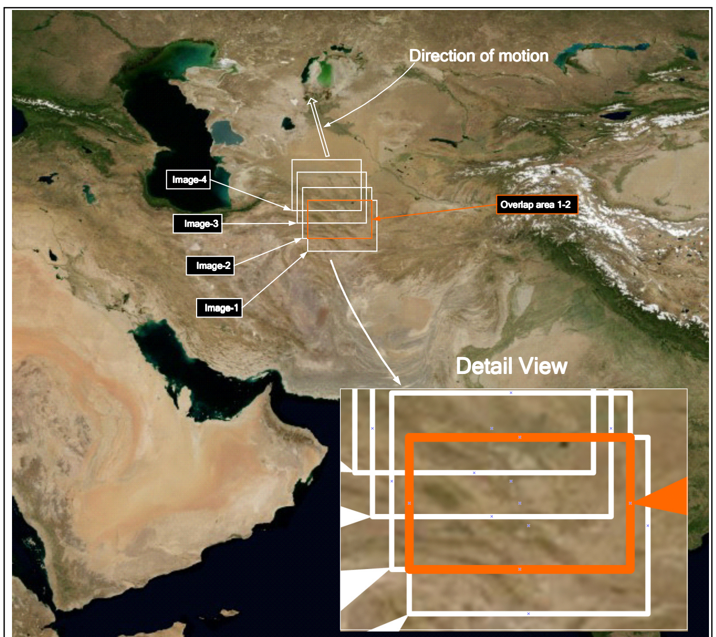

Figure-2

[1] Our larger **FDCMP** paper can be found within the **DTIC IR&D Collection** (www.dtic.mil) with Accession-Number **08241205**

[2] COGNIMAX is a trademark of UNICON Inc.

Overall, we believe that the NASA-CMU compression approach can be greatly enhanced such that it might be applied in a variety of DOD/IC applications. To illustrate some possible applications our paper first explores some potential aerial/space based imagery applications as well as an RF-geolocation application.

Figure-2 above shows an example of such an application. Our paper explains why we believe that significant image redundancy exists in such applications and how this redundancy might be exploited by an effective FDCMP scheme. Much emphasis here is devoted to multiplying effective downlink bandwidth via data compression. From our involvement in the SBIR program we have come to understand that limited bandwidth is a common problem across many DOD data collection domains. We recognize that our FDCMP approach is not always applicable, but we believe that it might prove to be a powerful tool in a larger toolbox of compression methods.

Our paper then briefly discusses how our FDCMP scheme might also be applied to the RF-geolocation (SIGINT) problem domain. This is shown in Figure-3. Our hypothesis is that if SIGINT/COMINT data is collected and compressed via our FDCMP method and the process only introduces a small amount of error, then it might still be possible to accurately correlate the data once decompressed. This would then not degrade RF-geolocation back-end processing when processing the datasets from a variety of collection sites or platforms.

If our hypothesis turns out to be correct, then our compression method might enable longer data collection times, higher sampling rates to be used, more collection stations to be effectively employed, or other system infrastructure level enhancements to be implemented.

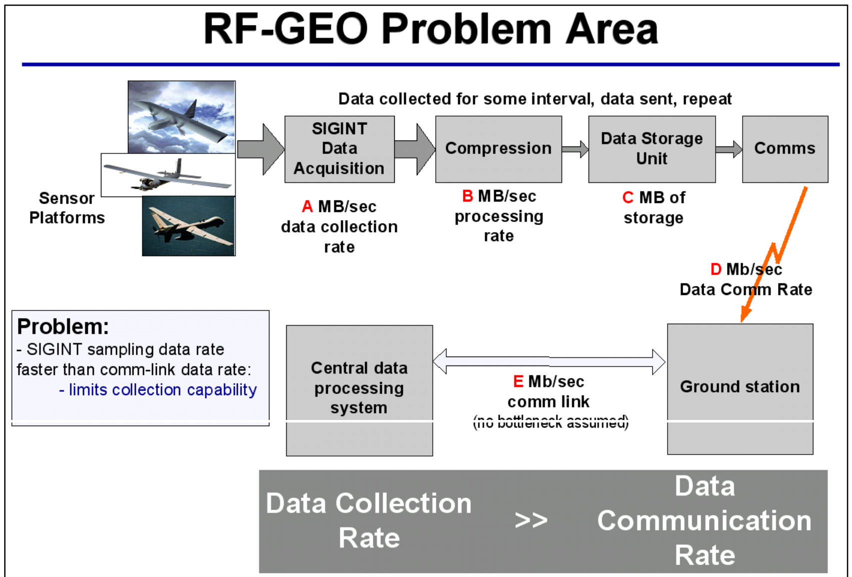

Figure-3

3 SUMMARY

Although our paper only reflects our current hunch that a greatly enhanced fuzzy data compression scheme is possible, our idea here is supported by the stunning results previously obtained by the NASA-CMU team. We recognize that an effective fuzzy compression scheme is not applicable to every problem domain, but we believe that such an approach might enable a variety of powerful new solutions within the DOD and IC. Communication bandwidth appears to be a commodity that is always in short supply. DOD/IC applications are generally hungry for all the data they can get and our FDCMP idea has the potential to put a powerful new tool in the system designer's toolbox. When combined with a variety of other compression methods, powerful new capabilities might be possible that might greatly multiply the effective data rates of existing communication channels.

This paper has been generated for Program Managers, Scientists, and Engineers to provide a quick summary introduction to UNICON's CogniMax® technology, ideas, and skills related to massive-scale pattern recognition and methods of fast/fuzzy data compression. It is our hope that his paper will stimulate discussion and foster the development of advanced data compression system solutions. If you have a need for data compression that might possibly benefit from imprecise (or fuzzy) compression methods, please feel free to contact us to discuss your needs.