MESSAGE PASSING ITERATIVE DECODERS BASED ON IMPRECISE ARITHMETIC FOR MULTI-OBJECTIVE POWER-AREA-DELAY OPTIMIZATION

Goal of the project

The DIAMOND project proposes to exploit the robustness of modern decoders to arithmetic inaccuracies, for improving their latency and power consumption. The project focuses on Low-Density Parity-Check (LDPC) codes widely used in modern communication systems, and targets the design of message-passing iterative decoders using imprecise arithmetic units. We aim at harnessing the inaccuracies produced by imprecise computational units, while benefiting of their significant reductions in area, latency and power consumption.

Short description of the project

The project investigates the possibility of optimizing LDPC decoding architectures by employing imprecise and approximate techniques at different levels: message representation, processing unit and architecture.

Project implemented by

- Universitatea Politehnica Timisoara (UPT) – Romanian partner
- CEA-LETI, Grenoble – French coordinator partner
- ETIS Laboratory – French partner

Implementation period

March 2014 – March 2017

Main activities:

DIAMOND project have analyzed the impact of the introducing impreciseness and approximations in LDPC decoding architecture on the decoding performance, cost and throughput. The main activities involved:

1. Development of LDPC decoding techniques using imprecise message representation
2. Analysis and development of imprecise processing units
3. Development of imprecise stopping criteria for layered decoding
4. Development of proof-of-concept decoders using the imprecise techniques at different levels.

Results

The main results of the DIAMOND project include:

1. Imprecise message representation techniques – these include the development of the modified offset min-sum (MOMS) LDPC decoding, as well as the non-subjective finite alphabet iterative decoding of LDPC codes.
2. Imprecise processing units – the main developments have consisted in a novel check node unit using one-hot representation of messages, and a novel version of self-correcting min-sum (SCMS), that allows the implementation of this SCMS based LDPC decoder with a similar cost as the Min-Sum based ones.
3. Imprecise early termination criteria for layered LDPC decoders

In order to provide a wide range of proof-of-concept decoding architectures, for which a wide range of architecture and code parameters can be analyzed, an integrated environment for the architecture generation, verification and implementation – TEDI – has been developed.

Applicability and transferability of the results

The DIAMOND project aims at optimizing LDPC decoding architectures used for forward error correction in both wireless communications and data storage. Several steps for economic and industrial results dissemination have been undertaken. On one hand, a simplified version of the LDPC decoding architecture generator has been made publicly available on the webpage dbyaclick.cs.upt.ro . On the other hand, the proposed stopping criteria for layered LDPC decoding architectures has been considered for a joint patent application between the project partners.

Financed through/by

UEFISCDI – Romanian funding agency
ANR – French funding agency
Romanian project number: PN-II-ID-JRP-RO-FR-2012-0109

Research Centre

Research Centre in Computing and Information Technology – CCCTI

Research team

Dr. Oana Boncalo – Principal Investigator
Dr. Petru Mihancea
Ioana Mot
Gyorgy Kolumban Antal
Petra Csereoka

Contact information

Oana Boncalo, PhD
Department of Computer and Information Technology
Address: Vasile Parvan Blvd., Nr. 2, 300223, Timisoara
Phone: (+40) 256 403264
E-mail: oana.boncalo@cs.upt.ro
Web: http://staff.cs.upt.ro/~boncalo/diamond/contact.html