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Volume 67, Issue 1 • January 2020 • Current Issue • Issue Archive



Publisher: Association for Computing Machinery

ISSN: 0004-5411

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Tags: Computations on matrices

Sections

Volume 67, Issue 1
January 2020

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SECTION: Scientific and High Performance Computing

SECTION: Design and analysis of algorithms

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Elaye Karstadt, Oded Schwartz

January 2020, Article No.: 1, pp 1–31 • <https://doi.org/10.1145/3364504>

Strassen's algorithm (1969) was the first sub-cubic matrix multiplication algorithm. Winograd (1971) improved the leading coefficient of its complexity from 6 to 7. There have been many subsequent asymptotic improvements. Unfortunately, most of these ...

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SECTION: Design and analysis of algorithms

RESEARCH-ARTICLE [Fully Functional Suffix Trees and Optimal Text Searching in BWT-Runs Bounded Space](#)

Travis Gartle, Gonzalo Navarro, Nicola Prezza

January 2020, Article No.: 2, pp 1–54 • <https://doi.org/10.1145/3375890>

Indexing highly repetitive texts—such as genomic databases, software repositories and versioned text collections—has become an important problem since the turn of the millennium. A relevant compressibility

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Sections

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RESEARCH-ARTICLE **Matrix Multiplication, a Little Faster**

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intelligence
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RESEARCH-ARTICLE [Image processing](#)

Andrew Tescher

AFIPS '80: Proceedings of the May 19-22, 1980, national computer conference • May 1980, pp 369 • <https://doi.org/10.1145/1500518.1500578>



NCC '80 has addressed three important areas of image processing through individually organized sessions.

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5. เพิ่มคำค้นเพิ่มเติม เพื่อกรองผลลัพธ์ให้แคบลง

with applications to image analysis and automated cartography



Authors:  [Martin A. Fischler](#),  [Robert C. Bolles](#) [Authors Info & Affiliations](#)

Publication: Communications of the ACM • June 1981 • <https://doi.org/10.1145/358669.358692>

11,348  23,642

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Communications of the ACM

Volume 24, Issue 6

June 1981

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[Abstract](#)

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Abstract

A new paradigm, Random Sample Consensus (RANSAC), for fitting a model to experimental data is introduced. RANSAC is capable of interpreting/smoothing data containing a significant percentage of gross errors, and is thus ideally suited for applications in automated image analysis where interpretation is based on the data provided by error-prone feature detectors. A major portion of this paper describes the application of RANSAC to the Location Determination Problem (LDP): Given an image depicting a set of landmarks with known locations, determine that point in space from which the image was obtained. In response to a RANSAC requirement, new results are derived on the minimum number of landmarks needed to obtain a solution, and algorithms are presented for computing these minimum-landmark solutions in closed form. These results provide the basis for an automatic system that can

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with applications to image analysis and automated cartography



Authors:  [Martin A. Fischler](#),  [Robert C. Bolles](#) [Authors Info & Affiliations](#)






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issue_date = {June 1981},
publisher = {Association for Computing Machinery},
address = {New York, NY, USA},
volume = {24},
number = {6},
issn = {0001-0782},
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Automatically Scheduling Halide Image Processing Pipelines

Ravi Teja Mullapudi* Andrew Adams[‡] Dillon Sharlet[‡] Jonathan Ragan-Kelley[†] Kayvon Fatahalian*

*Carnegie Mellon University

[‡]Google

[†]Stanford University

Abstract

The Halide image processing language has proven to be an effective system for authoring high-performance image processing code. Halide programmers need only provide a high-level strategy for mapping an image processing pipeline to a parallel machine (a *schedule*), and the Halide compiler carries out the mechanical task of generating platform-specific code that implements the schedule. Unfortunately, designing high-performance schedules for complex image processing pipelines requires substantial knowledge of modern hardware architecture and code-optimization techniques. In this paper we provide an algorithm for automatically generating high-performance schedules for Halide programs. Our solution extends the function bounds analysis already present in the Halide compiler to automatically perform locality and parallelism-enhancing global program transformations typical of those employed by expert Halide developers. The algorithm does not require costly (and often impractical) auto-tuning, and, in seconds, generates schedules for a broad set of image processing benchmarks that are performance-competitive with, and often better than, schedules manually authored by expert Halide developers on server and mobile CPUs, as well as GPUs.

Keywords: image processing, optimizing compilers, Halide

Concepts: •Computing methodologies → Graphics systems and interfaces;

algorithm's execution on a machine (called a *schedule*). The Halide compiler then handles the tedious, mechanical task of generating platform-specific code that implements the schedule (e.g., spawning threads, managing buffers, generating SIMD instructions).

Although Halide provides high-level abstractions for expressing schedules, *designing* schedules that perform well on modern hardware is hard; it requires expertise in modern optimization techniques and hardware architectures. For example, around 70 software engineers at Google currently write image processing algorithms in Halide, but they rely on a much smaller cadre of Halide scheduling experts to produce the most efficient implementations. Further, production image processing pipelines are long and complex, and are difficult to schedule even for the best Halide programmers. Arriving at a good schedule remains a laborious, iterative process of schedule tweaking and performance measurement. Also, in large production pipelines, software engineering considerations (e.g., modularity, code reuse) may preclude experts from having the global program knowledge needed to create optimal schedules.

In this paper we address this problem by providing an algorithm for automatically generating high-performance schedules for Halide programs. Our approach is to leverage the function bounds analysis already present in the Halide compiler to automatically perform locality enhancing global program transformations similar to those employed by expert Halide developers. The algorithm does not require costly (and often impractical) auto-tuning, and, in seconds,

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