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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte JACOPO PANTALEONI

Appeal 2017-008118
Application 13/719,796
Technology Center 1600

Before DEMETRA J. MILLS, JEFFREY N. FREDMAN and
JOHN G. NEW, *Administrative Patent Judges*.

MILLS, *Administrative Patent Judge*.

DECISION ON APPEAL

This is an appeal under 35 U.S.C. § 134. The Examiner has rejected as directed to an abstract idea, and for obviousness. We have jurisdiction under 35 U.S.C. § 6(b).

We affirm.

NATURE OF THE INVENTION

The present invention generally relates to bioinformatics and, more specifically, to the streaming processing of short read alignment algorithms. Spec. 1. In bioinformatics, aligning portions of DNA (referred to herein as “short read”) with a reference genome provides valuable information for DNA analysis, such as identifying sequence variations and mutations. To generate such information, hundreds of thousands of short reads are aligned with a reference genome. Performing alignment operations in an efficient manner requires fast and accurate alignment algorithms, such as the Burrows Wheeler Aligner (BWA). *Id.*

Typically, an instance of an alignment algorithm for aligning a particular short read with a reference genome is executed on a single thread within a processing unit in a single thread, multiple data (SIMT) environment, however, such an execution mode is not efficient because the alignment algorithm does not execute uniformly across every thread. More specifically, when each thread in multiple threads executes an entire instance of the alignment algorithm, at given points in time, each thread may be executing different portions of the alignment algorithm as necessary. In a SIMT environment, having different threads executing different stages of an algorithm is extremely inefficient because the threads that are ahead must wait for the remaining threads to reach the same execution point. Requiring threads to wait for the remaining threads wastes processing cycles and slows down the overall execution of the various instances of the alignment algorithm.

Spec. 2. An advantage of claimed method

is that threads within a thread group executing a particular stage of the alignment algorithm perform the same alignment operations on data associated with different short reads. Having a distinct thread group perform each stage of the alignment algorithm reduces the

number of wasted processing cycles because all the threads within a particular thread block perform the same operations and thus do not have to wait for other operations to complete.

Spec. 6.

STATEMENT OF CASE

The following claim is representative.

1. A computer-implemented method for aligning a plurality of short reads, each short read comprising a set of base pairs, with a reference genome, the method comprising:

generating a plurality of root nodes, wherein each root node in the plurality of root nodes is a root node of a search tree corresponding to each short read in the plurality of short reads;

instantiating a plurality of thread groups within a processing unit for performing an alignment algorithm based on the tree representation, wherein the alignment algorithm includes a plurality of sequential stages, and each thread group is responsible for executing a different stage included in the plurality of sequential stages; and

transmitting the plurality of root nodes to the processing unit for processing.

Grounds of Rejection

Claims 1-20 are rejected under 35 U.S.C. §101 because the claimed inventions are directed to non-statutory subject matter.

Claims 1-20 are rejected under pre-AIA 35 U.S.C. §103(a) as being unpatentable over Schatz, Mattson, and Meijer.

FINDINGS OF FACT

The Examiner's findings of fact are set forth in the Answer at pages 3-10; Final Action at pages 2-11.

PRINCIPLES OF LAW

In making our determination, we apply the preponderance of the evidence standard. *See, e.g., Ethicon, Inc. v. Quigg*, 849 F.2d 1422, 1427 (Fed. Cir. 1988) (explaining the general evidentiary standard for proceedings before the Office).

“The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.” *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007).

In *KSR*, the Supreme Court stated:

When there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. If this leads to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense. In that instance the fact that a combination was obvious to try might show that it was obvious under § 103.

KSR International Co., v. Teleflex Inc., 550 U.S. 398, 421 (2007).

§101 Rejection, unpatentable subject matter

The Examiner finds that

The claims as a whole, considering all claim elements both individually and in combination, do not amount to significantly more than the abstract idea of an algorithm that aligns a set of short

nucleotide reads to a reference sequence; a series of data processing steps or algorithm is a court-established abstract idea, and further is similar to other court-established abstract ideas such as mathematical operations and procedures for organizing information.

Final Act. 2.

Appellant contends that when the pending §101 rejection is evaluated under the two-step framework set forth in *Alice Corp. Pty. Ltd. v. CLS Bank Int'l*, 134 S.Ct. 2347, 2355 (2014), it is found that the claimed method “improves computer capabilities, as opposed to simply invoking a computer as a tool. In particular, the claimed approach enables a parallel processing environment - including a plurality of thread groups – to more efficiently execute an alignment algorithm to align a plurality of short reads with a reference genome. See Application at ¶ [0004].” Reply Br. 9. Appellant argues that, “The claimed approach improves the functionality of the parallel processing system by dividing the alignment algorithm into a plurality of sequential stages.” Reply Br. 10. Appellant argues that “under the Guidance and DDR Holdings,^[1] the claimed approach provides a technical solution to a technical problem arising in computing systems.” Reply Br. 11. Appellant argues that the claims do not preempt an abstract idea and that, “with respect to the second prong of the two-step Alice test, the claims include additional elements that amount to “significantly more” than an abstract idea itself,” and the claims include one unconventional step. Reply Br. 13.

¹ *DDR Holdings, LLC v. Hotels.com, L.P.*, 773 F.3d 1245, 1257 (Fed. Cir. 2014).

ANALYSIS

We agree with the Examiner's fact finding, statement of the rejection and responses to Appellant's arguments as set forth in the Answer. We find that the Examiner has provided argument/evidence to support a prima facie case of unpatentable subject matter because the claims are directed to an abstract idea. We provide the following additional comment to the Examiner's argument set forth in the Final Rejection and Answer.

The Examiner argues that additional non-abstract claim elements do not provide meaningful limitations to transform the abstract idea into a patent eligible application of the abstract idea such that the claims amount to significantly more than the abstract idea itself. Ans. 6. In particular, the Examiner argues that the claims do not recite additional elements other than the abstract idea per se and the claims

amount to no more than mere instructions to implement the abstract idea as "a plurality of thread groups within a processing unit" (as in claim 1 and its dependents), and other generic computer structures such as "a computer-readable medium" and "a memory" and "an instantiation engine" (as in claims 10, 19 and their dependents). As demonstrated by numerous references of record (*e.g.* Klus 2012, Ligowski 2009, Liu 2011, Lu 2012, Mahmood 2011, Schatz2007, Shi 2009 and Trapnell 2009), implementing algorithms - including nucleotide sequence alignment or assembly algorithms - as multithreaded GPGPU-accelerated computer programs was a well-understood, routine and conventional activity in the art prior to the time of invention.

Final Act. 3. Furthermore, the Examiner finds that

"the claimed solution is directed to solving the problem in the conventional art [of alignment algorithms] ... to provide a more efficient way to execute an alignment algorithm via multiple thread

groups” (Reply, p. 11). Sequence alignment is not “a problem rooted in computer technology”; problems of sequence alignment do not arise from the use of computers, nor are computers necessary to perform sequence alignment.

Final Act. 4. The Examiner argues that, “the claims are not actually limited to executing the alignment algorithm using “a specific type of computer hardware” (Reply, p. 9) or “in a SIMT [single instruction multiple thread] environment” (Reply, pp. 8-10).” Final Act. 4. The Examiner finds that

The disclosure describes an exemplary “parallel processing unit” (0023; 202@ Fig. 2), but the description is so generic that it encompasses any multi-core processor, which were essentially ubiquitous at the time of invention, and this description does not limit the claims. The examiner has applied art wherein a GPGPU constitutes the claimed “processing unit”, but a generic claim limitation cannot be interpreted as being limited only a particular species disclosed in the art applied in a § 103 rejection. So all of Applicant’s discussion of SIMT environments or any other particular hardware is irrelevant to the claims because the claims are not limited to being implemented by any device more specific than “a processing unit”. The fact that the claims are not limited to any particular computer hardware or processing environment is further evidence that the claims are not an improvement to computer technology.

Final Act. 5.

In *Alice*, the Supreme Court referred to the two-step analysis set forth in *Mayo Collaborative Servs. v. Prometheus Labs., Inc.*, 132 S.Ct. 1289 (2012), as providing “a framework for distinguishing patents that claim laws of nature, natural phenomena, and abstract ideas from those that claim patent-eligible applications of those concepts.” *Alice*, 134 S.Ct. at 2355 (citing *Mayo*, 132 S.Ct. at 1289). Under *Mayo*, “[w]e must first determine

whether the claims at issue are directed to a patent-ineligible concept.” *Id.* Next, “we consider the elements of each claim both individually and ‘as an ordered combination’ to determine whether the additional elements ‘transform the nature of the claim’ into a patent-eligible application.” *Id.* (citing *Mayo*, 132 S.Ct. at 1297–98).

Under *Mayo*, to be patentable, a claim must do more than simply state the law of nature or abstract idea and add the words “‘apply it.’” *Mayo*, 132 S.Ct. at 1294; *Benson*, 409 U.S. at 67. For example, “the mere recitation of a generic computer cannot transform a patent-ineligible abstract idea into a patent-eligible invention.” *Alice*, 134 S.Ct. at 2358. “Thus, if a patent’s recitation of a computer amounts to a mere instruction to ‘implemen[t]’ an abstract idea ‘on . . . a computer,’ that addition cannot impart patent eligibility.” *Id.* (internal citation omitted).

In addition, the “notion that [extra]-solution activity, no matter how conventional or obvious in itself, can transform an unpatentable principle into a patentable process exalts form over substance.” *Parker v. Flook*, 437 U.S. 584, 590 (1978). *See also Mayo*, 132 S.Ct. at 1298 (“Purely ‘conventional or obvious’ ‘[pre]-solution activity’ is normally not sufficient to transform an unpatentable law of nature into a patent-eligible application of such a law.”).

A challenged patent claim, properly construed, must incorporate enough meaningful limitations to ensure that it claims more than just an abstract idea and not just a mere “drafting effort designed to monopolize the [abstract idea].” *Alice*, 134 S.Ct. at 2357 (quoting *Mayo*, 132 S.Ct. at 1297). “Simply appending conventional steps, specified at a high level of

generality,” is not “*enough*” for patent eligibility. *Id.* (quoting *Mayo*, 132 S. Ct. at 1300).

In the present case, under the *Mayo* analysis, our first question is whether claim 1 is directed to a judicial exception, an abstract idea. Similar to the claim in *Alice*, present claim 1 is directed to a computer-implemented method, in particular, a method for aligning a plurality of short reads, each short read comprising a set of base pairs, with a reference genome. Essentially, claim 1 is directed to an abstract idea, an alignment algorithm, which is executed in sequential stages.

With respect to the first prong of the two-step test, the Federal Circuit has emphasized that the first prong “asks whether the focus of the claims is on the specific asserted improvement in computer capabilities ... or, instead, on a process that qualifies as an ‘abstract idea’ for which computers are invoked merely as a tool.” *See Enfish, LLC v. Microsoft Corp.*, No. 2015-1244, slip op. at 11 (Fed. Cir. May 12, 2016). We, therefore find that under *Alice*, step 1, the claims are directed to an abstract idea, an alignment algorithm, for which computers are invoked as a tool. We further find that the claims do not recite an inventive concept sufficient to transform any abstract idea into patent-eligible subject matter.

Next, “we consider the elements of each claim both individually and ‘as an ordered combination’ to determine whether the additional elements ‘transform the nature of the claim’ into a patent-eligible application.” *Id.* (citing *Mayo*, 132 S. Ct. at 1297–98).

We agree with the Examiner that

The claimed invention is not an improvement to a computer technology, nor to the computer itself: “the present invention

generally relates to bioinformatics and, more specifically, to the streaming processing of short read alignment algorithms” (Specification ¶ 0001) and “the present invention sets forth a method for aligning a plurality of sets of base pairs to a reference genome (Specification ¶ 0005).”

Ans. 6. We further agree with the Examiner that the claims “are not directed to a parallel processing environment” (Brief, p. 15) or “a specific type of computer hardware” (Brief, p. 17). The claims recite only a generic “processing unit”, which does not imply any particular type of computer hardware, much less “a parallel processing environment.” Ans. 7. None of the claims actually require execution of the alignment algorithm in a parallel processing environment (or any other environment for that matter). Ans. 8. Thus, the claims amount to mere use of a generic, general-purpose computer to prepare data, and an algorithm for execution on another generic processing unit (*cf.* Specification ¶¶ 0067-0068). Ans. 8-9.

Appellant argues that the pending claims recite at least one unconventional step. App. Br. 19. The Examiner, in turn, argues that, “Schatz and numerous other references of record demonstrate that[,] prior to the time of invention, multithreaded computer programs, and GPGPU acceleration of such programs (*i.e.* the non-abstract elements on the claims) were well-understood, routine and conventional practices for implementing algorithms, including sequence alignment and assembly algorithms.” Ans. 9. We do not find that Appellant has provided sufficient evidence to counter the Examiner’s evidence that the claimed methods were well-understood, routine and conventional practices for implementing algorithms as described

in Mattson. The additional elements ‘transform the nature of the claim’ into a patent-eligible application.

In sum, “[s]imply appending conventional steps, specified at a high level of generality,” to a method already “well known in the art” (parallel processing of an algorithm) is not “enough” to supply the “ ‘inventive concept’ ” needed to make this transformation.” *Alice*, 134 S.Ct. at 2350 (quoting *Mayo*, 132 S.Ct. at 1297). “The introduction of a computer into the claims does not alter the analysis.” *Alice*, 134 S.Ct. at 2357 (quoting *Mayo*, 132 S.Ct. at 1294).

For the reasons of record, we affirm the Examiner’s lack of patentable subject matter rejection.

Obviousness Rejection

For the reasons outlined in the Final Action at pages 6-9, we find that the Examiner has set forth a prima facie case of obviousness. The Examiner found that Schatz teaches each element claimed, but “differs from the claimed invention in that only one stage of the algorithm is executed as a thread group on the GPU, whereas in the claimed invention, multiple different stages of the algorithm are implemented as thread groups on the processing unit.” Final Act. 6. The Examiner relies on Mattson to make up for the deficiency of Schatz. Final Act. 7.

Mattson teaches design patterns for parallelizing computational problems. These patterns include data parallelism (p. 36 § 3.3.1.2), for which “GPU hardware is specifically designed to support problems that use the data parallelism pattern” (p. 37); and pipelines, in which sequential independent steps are performed by a thread or a group of threads (p. 39 § 3.3.1.4). A common parallel implementation

pattern is the task-queue pattern (p. 49 § 3.3.2.5), in which a pool of threads pull independent tasks from a shared queue. Since Schatz teaches that the overall algorithm constitutes several different stages (p. 4 § “Implementation”), the combined teachings of Schatz and Mattson suggest implementing the multiple stages on the GPU as a pipeline, in which each stage of the pipeline is implemented as a separate group of threads that execute a task pulled from a share queue.

Final Act. 7.

We are not persuaded by Appellant’s arguments. Appellant argues that, “Schatz fails to disclose instantiating a plurality of thread groups within the GPU, where each thread group is responsible for executing a different stage of an alignment algorithm.” Reply Br. 3; App. Br. 12. However, Appellant errs in attacking the references individually, as the rejection is based on a combination of references, both Schatz and Mattson. *See In re Merck & Co., Inc.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986). The references cannot be read in isolation, but for what they teach in combination with the prior art as a whole. *See id.*

The Examiner relied on Mattson, not Schatz, for the disclosure that it was well known in the art to employ parallel algorithm strategy patterns to solve any problem with segments that can execute concurrently. Mattson, p. 34, § 3.31. In particular, Mattson discloses that

Parallel programming is the application of concurrency to (1) solve a problem in less time or (2) solve a bigger problem in a fixed amount of time. Concurrency is present in a system when multiple tasks can be active and potentially make progress at the same time. The processes of creating a parallel algorithm can therefore be summarized in two steps:

1. Find tasks that can execute concurrently.
2. Manage data conflicts between tasks so the same results are produced (within round-off error) for every semantically allowed way the execution of the tasks can be interleaved.

To solve any problem in parallel, you must decompose the problem into concurrent tasks AND decompose the data to manage data access conflicts between tasks.

The goal of the algorithm strategy patterns is to define this dual task/data decomposition. They start with a conceptual understanding of a problem and how it can be executed in parallel. They finish with a decomposition of the problem into concurrent tasks and data.

Mattson, p. 34, § 3.3.1, § 3.3.1.4; Ans. 4.

We agree with the Examiner that,

Since Schatz teaches that the overall algorithm constitutes several different stages (p. 4 § “Implementation”), the combined teachings of Schatz and Mattson suggest implementing the multiple stages on the GPU as a pipeline, in which each stage of the pipeline is implemented as a separate group of threads that execute a task pulled from a share queue.

Final Act. 7.

In *KSR*, the Supreme Court stated:

When there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. If this leads to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense.

KSR International Co., v. Teleflex Inc., 550 U.S. 398, 421 (2007). In the present case, Appellant combines the predictable solution of parallel

processing of algorithm steps (as described in Mattson, Schatz) with a method for aligning a plurality of short reads, each short read comprising a set of base pairs, with a reference genome (as described in Schatz). This led to the anticipated success of faster processing of sequence alignment and is the obvious result of the ordinary skill in the art.

The obviousness rejection is affirmed for the reasons of record.

CONCLUSION OF LAW

The cited references support the Examiner's obviousness rejection, which is affirmed for the reasons of record. The lack of patentable subject matter rejection is also affirmed. All pending, rejected claims fall.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED