Lemelson-MIT Prize

Patent Portfolio of Ramesh Raskar - 2016 Winner

Report for: Lemelson-MIT Program

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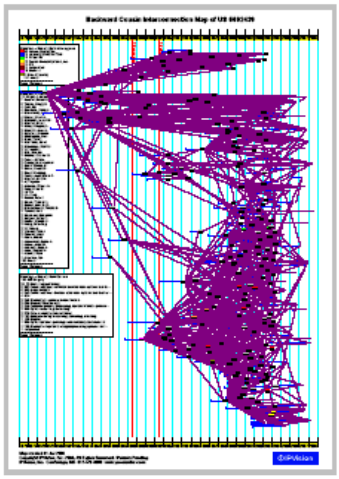

IPVision
Patent Interconnection Map

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Report Date: August 15, 2016

Patent Portfolio of Ramesh Raskar - 2016 Winner
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Important Note About Data. The analyses presented in this Report were based on data as of August 15, 2016 – i.e., the patents listed for a given company represent patents owned of record as shown at the U.S. Patent and Trademark Office databases as of that date. Patents issued to, acquired by or disposed of by such a company after August 15, 2016 will not appear in the list of patents shown in this Report or on IPVision See-The-Forest.com™. However, patents that issue after August 15, 2016 that cite a patent shown in an analysis in this Report will appear in any citation analysis run after August 15, 2016 on the information stored on IPVision See-The-Forest.com ™. In such as case there will be an inconsistency between the results presented in this Report (which is a snapshot in time) and the results shown on IPVision See-The-Forest.com ™.

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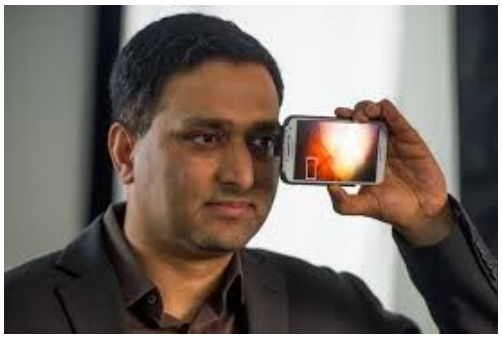
1. RAMESH RASKAR



Dr. Ramesh Raskar, the 2016 Winner of the Lemelson-MIT Prize, is Associate Professor of Media Arts and Sciences at the MIT Media Lab. Dr. Raskar joined the Media Lab from Mitsubishi Electric Research Laboratories in 2008 as head of the Lab's Camera Culture research group. His research interests span the fields of computational photography, inverse problems in imaging, and human-computer interaction. Recent inventions include transient imaging to look around a corner, a next-generation CAT-scan machine, imperceptible markers for motion capture (Prakash), long-distance barcodes (Bokode), touch + hover 3D interaction displays (BiDi screen), low-cost eye care devices (NETRA) and new theoretical models to augment light fields (ALF) to represent wave phenomena. He received a Ph.D. in Computer Science from the University of North Carolina at Chapel Hill (2002).

As of the date of this report Dr. Raskar is listed as a named inventor on 71 issued U.S. patents and 26 published pending U.S. patent applications (the "Raskar Patent Properties"). The 10 most hightly cited issued Raskar Patents are:

Top Ten Most Highly Cited U.S. Patents of Ramesh Raskar				
Patent #	Inventors	Title	Citations By (BCs)	Citations To (FCs)
6764185	Beardsley, Paul A.; Raskar, Ramesh; Forlines, Clifton L.; Brinkman, Dirk	Projector as an input and output device	6	75
6520647	Raskar, Ramesh	Automatic keystone correction for projectors with arbitrary orientation	5	70
6733138	Raskar, Ramesh	Multi-projector mosaic with automatic registration	2	70
6793350	Raskar, Ramesh; van Baar, Jeroen; Rao, Srinivasa G.; Willwacher, Thomas H.	Projecting warped images onto curved surfaces	4	52
6811264	Raskar, Ramesh; van Baar, Jeroen; Beardsley, Paul A.	Geometrically aware projector	5	49
7792423	Raskar, Ramesh; Agrawal, Amit Kumar	4D light field cameras	10	49
7580620	Raskar, Ramesh; Tumblin, Jack; Agrawal, Amit	Method for deblurring images using optimized temporal coding patterns	2	45
6755537	Raskar, Ramesh; van Baar, Jeroen; Beardsley, Paul A.	Method for globally aligning multiple projected images	3	40
7154395	Raskar, Ramesh; Beardsley, Paul A.; van Baar, Jeroen; Dietz, Paul H.	Interactive wireless tag location and identification system	8	40
6527395	Raskar, Ramesh; Beardsley, Paul	Method for calibrating a projector with a camera	5	36

View Raskar Patents on IPVision *See-The-Forest.com* ™ ► Link to List

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Top Ten Most Highly Cited U.S. Patents of Ramesh Raskar				
Patent #	Inventors	Title	Citations By (BCs)	Citations To (FCs)

View Full List of Patent Properties on IPVision *See-The-Forest.com* ™ ► Link to List

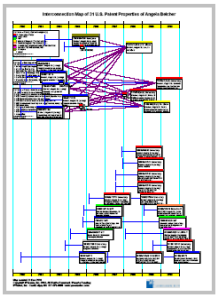
1.1 RASKAR PATENT PORTFOLIO INTERCONNECTION MAP

An IPVision Patent Portfolio Interconnection Map shows all of the U.S. patents and published U.S. patent applications that comprise the patent portfolio of the Inventor. These are displayed as "patent boxes" arrayed in time from left (earliest) to right (more recent). A line connecting a later patent box to an earlier patent box shows that the later patent cited the earlier patent as "prior patent art". See, Appendix A – Reading IPVision Maps.

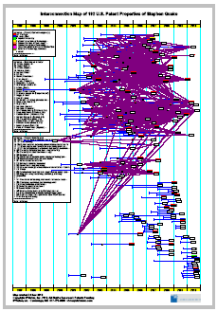
Note: A portfolio with a high degree of self citation is likely to have more commercial potential than a portfolio of individual inventions "scattered about".

Two examples of patent portfolios are shown to the right. The top portfolio is of Angela Belcher (44 patent properties), the 2013 Lemelson-MIT Prize Winner. The bottom portfolio is that of Stephen Quake (192 patent properties), the 2012 Lemelson-MIT Prize Winner. Not only does Dr. Quake have more patents, they are also more "clustered" than those of Dr. Belcher. Note: in both cases we have included published U.S. patents applications that have issued as U.S. patents.

Dr. Quake's portfolio is more clustered primarily because of the patents issued to Fluidigm, a leading microfluidics company founded by Dr. Quake.



Angela Belcher – 2013 Winner



Stephen Quake – 2012 Winner

The following is an IPVision Patent Portfolio Interconnection Map™ showing the patent citation relationships among the Raskar Patent Properties:

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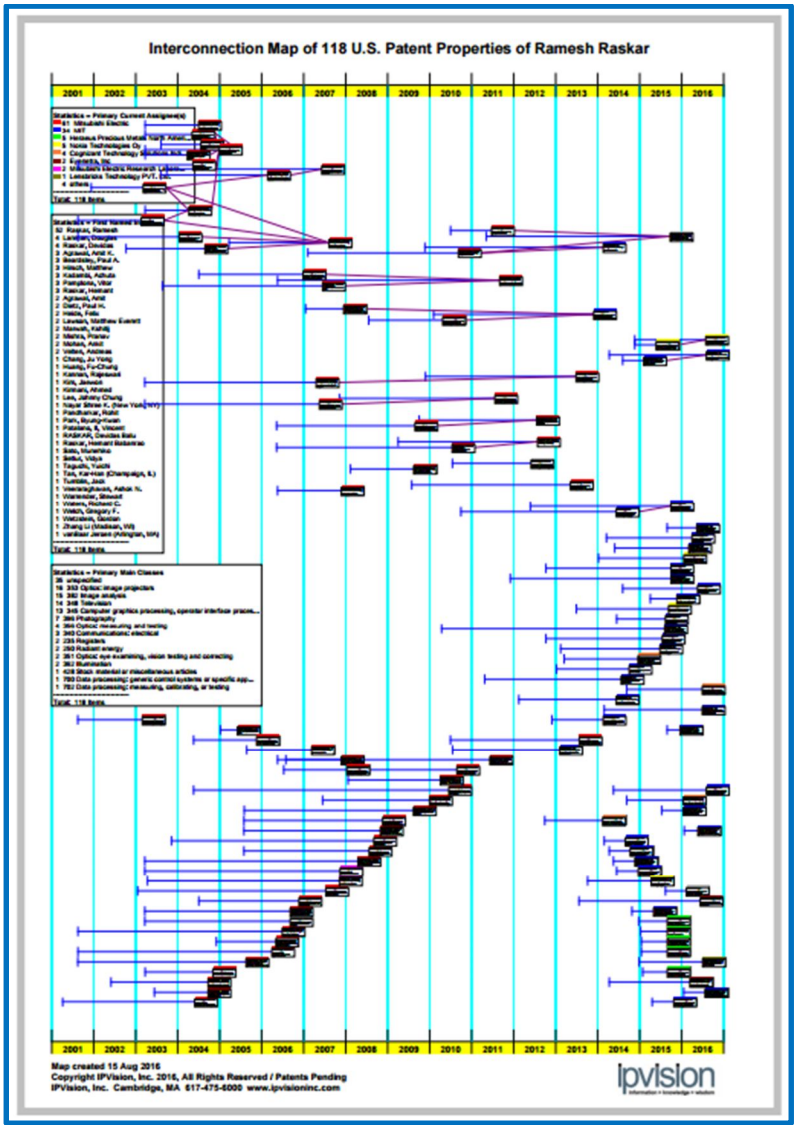
Patent Portfolio Interconnection Map™ of Ramesh Raskar



Statistics -- Primary Current Assignee(s)

- 61 Mitsubishi Electric
- 34 MIT
- 5 Heraeus Precious Metals North Ameri...
- 5 Nokia Technologies Oy
- 4 Cognizant Technology Solutions Indi...
- 2 Eyenetra, Inc
- 2 Mitsubishi Electric Research Labora...
- 1 Lensbricks Technology PVT. Ltd.
- 4 others

Total: 118 Items

Patent Portfolio Interconnection Map™: This IPVision Patent Portfolio Interconnection Map™ shows the U.S. patent properties of Ramesh Raskar on a timeline from left to right. Each box is a patent or pending application with the left edge of the box aligned in time based on issue date (for patents) or publication date (for applications).

The lines connecting the boxes are citation references.

Click on the Map Image to view an interactive map online. When viewing the interactive map you can "right click" to view the underlying patent and related information.

Note: For information about Reading IPVision Maps, see Appendix A

View Live IPVision Map™ ► Link to Map

1.2 PATENTS CITING THE RASKAR PATENTS

In order to obtain a patent an inventor must show that his or her invention is new or "novel". During the patent prosecution process the inventor must disclose to the U.S. Patent and Trademark Office all "prior art" of which the inventor is aware that is relevant to the determination of whether the invention is novel. Prior art consists of papers, articles and patents. In addition the Patent Examiner conducts searches of literature and patents as part of the novelty determination.

The citations by patents of prior art are often more relevant than citations in academic papers because the prior art citations have legal significance, – i.e., a patent can be invalidated if an inventor fails to cite prior art of which he or she is aware.

Patent citations also provide insights into how the invention(s) described in the patent lead to later

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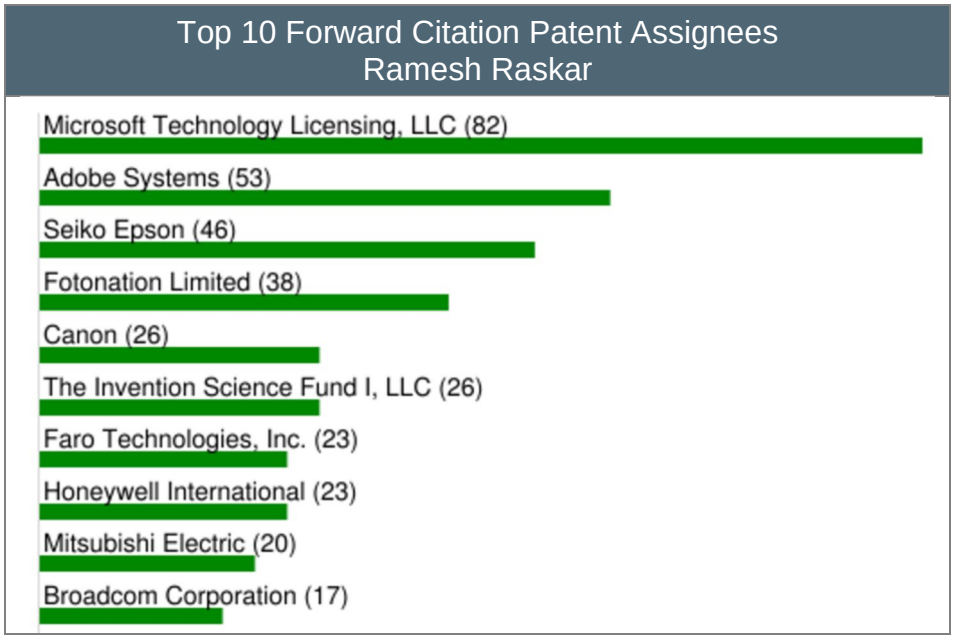
inventions, – i.e., how those inventions "spawned" later inventions.

With these considerations in mind we identified the 805 U.S. patents that cite the Raskar Patent Properties as prior patent art ("Forward Citation Patents"). These patents cite the Raskar Patent Properties 1,205 times.

View "List of Forward Citation Patents" on IPVision *See-The-Forest.com*™ ► Link to List

According to the U.S. Patent and Trademark Office records, the Top 10 Current Assignee/Owners of the Forward Citation Patents are:



View "Forward Citation Assignee Analysis™" on *See-The-Forest.com*™ ► Link to Analysis

1.3 Relative Citation Frequency

The number of citations of an inventor's patents by other inventors is a measure of the importance of an invention.[1] The Relative Citation Frequency for a patent is an IPVision developed normalized metric that measures how highly cited the patent is relative to Peer Patents (patents in the same technology area of the same age) where 100 equals the most cited.[2]

[1] See, Jaffe, Adam B. and Trajtenberg, Manuel, *Patents, Citations & Innovations: a Window on the Knowledge Economy* (Cambridge, The MIT Press, 2002)
[2] See "Appendix B - Relative Citation Frequency" for a fuller description of Relative Citation Frequency.

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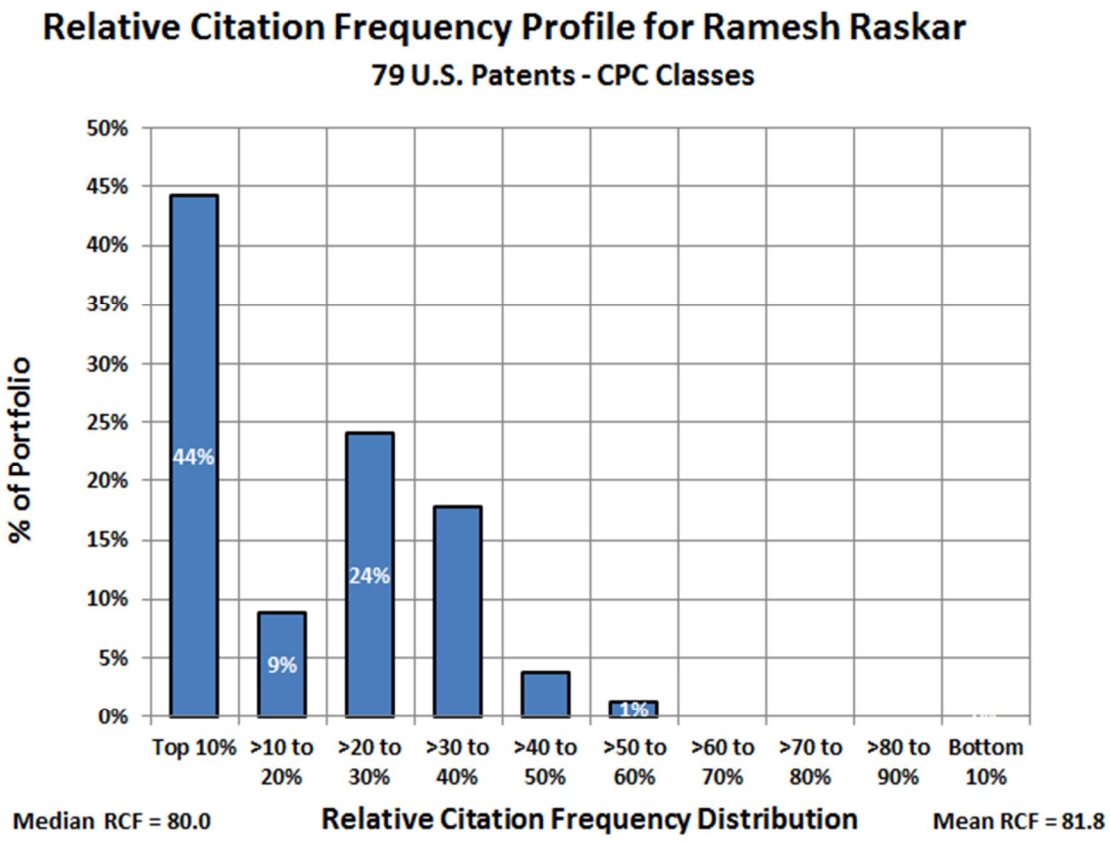
The Relative Citation Frequency scores distribution for the Raskar Portfolio are:



This profile shows that the Raskar patents are **Highly Cited** relative to their Peer Patents, with 53% of the patents in the portfolio being in the top 20% most highly cited range and 44% in the top 10%.. Mean RCF Score = 81.8; Median = 80.0. See Appendix B - Relative Citation Frequency.

1.4 RASKAR PATENT LANDSCAPE MAP

It is not practicable to produce a Full IPVision Forward Citation Landscape Map for the Raskar Patent Properties because there are too many patents citating the Raskar Portofolio. The following “Forward Citation Landscape Map” shows the 5 most highly cited Raskar Patents and the patents that cite them:

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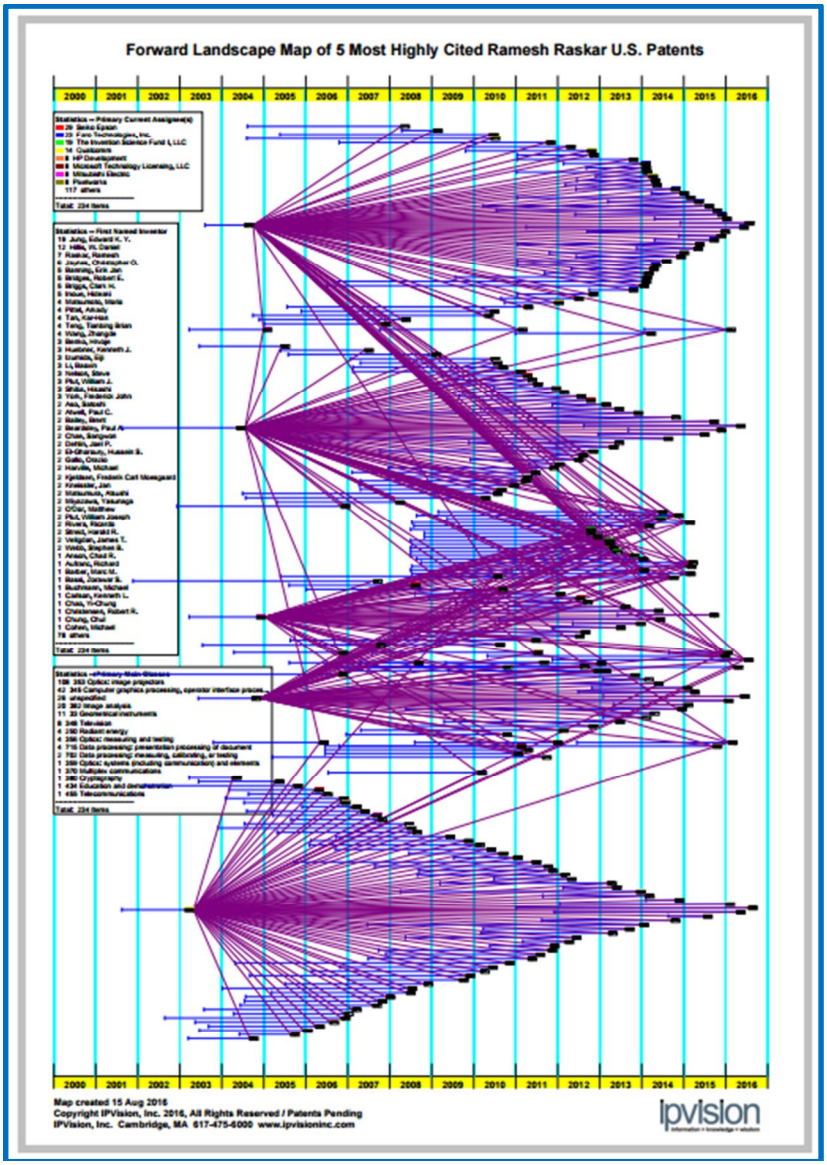
Forward Patent Citation Landscape Map™ of Ramesh Raskar's 5 Most Highly Cited U.S. Patents



Note: For information about Reading IPVision Maps, see Appendix A

Statistics -- Primary Current Assignee(s)

29	Seiko Epson
23	Faro Technologies, Inc.
19	The Invention Science Fund I, LLC
14	Qualcomm
8	HP Development
8	Microsoft Technology Licensing, LLC
8	Mitsubishi Electric
8	Pixelworks
117	others
Total:	234 Items

Patent Citation Landscape Map™: This IPVision Forward Patent Citation Landscape Map™ shows the 5 most highly cited Raskar Patents on a timeline from left to right. The Raskar Patents are on the left of the "fans". To the right of each Raskar patent are the Forward Citation Patents – i.e., patents that cite the Raskar Patents as prior patent art.

View Live IPVision Map™ ► Link to Map

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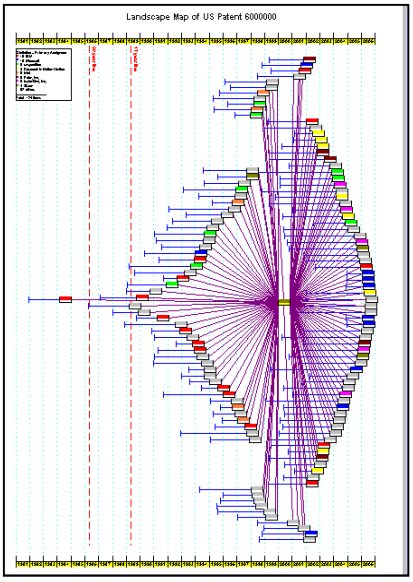
APPENDICES AND EXHIBITS

APPENDIX A – HOW TO READ AN IPVISION MAP

An IPVision Map is a visual representation of the relationships between objects. The following is an example of a Landscape Map for a single U.S. Patent:

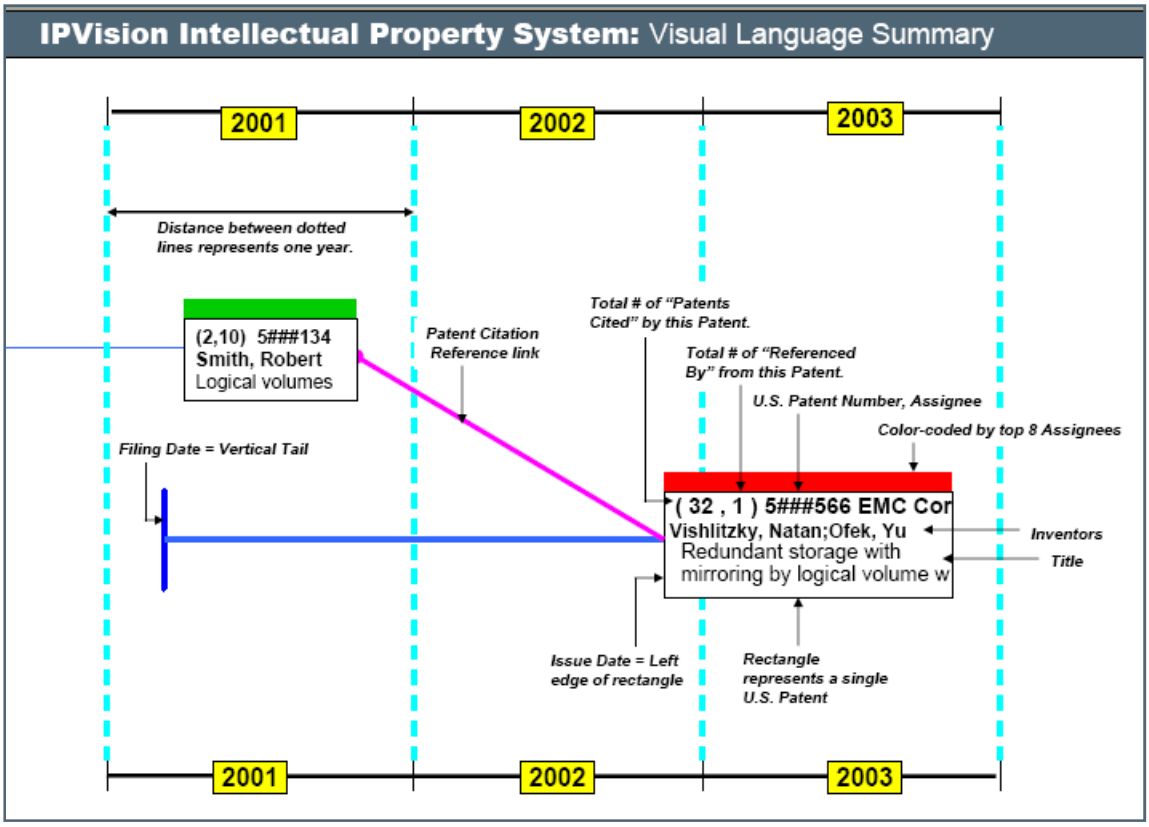


This Landscape Map is of U.S. Patent 6,000,000 entitled "Extendible method and apparatus for synchronizing multiple files on two different computer systems". It is the basic patent for the Palm Pilot software.

The horizontal X axis is "time"

Patent 6000000 is in the middle of the "fan". The lines going backward (to the left) are the patents cited by Patent 6000000 and the lines going forward (to the right) show the patents which cite Patent 6000000.

The details of an IPVision Map are explained in more detail below. See also a Guide To Reading IPVision Patent Maps.



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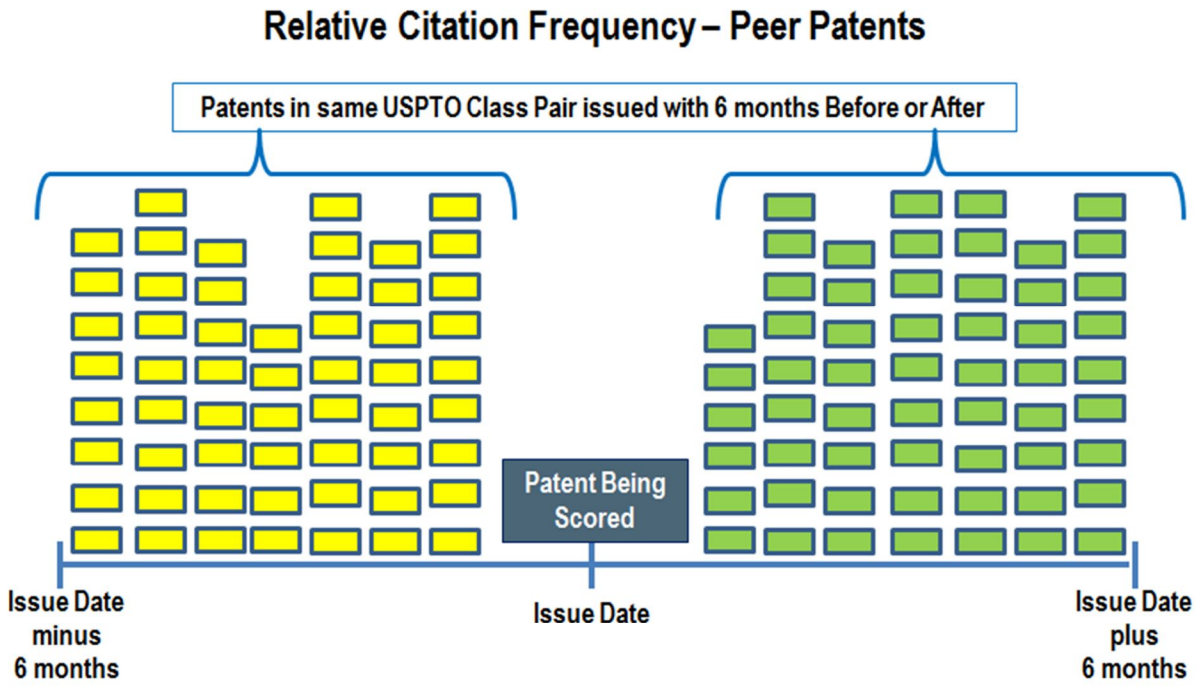
APPENDIX B - RELATIVE CITATION FREQUENCY

The number of citations of an inventor's patents by other inventors is a measure of the importance of an invention.[3] However, the number of patent citations to a patent is a function of the importance of the patent, the speed of patenting in the technology area and the age of the patent (the older the patent the more time it has to be cited). Accordingly, one can not tell whether a patent that is cited 50 times is "highly cited" or whether 50 citations is "average" unless you look at the number of citations relative to the patent's "peers".

IPVision has developed a Relative Citation Frequency (RCF) Score for a patent. For a given patent the RCF Score algorithm finds that patent's "Peer Patents", i.e., all patents in the same U.S. Patent Classification System[4] "class pair" that were issued within 6 months before or after the patent being scored. RCF then determines the relative citation frequency of the patent versus its Peer Patents.



RCF Score for a Patent

Once the Peer Patents are assembled for the patent being scored we look at the minimum and maximum number of citations to the Peer Patents and we normalize these on a scale from 0 to 100 where 100 is the most highly cited of the Peer Patent group. We then place the patent being scored in context in the Peer Patent group. The resulting score represents the percentage of the Peer Patents that are cited LESS than the patent being scored, -e.g., a score of 92 means the patent is cited more often than 91.9% of the Peer Patents.

RCF Score for a Portfolio

To analyze a group or portfolio of patents we run RCF Scores on each patent and then calculate the Mean or Average RCF Score for the group. We then group the individual scores into deciles and present this

[3] See, Jaffe, Adam B. and Trajtenberg, Manuel, *Patents, Citations & Innovations: a Window on the Knowledge Economy* (Cambridge, The MIT Press, 2002)
[4] See the description of the Patent Classification System at the end of this Appendix.

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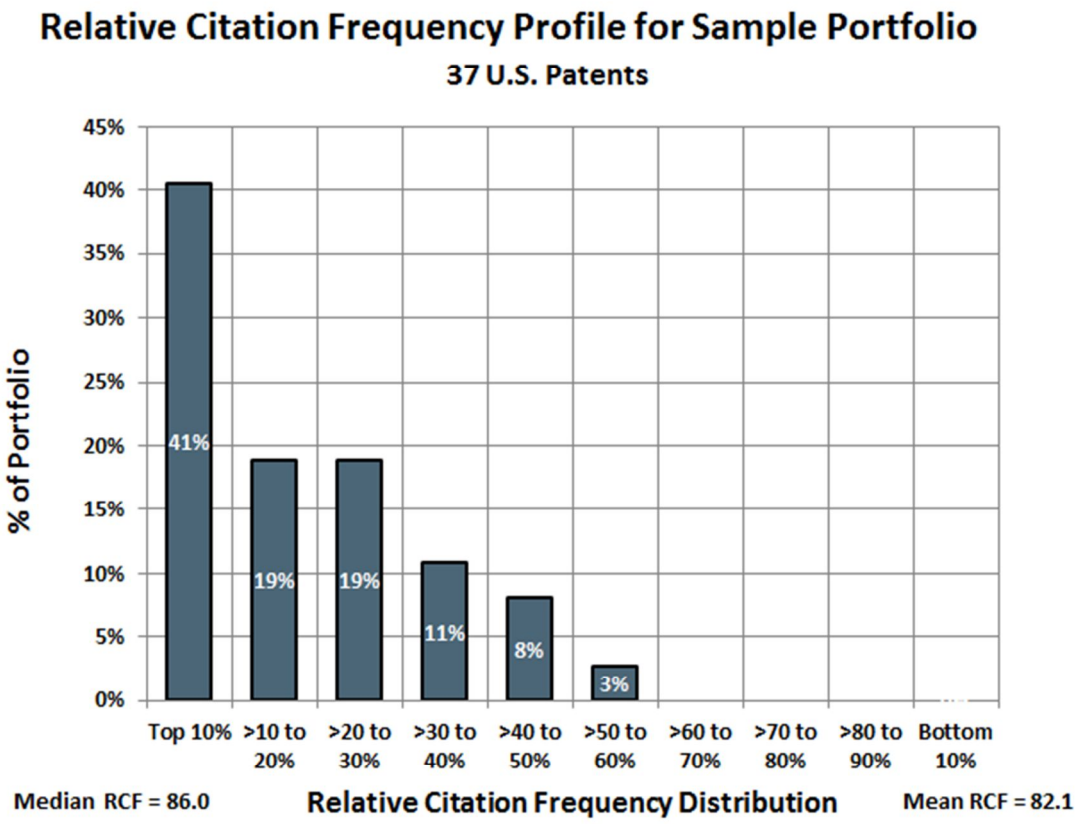
information in a visual form such as:



This profile shows that the patents in this Sample Portfolio are highly cited relative to their Peer Patents, with 60% of the patents in the portfolio being in the top 20% most highly cited range and 41% in the top 10%. Mean RCF Score = 82.1; Median = 86.0 Explanation: a RCF Score of 92 on an individual patent means that it is more highly cited than 91.9% of its Peer Patents (all patents in its technology area that were issued in the same time period) – i.e. it is in the "Top 10%" category in the above chart. For this Sample Portfolio 41% of the patents are in the Top 10% most highly cited category and the Mean RCF Score of 86.0 means that overall the patents in the Sample Portfolio are more cited than 85.9% of Peer Patents.

What is a Patent Classification? This is how the U.S. Patent and Trademark Office describes a Patent Classification:

> "*A Patent Classification is a code which provides a method for categorizing the invention. Classifications are typically expressed as "482/1". The first number, 482, represents the class of invention. The number following the slash is the subclass of invention within the class. There are about 450 Classes of invention and about 150,000 subclasses of invention in the USPC.*
>
> *Classes and subclasses have titles which provide a short description of the class or subclass. Classes and subclasses also have definitions which provide a more detailed explanation. Many Classes and subclasses have explicitly defined relationships to one another….*
>
> *A patent classification also represents a searchable collection of patents grouped together according to similarly claimed subject matter.*

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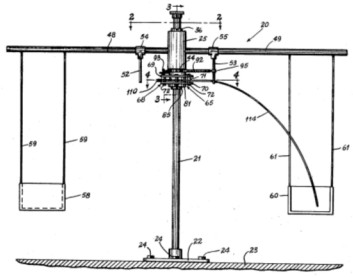
A classification is used both as a tool for finding patents (patentability searches), and for assisting in the assignment of patent applications to examiners for examination purposes.…. Classifications have hierarchical relationships to one another."

What is a Class Hierarchy? The USPTO Classification System sets up a hierarchy of classes to describe areas of technology and invention. The following Class Hierarchy for "playground equipment" illustrates how a hierarchy is set up:

Example: Class Hierarchy for "Playground Equipment"



This is the drawing of the invention described in a patent entitled "Occupant-Propelled Roundabout Swing Set". A rider sitting in one of the swings can pull on a cable which causes the swings to rotate around the poll.

The USPTO placed this invention in Class 472/122: Amusement Devices/Swing/Having a hand operator/Cable grasp. This Hierarchy is illustrated as follows:

US Patent Class 472 - Amusement Devices		
106	SEESAW	
	107	Motor Operated
	108	Foot, hand or seat operated
	109	Having a safety feature
	etc	
116	BODY SLIDE	
	117	Water Slide
118	SWING	
	119	Motor operated
	120	Having hand and foot operator
	121	Having hand operator
	122	Cable grasp
	124	Having foot operator with separate suspender

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