MV4D Survey

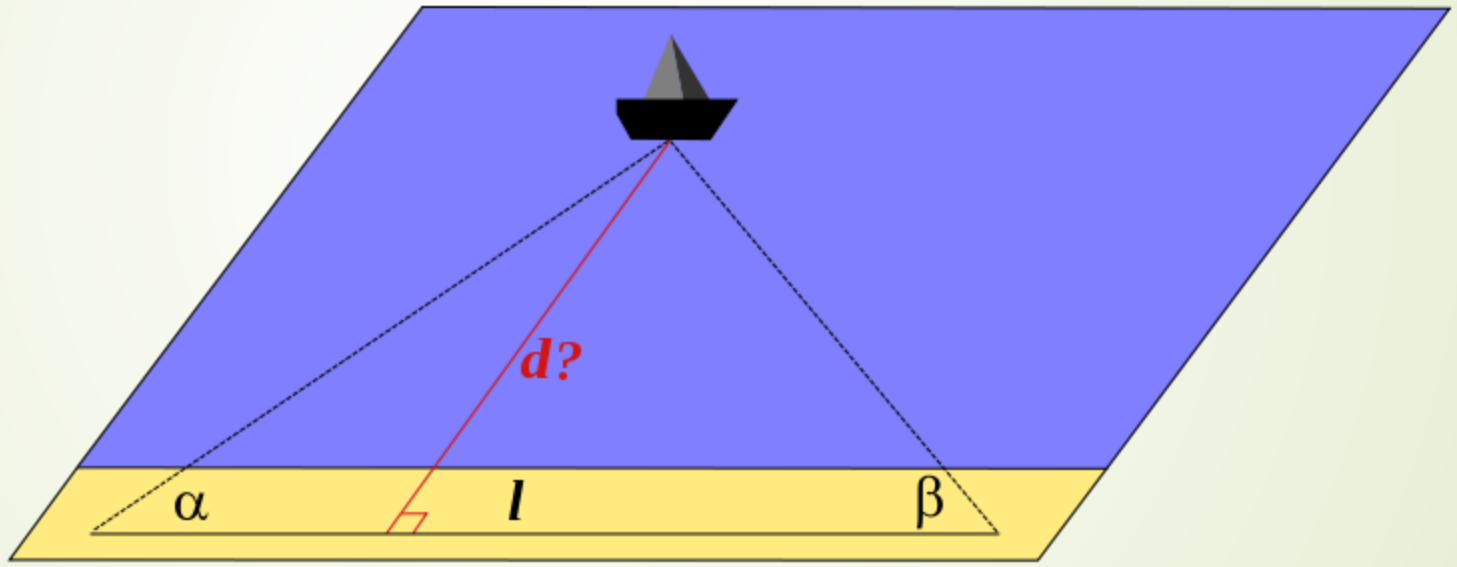
Henry Chen

2015/05/27

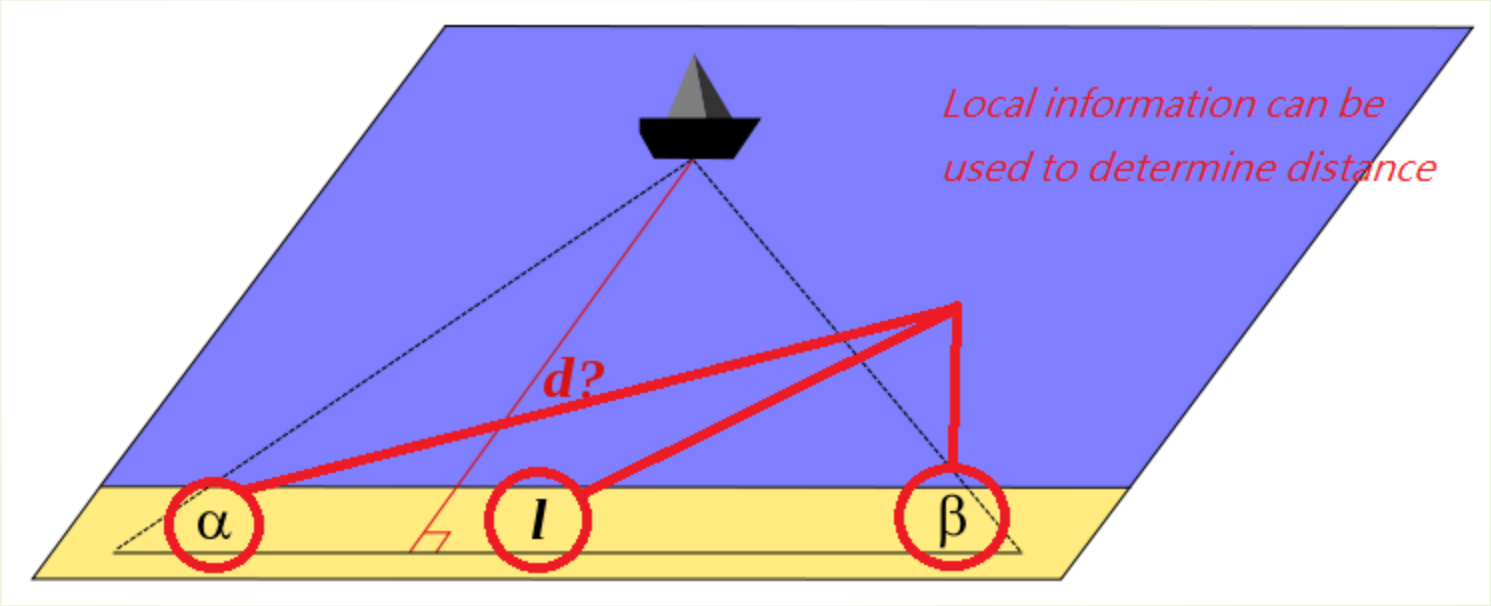
Agenda

- Basic Depth Map Technique – Triangulation
- Common Depth Measurement Techniques
- What is MV4D (Project Tango Tablet)
- Patents and Major Players
- Analysis Matrix
- Future Application

Basic Depth Map Technique – Triangulation



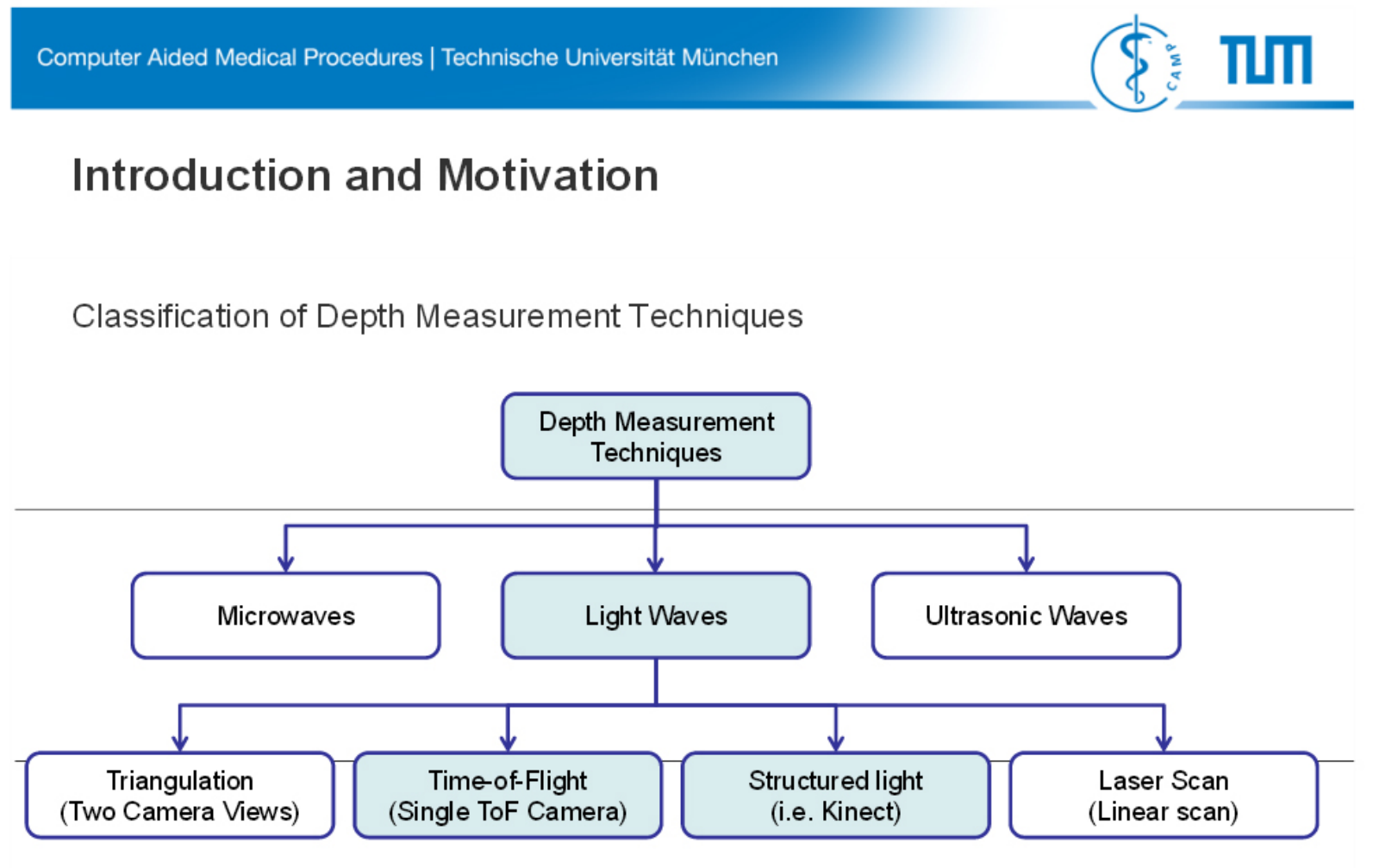
Basic Depth Map Technique – Triangulation



Basic Depth Map Technique – Triangulation

- Correspondence Problem
- The **correspondence problem** refers to the problem of ascertaining which parts of one image correspond to which parts of another image, where differences are due to movement of the camera, the elapse of time, and/or movement of objects in the photos -- Wikipedia

Common Depth Measurement Techniques



Common Depth Measurement Techniques

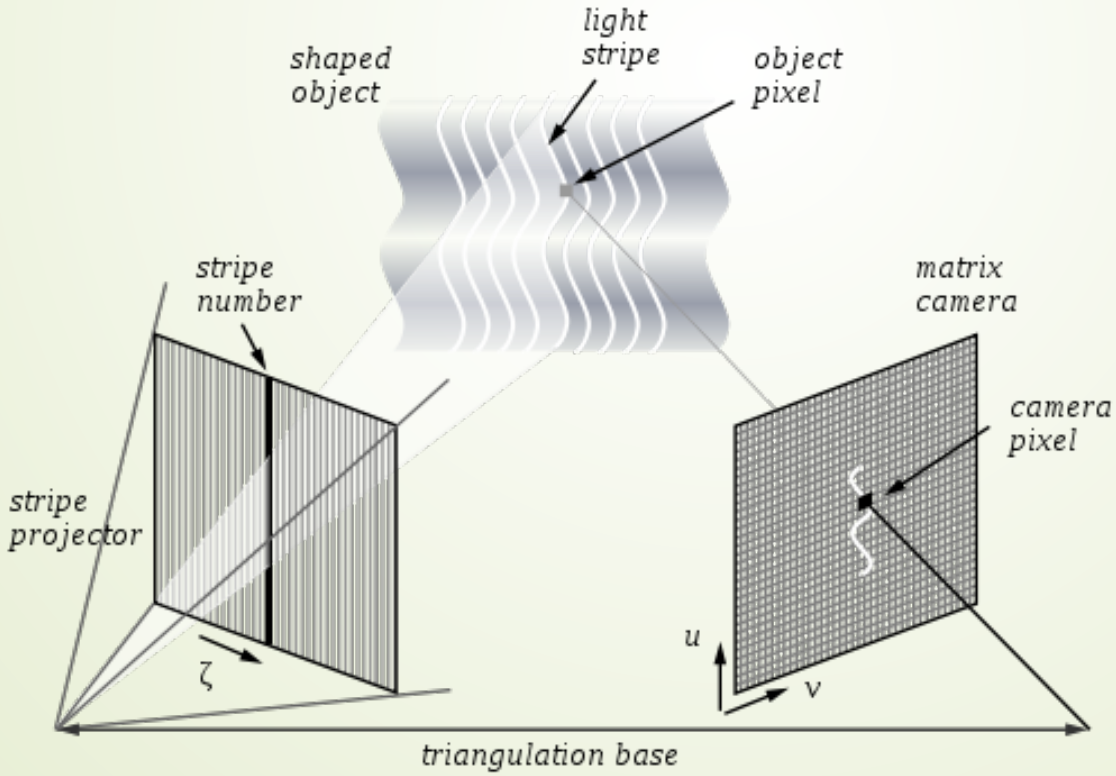
- Triangulation – Two Camera Views
  - Human Eyes
  - HTC Dual Camera

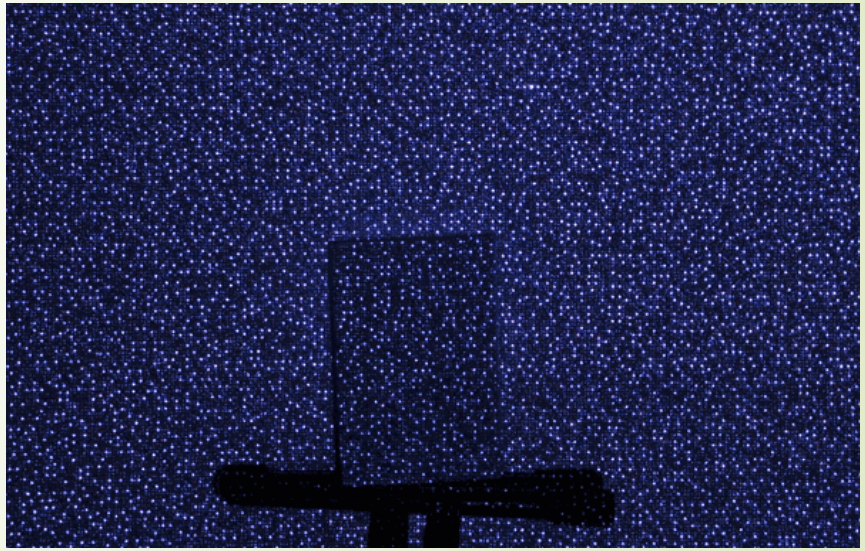
Common Depth Measurement Techniques

- Triangulation – Two Camera Views
- Pros:
  1. Passive
  2. No interference on objects
  3. Low dependency on objects' texture/material
  4. Relatively low hardware cost
- Cons:
  1. Need image processing algorithm to solve Correspondence Problem
  2. Relatively high software cost (algorithm, computing power, …)
  3. High dependency on lighting condition
  4. Hard to get real-time information (computing)
  5. Medium accuracy

Common Depth Measurement Techniques

- Structured Light
  - Microsoft 1st gen Kinect (XBOX 360)



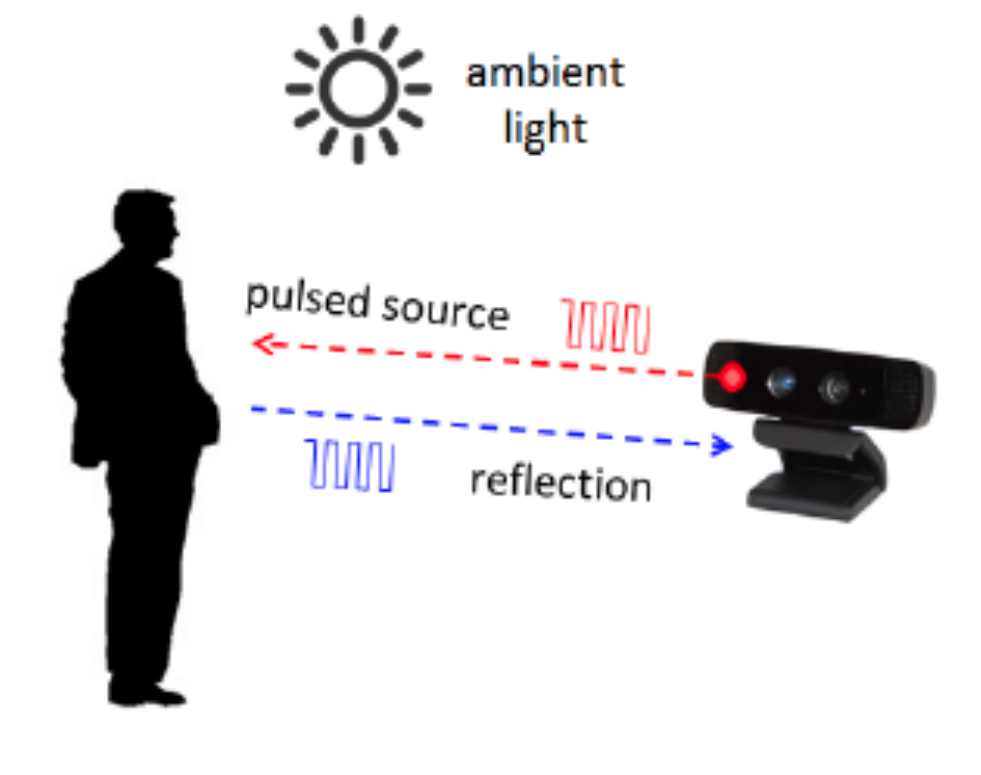


Common Depth Measurement Techniques

- Structured Light
- Pros:
  1. Active
  2. Correspondence Problem is easily solved
  3. Low software cost
  4. Low dependency on lighting condition
  5. Can get real-time information
  6. High accuracy
- Cons:
  1. Interference on objects (use IR to avoid this)
  2. High dependency on objects' texture (strong reflective, strong absorption)
  3. Relatively high hardware cost.

Common Depth Measurement Techniques

- Time-of-Flight
  - Microsoft 2nd gen Kinect (XBOX One)

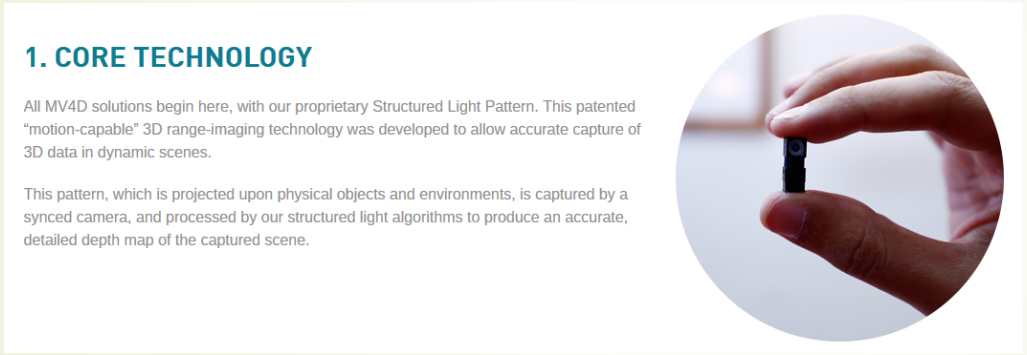


Common Depth Measurement Techniques

- Pros:
  1. Real-time
  2. High accuracy
  3. Single camera (theoretically)
- Cons :
  1. Super expensive in money, size, and power

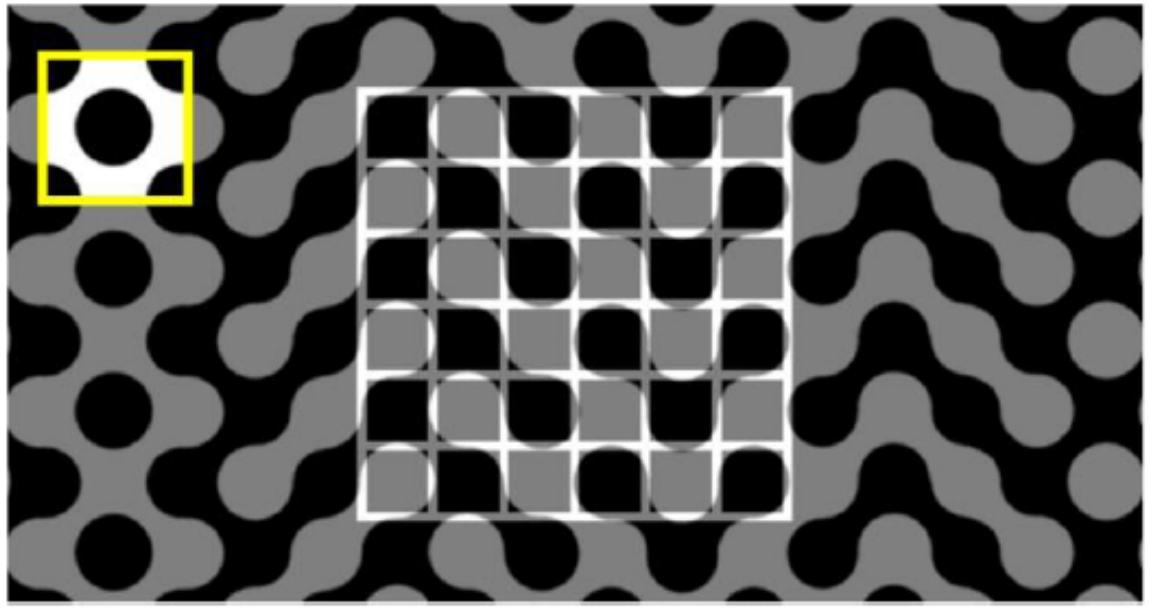
What is MV4D (Project Tango Tablet)

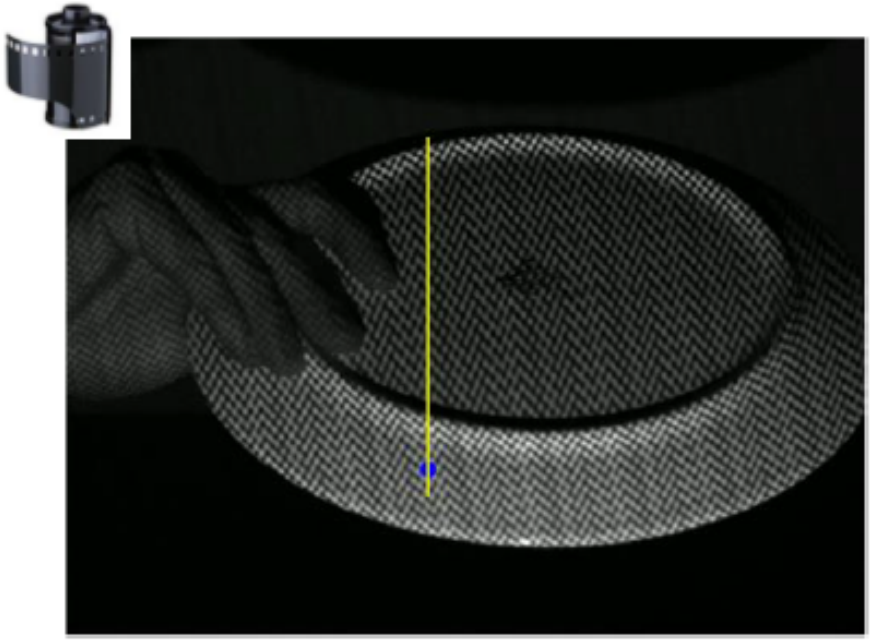
- From MV4D website: http://www.mv4d.com/



Core Technology:
All MV4D solutions begin here, with our proprietary Structured Light Pattern.
This patented "motion-capable" 3D range-imaging technology was developed to allow accurate capture of 3D data in dynamic scenes ……

What is MV4D (Project Tango Tablet)





What is MV4D (Project Tango Tablet)

3D geometric modeling and motion capture using both single and dual imaging

US 8090194 B2

摘要

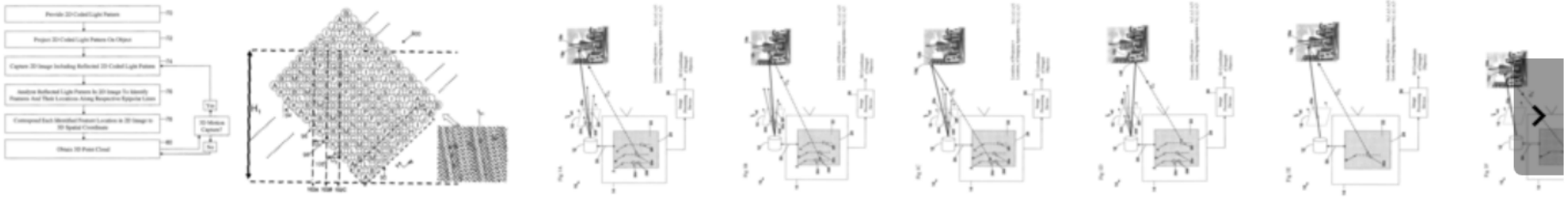
A method and apparatus for obtaining an image to determine a three dimensional shape of a stationary or moving object using a bi dimensional coded light pattern having a plurality of distinct identifiable feature types. The coded light pattern is projected on the object such that each of the identifiable feature types appears at most once on predefined sections of distinguishable epipolar lines. An image of the object is captured and the reflected feature types are extracted along with their location on known epipolar lines in the captured image. Displacements of the reflected feature types along their epipolar lines from reference coordinates thereupon determine corresponding three dimensional coordinates in space and thus a 3D mapping or model of the shape of the object at any point in time.

公開號	US8090194 B2
出版類型	授權
申請書編號	US 11/837,553
發佈日期	2012年1月3日
申請日期	2007年8月13日
優先權日期	2006年11月21日
其他公開專利號	US8208719, US20080118143, US20120063672
發明人	Eyal Golrdon, Gur Arie Bittan
原專利權人	Mantis Vision Ltd.
匯出書目資料	BiBTeX, EndNote, RefMan

專利引用 (78), 非專利引用 (137), 被以下專利引用 (26), 分類 (11), 法律事件 (2)

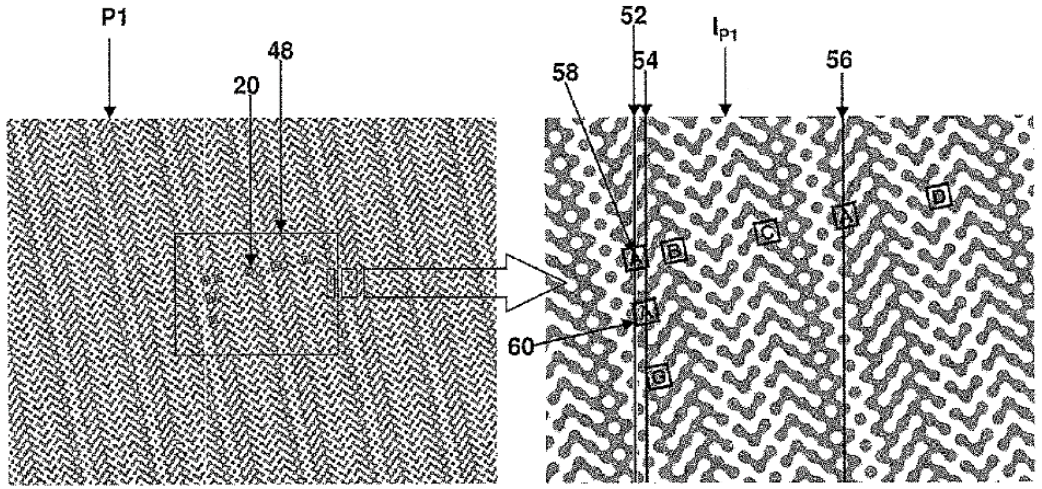
外部連結: 美國專利商標局, 美國專利商標局專利轉讓訊息, 歐洲專利局

圖片 (35)



What is MV4D (Project Tango Tablet)

Fig 3



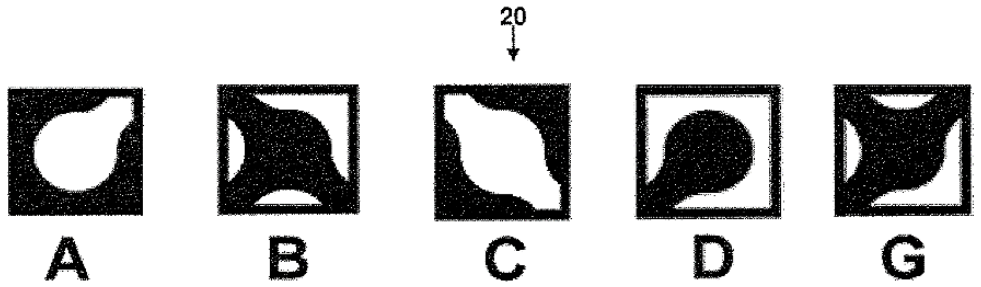
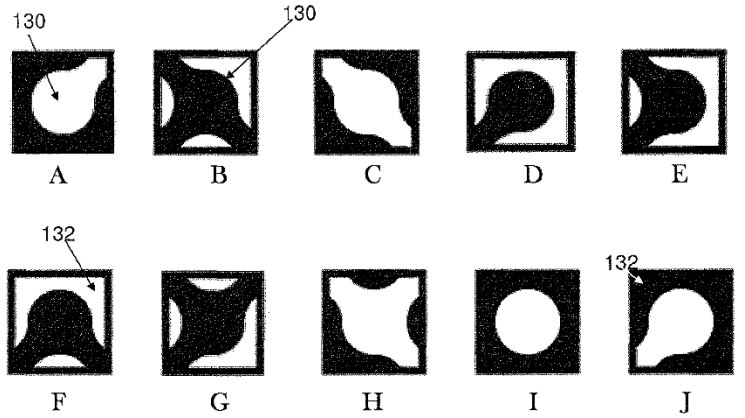
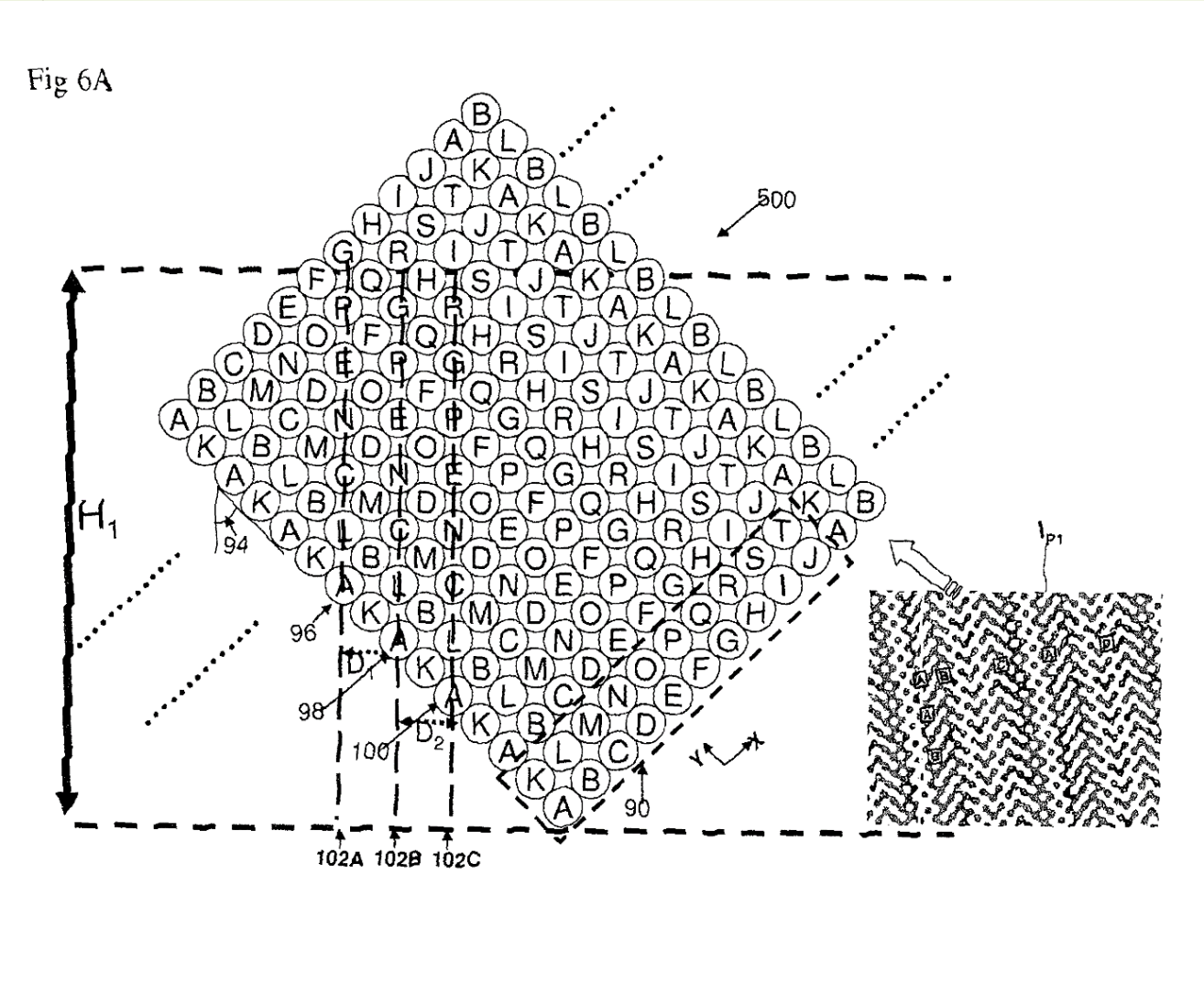


Fig 10



What is MV4D (Project Tango Tablet)



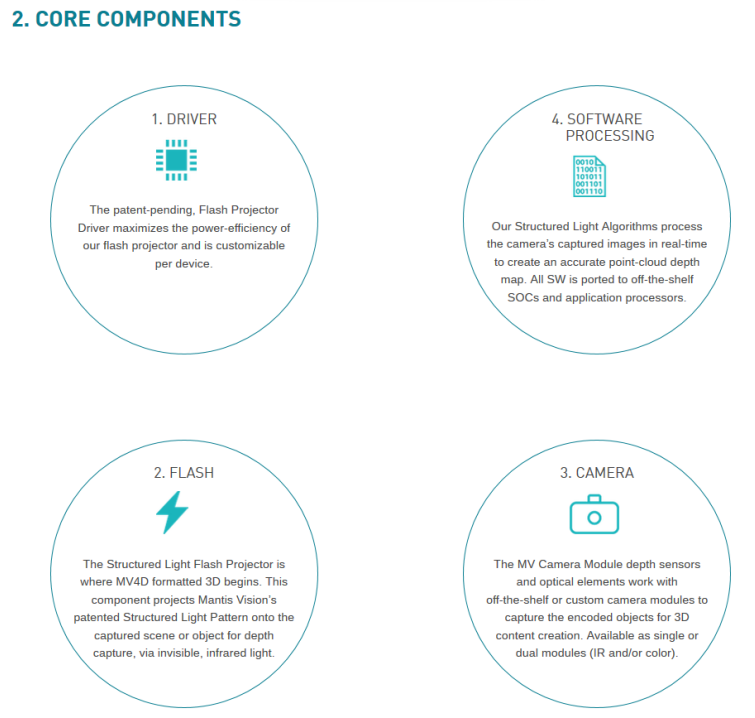
What is MV4D (Project Tango Tablet)

- From iFixit: Project Tango Tablet Teardown
- https://www.ifixit.com/Teardown/Project+Tango+Tablet+Teardown/28148

What is MV4D (Project Tango Tablet)

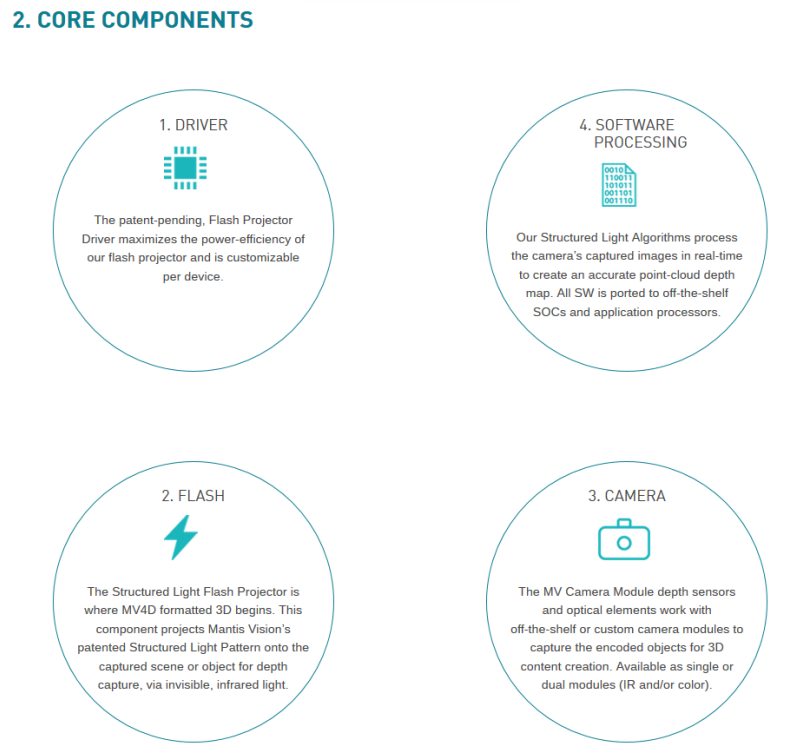
From Google: The IR projector is from Mantis Vision, and designed specific to our specs ……

What is MV4D (Project Tango Tablet)



1. Driver:
   The patent-pending, Flash Projector Driver maximizes the power-efficiency of our flash projector and is customizable per device.
2. Flash:
   The Structured Light Flash Projector is where MV4D formatted 3D begins ……

What is MV4D (Project Tango Tablet)



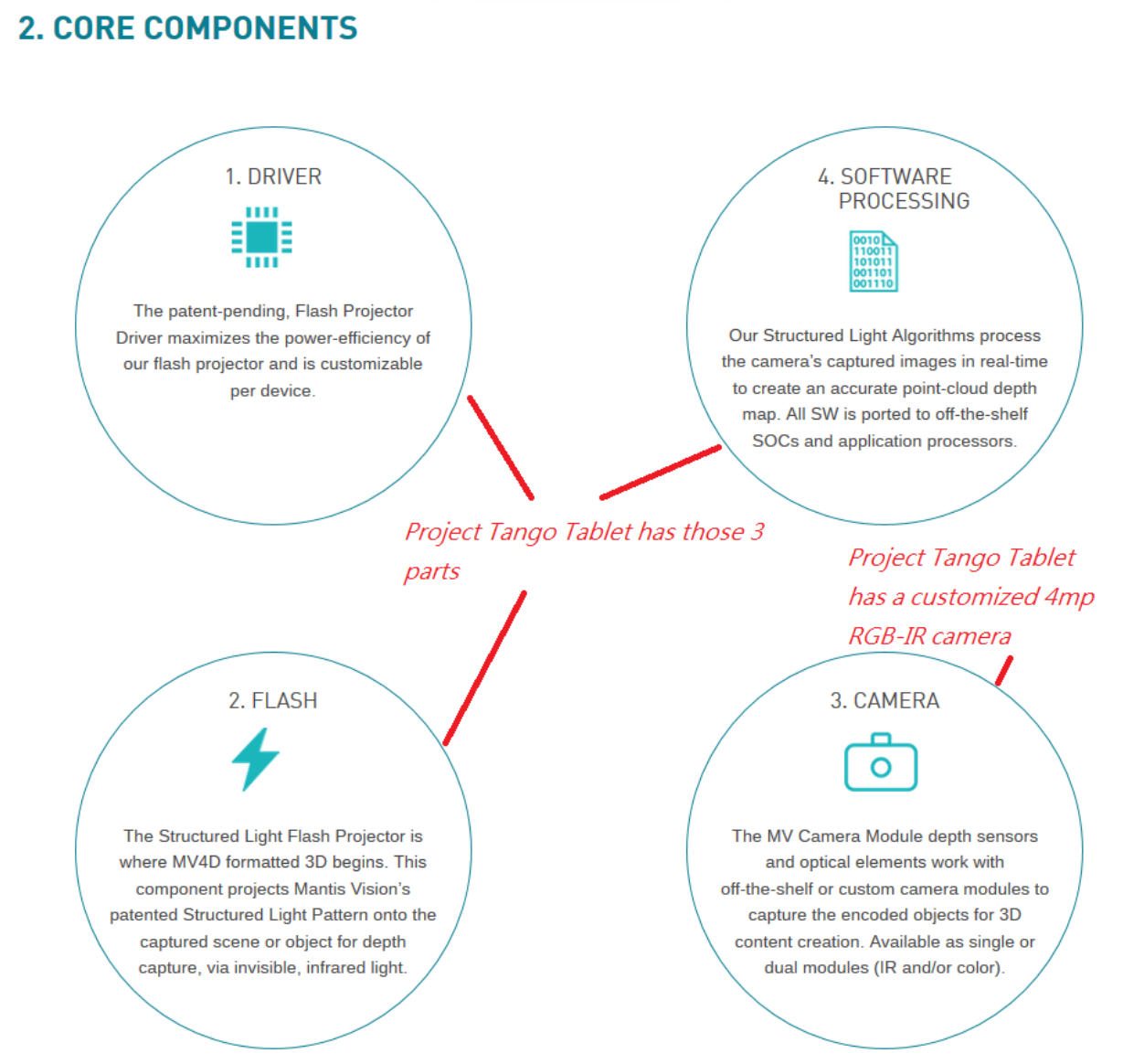
3. Camera:

The MV Camera Module depth sensors and optical elements work with off-the-shelf or custom camera modules to capture the encoded objects for 3D content creation. Available as single or dual modules (IR and/or color).

4. Software Processing:

Our Structured Light Algorithms process the camera's captured images in real-time to create an accurate point-cloud depth map. All SW is ported to off-the-shelf SOCs and application processors.

What is MV4D (Project Tango Tablet)



What is MV4D (Project Tango Tablet)

3. INTEGRATED SOLUTIONS

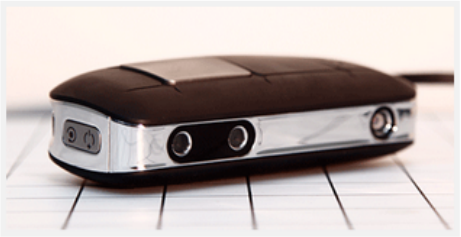
AQUILA 3D TABLET

3D for Developers, Creators and Makers. An OEM-ready 3D tablet, specifically designed for dynamic 3D content creation, and featuring Mantis Vision's MV4D core 3D engine and depth sensing platform.

AQUILA PAGE

3D POCKET CAMERA

3D for Everyone. A handheld, mobile 3D scanner for real-time modeling of physical objects and environments. Quick, easy user-generated 3D content for design, printing, virtual planning, and more. Available as a fully manufactured solution or for integration with third-party solutions.



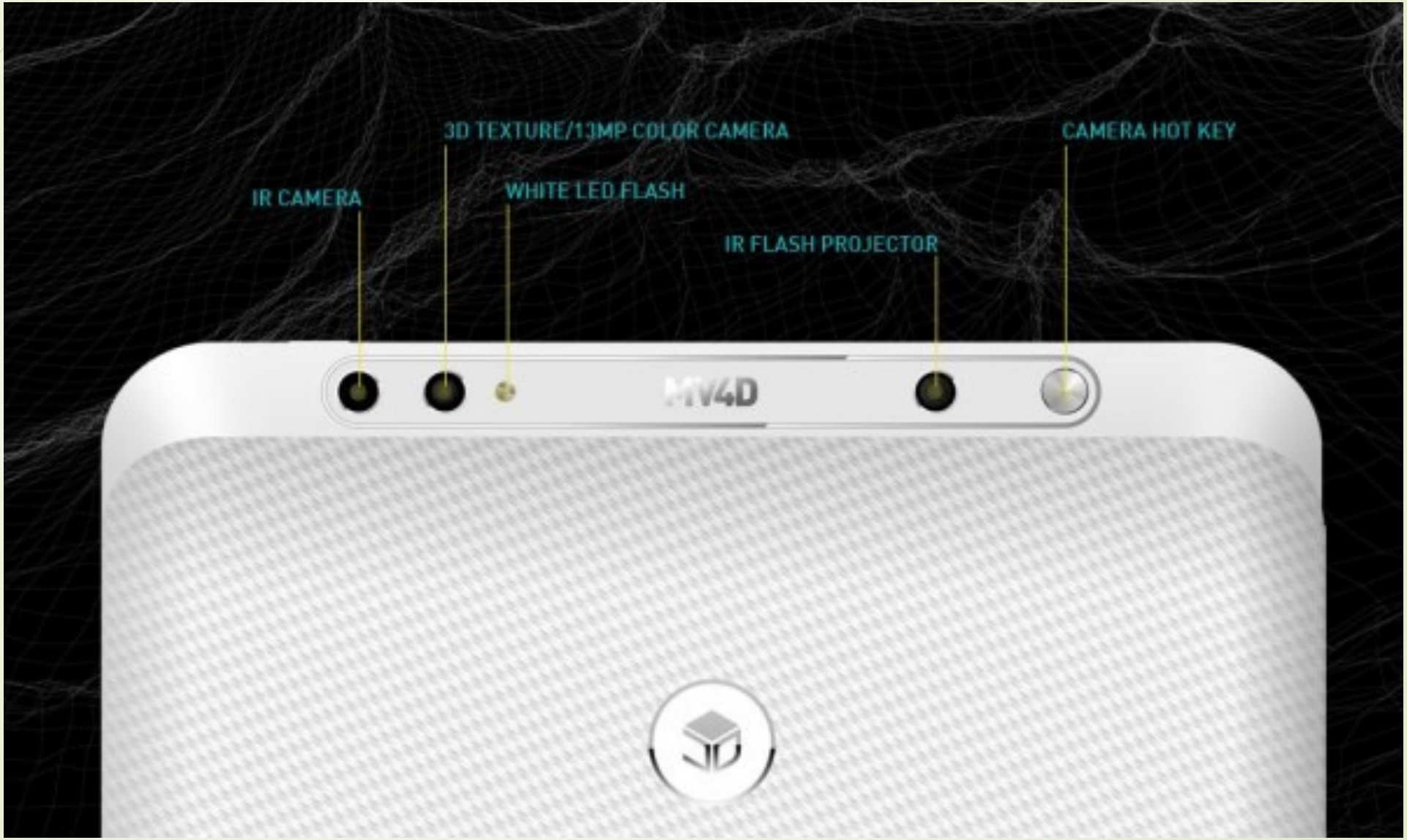
POCKETSCAN 3D PAGE

HANDHELD 3D SCANNERS

3D for Professional Applications. Our F5 Series of handheld 3D imagers was the first Mantis Vision solution built on our core technology to enter the market, and to this day is the only professional-grade mobile scanning solution specifically designed for field-use.

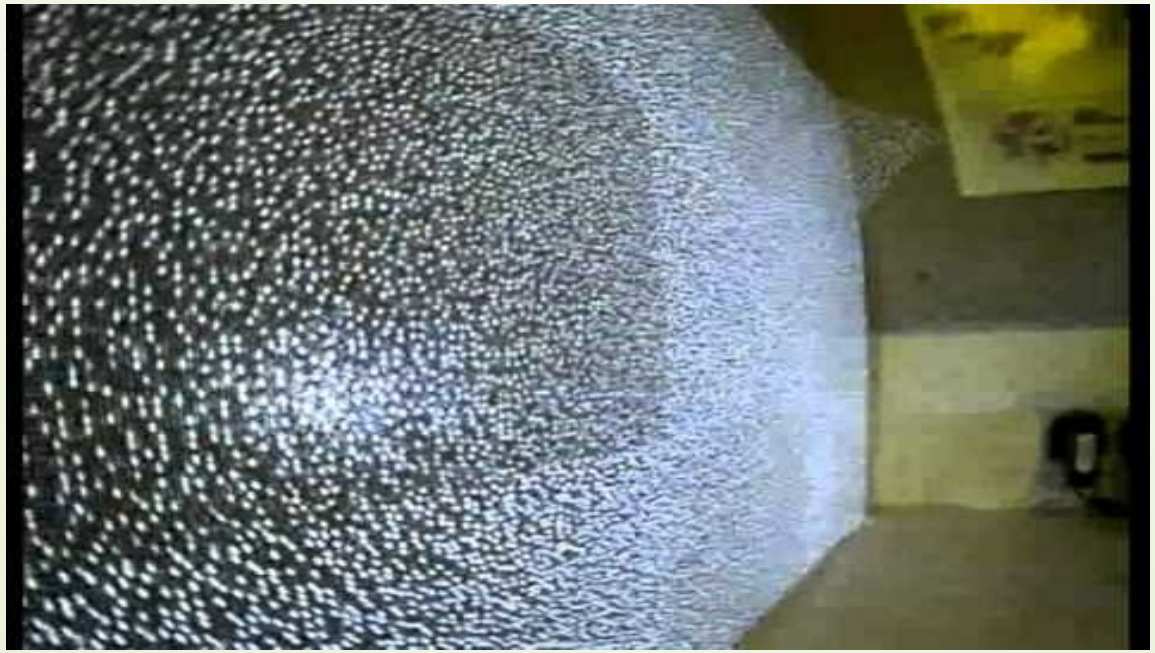
F5 PRODUCT PAGE

What is MV4D (Project Tango Tablet)



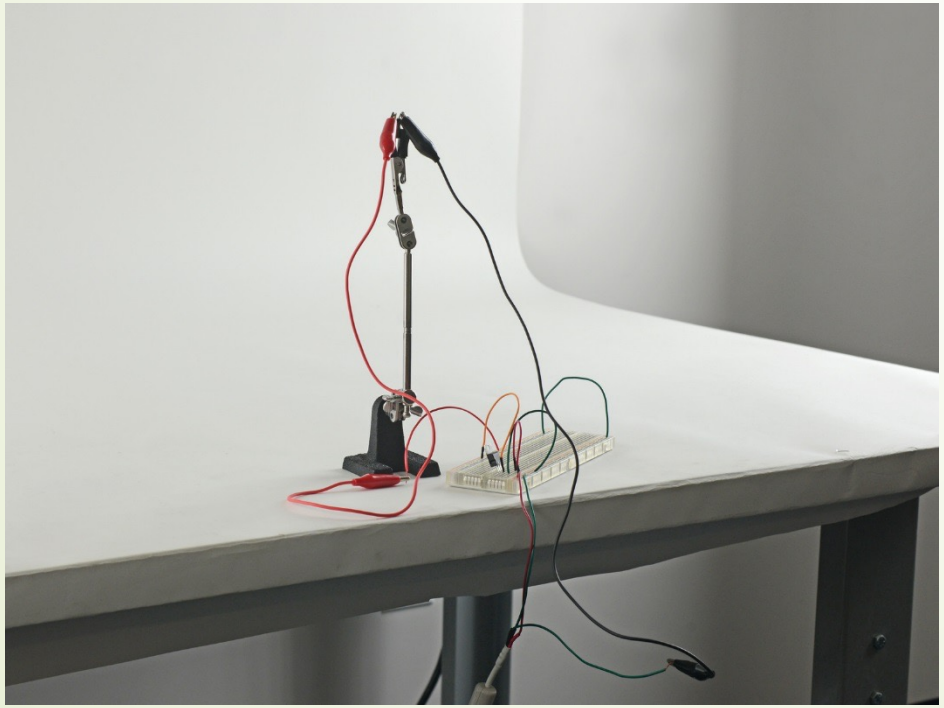
Patents and Major Players

- Microsoft 1st gen Kinect (XBOX 360)
- Light code technology and patent from PrimeSense
- PrimeSense was bought by Apple on November 24, 2013
- https://www.youtube.com/watch?v=Tpa1JP1AtCo



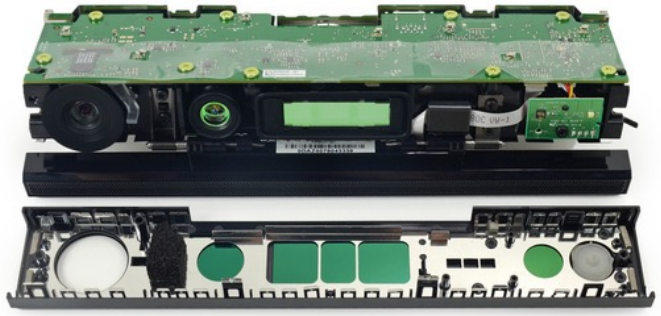
Patents and Major Players

- 1st gen Project Tango Phone (Tablet is 2nd gen)
- Light code looks like 1st gen Kinect



Patents and Major Players

- Microsoft 2nd gen Kinect (XBOX One)
- Time-of-Flight technology
- ToF technology and patent from Canesta (M$ purchased this company)
- M$ also purchased 3DV Systems ,another low-cost ToF tech company, for patent concern



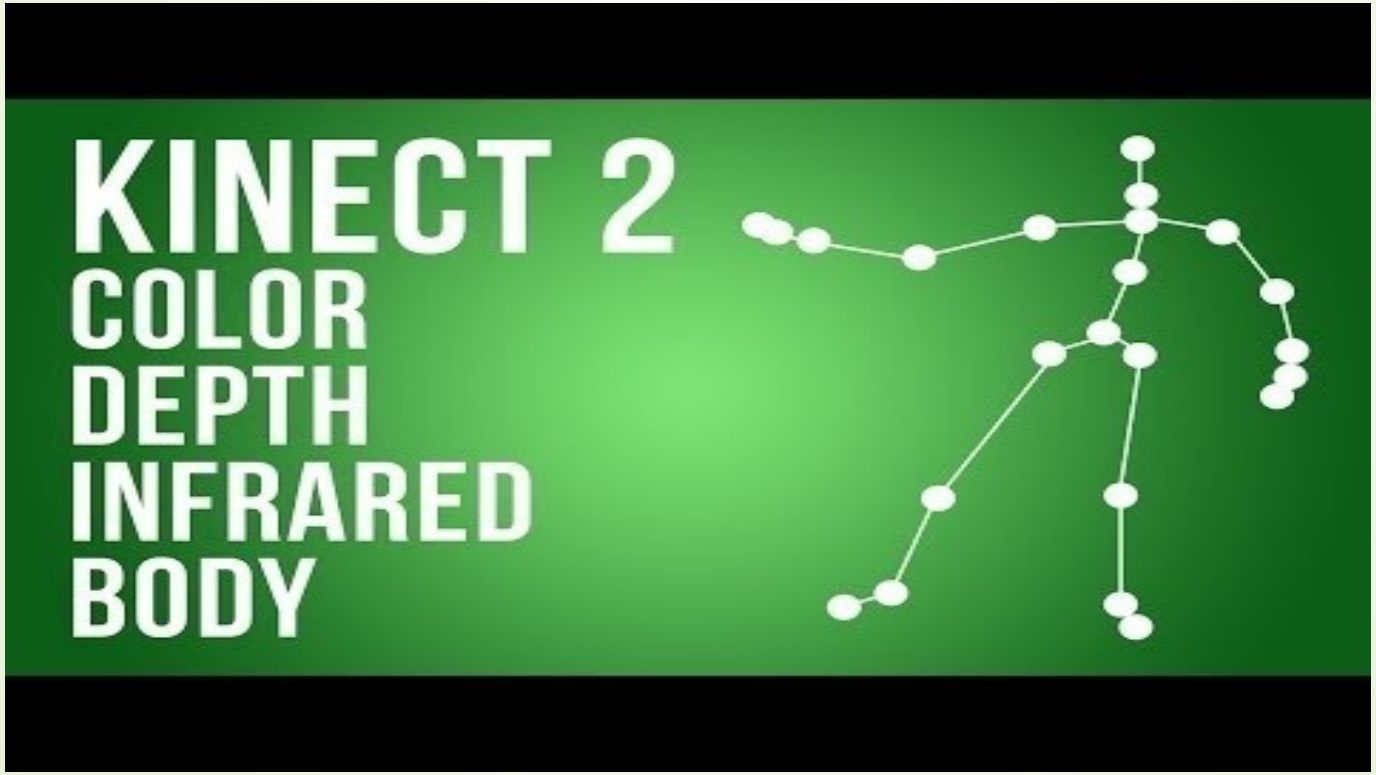
Patents and Major Players

- Kinect's depth map
- Depth stream is at 30fps for Kinect 2 (XBOX One)

	Version 1	Version 2
Depth range	0.4m → 4.0m	0.4m → 4.5m
Color stream	640×480	1920×1080
Depth stream	320×240	512×424
Infrared stream	None	512×424
Audio stream	4-mic array	4-mic array
USB	2.0	3.0

Patents and Major Players

https://www.youtube.com/watch?v=GZ3eYyBPv44



Analysis Matrix

Analysis Matrix

	Accuracy	*Real-Time Feasible*	*Battery*
Two-Camera (Passive)	Medium	Possible (correspondence problem)	Friendly
Projector-Camera (Active)	High (depends on good pattern)	Yes	Un-friendly
Time-of-Flight (Active)	High	Yes	Very Un-friendly

Analysis Matrix

Analysis Matrix

	Environment Lighting	*Object Texture Dependency*	*Price*
Two-Camera (Passive)	High	Low	Low
Projector-Camera (Active)	Low (IR-projector)	Medium	Medium
Time-of-Flight (Active)	Low (IR-projector)	Low ?	High ? (Microsoft)

Analysis Matrix

Analysis Matrix

	Size
Two-Camera (Passive)	Small
Projector-Camera (Active)	Small
Time-of-Flight (Active)	Large

Future Application

- Depth Map
  - Gesture Recognition Control
  - Apple wins the patent (M$: what the ……)
    - http://technews.tw/2015/01/14/apple-patent-minority-report-style-gesture-controls/
    - http://www.appshot.net/op/news?nid=2804

Future Application

- Depth Map
  - Robotics / AI

Future Application

- 3D modeling (Real-time)
  - Google's search engine could advanced to 3D
  - Text → Image → Video(stream of images) → 3D → Stream of 3Ds
  - On-line store
    - Fitting
    - Advertising
    - Recommendation (Avatar)

Future Application

- 3D modeling (Real-time)
  - AR / VR
  - Gaming
    - Interaction with designed 3D object → with real 3D object

Future Application

- http://www.mv4d.com/