3D scanning system based on dynamic structured light using a MEMS mirror

Berkan Zorlubas
OQmented

Company

Products & Technology

OQmented is a deep tech company developing and selling ultra-compact LBS display and 3D sensing solutions. The systems are customized for application in Augmented Reality, 3D cameras, large advertising panels with several projectors or automotive head-up displays.

100+ patents & patent applications

Founders & Team

Thomas von Wantoch (left) & Dr. Ulrich Hofmann (right) are major drivers in the development of MEMS mirror technology for more than 20 years.

Team

• 71 Technology & Engineering
• 8 Business Development & Marketing
• 14 Operations

Offices

Germany:
Headquarters: Itzehoe
Offices: Kiel, Jena

USA:
Office: Palo Alto

History

2023
Series A1 $20m

2022
Accumulated seed investment $ 14.5m
Office in Silicon Valley/ USA
Optics R&D site in Jena

2021
Strategic partnerships with Dispelix and ST Microelectronics

2020
Winner of 3 month Silicon Valley Program
Management buyout Fraunhofer

2019
Exclusive IP license agreement
Winner of 3 month Silicon Valley Program

2018
Founded OQmented as Fraunhofer Spin-Off

1995
Start of MEMS Mirror Developments at Fraunhofer ISIT

Investors

- SHARP
- vsquared ventures
- SALVIA
- MBG
- IT-FARM CORPORATION
- LENNERTZ & C9
- Leblon Capital
Content

- Insights into the MEMS scanner
- Introduction to 3D sensing
- Lissajous scanning based structured light
- Results & Discussion
- Conclusion
MEMS Technology

Bi-Resonant MEMS

- Hermetic sealing for maximized lifetime
- Resonant operation for energy efficiency on two axis
- Glass dome for high diagonal FOV angles up to 100°
- Gimble-less design for space efficiency
MEMS Technology
For Volume Production

- Scalable Wafer Technology
- Simultaneous encapsulation at wafer level in high precision
- Full manufacturing process based on 8” wafer
- R&D pilot production up to 1 Mio. units at ISIT
- Ramp up and high volume with foundries
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Introduction

3D Camera Market Review

- Widespread adoption across various markets (smartphones, healthcare, automotive, robotics...)
- New emerging markets: AR&MR&VR devices (spatial web computing, seamless object interaction, touchless control)
- Requirements the existing solutions need to fulfill get wider

Source: https://www.precedenceresearch.com/3d-camera-market
Introduction

Challenge & Solution

• **Challenge in the market** is that existing solutions cannot fulfill entire requirements all at once:
  - Structured light → high resolution but low range
  - ToF and iToF → higher range but lower spatial resolution
  - Stereovision → low performance on low light conditions and homogeneous scenes & user privacy

• **Proposed solution** is a 3D scanning system based on dynamic structured light using a MEMS mirror.
Introduction

Challenge & Solution

**static structured light pattern**

**dynamic structured light pattern**
LBS – Laser Beam Scanning

3D perception

**Principle**
- Structured light-based 3D sensing through Lissajous pattern

**Advantages**
- Fast full area depth reconstruction
- Interlaced frame rates at a high kHz rate
- Allows much smoother motion rendering
- Greatly reduces artifacts in 3D perception of fast-moving objects
- Increases line density
- Minimization of motion blur
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Product
MEMS-based LBS Light Engine for 3D sensing

Laser Beam Scanning – 3D sensing
- Light weight and low BOM
- High FoV scanning (up to 130° diagonal)
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Results & Discussion

Depth density & quality

- RC car at 1.2 meters distance
- Sparse (single-shot) and dense (multi-shot) results are given
- Object scanned with >60k points in multi-shot acquisition
Results & Discussion

Depth density & quality

- A person with thumbs-up gesture at 2.5 meters, wall in the background at 3 meters
- Object scanned with >85k points in multi-shot acquisition
Results & Discussion

Key advantages and possible use-cases

**Dynamic adaptation of spatial resolution and frame rate**

- Spatial resolution of a scan defined by the receiver, not by illuminator
- **Latency**: 30 fps for 720p and >60fps for 480p is achievable on the latest mobile chipsets.
- Operation modes: (same hardware, different use cases)
  - I. low latency & low accuracy mode → gesture scanning, presence detection, sparse spatial computing
  - II. high latency & high accuracy mode → detailed mesh generation, dense spatial computing

**Low & short BOM:**

- No laser modulation, no diffractive optics or illuminator arrays
- Standard low-cost camera
- All components are mass-producible and easy-to-assemble

**Potential target platforms:**

- AR & MR wearables → hand gesture detection, environment scanning, in-door SLAM
- Standalone system → object detection, presence detection, industrial applications
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Conclusion

✓ We presented an LBS-based 3D structured light scanner:
  • Active illuminator: bi-resonant MEMS mirror, together with a continuous-wave infrared laser
  • Receiver: standard CMOS imaging sensor

✓ Key advantages of Lissajous scanning for 3D sensing has been discussed.

✓ Features of OQmented’s MEMS technology have been introduced.
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