IIT MADRAS
Indian Institute of Technology Madras

Technology Transfer Office
TTO – IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

DEVICE FOR SENSING SURFACE PRESSURE AND METHODS THEREOF

IITM Technology Available for Licensing

PROBLEM STATEMENT

- **Object interaction and manipulation** involve forces at contact interfaces, either passive or active.
- **Active interfaces**, also known as dynamic interfaces, react to applied load and deform.
- **High-density contact force** information is crucial for enhancing passive object manipulation and quantifying dynamics at active surfaces.
- **Pulse morphology** is extensively studied in medical science to understand physiology.
- **Pulse diagnosis is non-invasive** and minimally invasive, but accuracy is challenging.
- **High-resolution map of pulse pressure** is essential for increasing accuracy.
- **Various sensors based on resistive, capacitive**, and piezo-resistive principles and optical markers are used to increase accuracy.
- **Various publications have attempted** to increase haptic feedback accuracy from surfaces.
- **Current requirements for pressure sensing devices** include dynamic sensing of **interactive surfaces, pulse sensing, grasping, indenting, surface exploration**, and data visualization.

TECHNOLOGY CATEGORY/ MARKET

Technology: Device for checking surface pressure
Category: Assistive, Test Equipment & Design Manufacturing
Industry: Advanced device manufacturing
Application: Robotics,Biomedical
Market: The global market size valued at **US$ 805 million in 2023** and is anticipated to reach **US$ 1361.2 million by 2030,** witnessing a **CAGR of 7.7% during the forecast period 2024-2030.**

INTELLECTUAL PROPERTY

IITM IDF Ref. 2518 ,Patent No: IN 545164

TRL (Technology Readiness Level)

TRL- 6, Technology validated in relevant environment (Industrially relevant enabling technologies);

Research Lab

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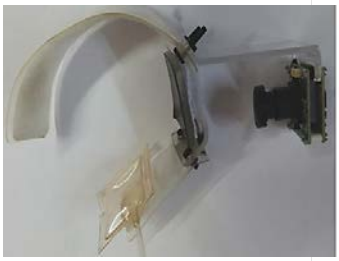
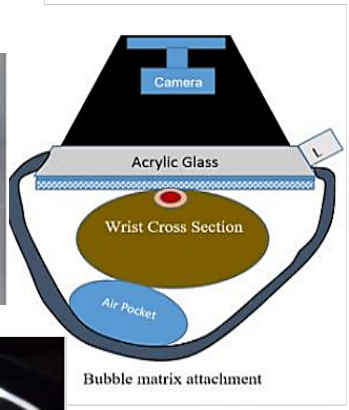
Dept. of Applied Mechanics

TECHNOLOGY

DEVICE





- A device for **measurement of pressure**, the device comprising:
- **optical markers** embedded in a flexible transparent **elastomer matrix** adapted to be placed in contact with a surface enveloping a **volume subject** to internal pressure variation,
- wherein the **optical markers** are composed of a plurality of bubbles configured to **deform or displace or both**, under the pressure variation;
- **a camera** for capturing deformation or displacement or both, of the bubbles in the matrix under said pressure variation; and
- **a processing unit** for receiving the images/videos captured by the camera to generate a signal characteristic of the pressure variation.

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METHOD

Receive images/videos captured by the camera in the processing unit

↓

Amplify the the images/videos captured by the camera

↓

Obtain frames from the amplified images/videos by transformation

↓

Determine a region of interest by bounding box in the frame

↓

Convert the frames into grayscale images

↓

Perform clahe equalization on the grayscale images with clip limit of 5

↓

Perform Lucas-Kanade optical flow with sparse features/parameters

↓

Obtain mean of norm for each frame

↓

Determine the displacement vector d

↓

Compare displacement vector d for all the frames and modify Lucas-Kanade parameters

↓

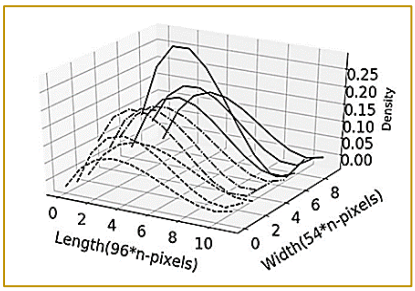
Perform Fast Fourier Transform on displacement vector d

↓

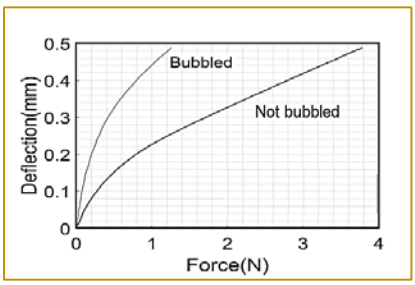
Filter transformed vector to obtain filtered noise free signal d(t)

Preparing Pressure Sensor Device

- **Mixing resin** and hardener solutions.
- **Curing the elastomer** at normal atmospheric pressure for 4 hours.
- **Degassing the elastomer** in a vacuum chamber to form optical markers.
- **Optical markers consist of controlled-size bubbles formed during degassing.**



The graph shows the the spatial map for the pulse sensing using the device, according to an embodiment of the present subject matter



The graph shows the sensitivity of the device for sensing pressure, according to an embodiment of the present subject matter

Key Features / Value Proposition

Surface Pressure Sensing Device

- **"Optical Markers in Elastomer"**
  - Composed of optical markers.
  - Flexible, transparent.
- **Camera for Deformation/Displacement Capture**
  - Captures pressure variation.
  - Captures displacement.
- **Processing Unit for Pressure Variation Signal Generation**
  - Includes amplification, frame transformation, grayscale image conversion, clahe equalization, segmentation, blob detection, bubble density, pressure distribution changes, and spatial map generation.
- **Optical Marker and Camera Process**
  - Placing marker on acrylic glass.
  - **Lucas-Kanade optical flow**.
  - Mean of norm comparison.
  - Determining displacement vector.
  - Fast Fourier Transform.
- **Noise-Free Signal Filtering for Surface Pressure Variation**
  - Mixing solution A and B.
  - Curing elastomer.
  - Vacuum chamber degassing.
- **Vacuum Range: 100mmHg to 650mmHg**
- **Device Processes Images/Videos**
  - Utilizes processing unit for amplification, frame transformation, and clahe equalization.
  - Segments frames into sub-frames for specific bubble density, blob detection, and pressure distribution changes.
- **Optical Marker and Camera Mounting**
  - Marker placed on acrylic glass.
  - Camera mounted on acrylic glass frame.
  - Markers deform under pressure variation.
- **Bubble Diameter Overview**
  - Ranges from **0.5mm to 4mm**.
- **Filtered Noise-Free Signal Overview**
  - Provides surface pressure variation.
- **"Current Method Increases Elastomer Viscosity"**
  - Increases elastomer viscosity from **2000cps to 5500cps in 2500 seconds.**
- **Bubble Stability Control**
  - Adjusting elastomer viscosity.
  - Solution A: Polydimethyle siloxane.
  - Solution B: Cross linker or resin/hardener combination.

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