1. Problem
- Given an image, can we find its acquisition device by just examining the digital image data?
- As an analogous to forensics science, are there any intrinsic fingerprints or bullet scratches in today’s digital images?
- The answer is: yes!

2. Motivation
- In recent years, several methods are proposed for camera source identification problem which use sensor or process defects and imperfections. Hot or dead pixels, device specific dark current noise, photo response non uniformity noise are the examples which can be used as device fingerprint.
- Here, we present a novel source identification method for digital single lens reflex (DSLR) cameras based dust particles in front of the imaging sensor called as sensor dust!

3. DSLR and sensor dust
- DSLR are top selling cameras today in the market
- Features: noise power, viewing the actual scene through an optical viewfinder, and ability to use different lenses.
- However, DSLR cameras suffer from an inevitable problem, sensor dust. When the lens is detached, the dust in the environment are attracted with electromagnetic fields and stay on the CCD sensor.

4. Sensor Dust Characteristics
- This tiny dust/hair/lint on the sensor reveal themselves as dark blemishes in the image which is called dust spots in this work.
- Dust spots in flat region
- Causes abrupt, localized intensity degradations; reduce image quality.
- Mostly appears in round shapes.
- Dust size, and intensity loss change with f-number, focal length, and aperture.
- Dusts stay on the same spot for a long time unless it is cleaned manually with air blower or cleaning liquid
- Dusts are cumulative. While lens is interchanged the camera body is exposed to outside and new dusts cling to the sensor.

5. Dust detection
- We model dust degradation as inverse Gaussian function.
- Given an image, dust template is scanned all over the image with normalized cross correlation to detect likely dust positions.
- Dust spots move when focal length is changed
- Dust size $S$ is proportional to aperture $A$
- Dust location shift $p$ is proportional to focal length and dust distance from image center $d_0$

6. Camera identification
- Dust Template Generation
  + Apply dust detection to several images
  + Combine all detected dust locations
  + Create a dust template
- Matching dust template with detected dust candidates
  + For each matched dust with template:
    + Compute dust strength
    + Compute if dust movement is valid
    + Compute region smoothness
- Based on analyzed dust features create a confidence value for source cam. ident.

Conclusion
- Sensor dust spots can be used as camera fingerprint.
- High detection accuracy %90 possible with %0.2 false positive.
- Robustness to JPG comp. and resizing.
- Dust template can be generated even with single image.