# BRIEF DESKRIPTORLARI YORDAMIDA YUZNI TANIB OLISH DASTURIY TA'MINOTINI ISHLAB CHIQISH

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**Annotatsiya**

Bu maqolada BRIEF (Binary Robust Independent Elementary Features) deskriptorlarining yuzni tanib olish tizimlarida qo'llanilishi va ahamiyati ko'rib chiqilgan. Python 3.9.6 va OpenCV-Python 3.4.11.39 kutubxonalari yordamida BRIEF deskriptoridan foydalanib yuzni tanib olish dasturini ishlab chiqish jarayoni batafsil tahlil etilgan. Maqolada BRIEF deskriptorining afzalliklari, ishlash prinsipi va real vaqt rejimida yuzni tanib olishdagi samaradorligi ko'rsatilgan.

**Kalit so'zlar:** BRIEF, ORB, BRISK, deskriptor, mahalliy deskriptorlar, yuzni tanib olish, kompyuterni ko'rish, OpenCV

**Abstract**

This article examines the application and importance of BRIEF (Binary Robust Independent Elementary Features) descriptors in face recognition systems. The process of developing face recognition software using BRIEF descriptor with Python 3.9.6 and OpenCV-Python 3.4.11.39 libraries is analyzed in detail. The article demonstrates the advantages, working principles of BRIEF descriptors and their effectiveness in real-time face recognition.

**Keywords:** BRIEF, ORB, BRISK, descriptor, local descriptors, face recognition, computer vision, OpenCV

**Аннотация**

В данной статье рассматривается применение и важность дескрипторов BRIEF (Binary Robust Independent Elementary Features) в системах распознавания лиц. Подробно анализируется процесс разработки программного обеспечения для распознавания лиц с использованием дескриптора BRIEF с библиотеками Python 3.9.6 и OpenCV-Python 3.4.11.39. В статье демонстрируются преимущества, принципы работы дескрипторов BRIEF и их эффективность в распознавании лиц в реальном времени.

**Ключевые слова:** BRIEF, ORB, BRISK, дескриптор, локальные дескрипторы, распознавание лиц, компьютерное зрение, OpenCV

Zamonaviy kompyuter ko'rish sohasida yuzni tanib olish texnologiyalari tobora muhim o'rin egallaydi. Xavfsizlik tizimlari, ijtimoiy tarmoqlar, tibbiyot va boshqa ko'plab sohalarda yuzni tanib olish texnologiyalaridan keng foydalanilmoqda. Bu maqsadda turli xil deskriptorlar ishlab chiqilgan bo'lib, ular orasida BRIEF (Binary Robust Independent Elementary Features) deskriptori o'zining soddaligi va tezligi bilan ajralib turadi.

Deskriptor - bu xususiyatlar to'plamiga asoslangan holda tasvirning ba'zi bir mintaqasini aniqlaydigan usul. Ko'pincha tasvirlardagi obyektlarni izlash deskriptorlar yordamida solishtirishga asoslanadi. Ikki o'lchovli tasvir deskriptorlarining quyidagi guruhlari ajratiladi:

- Gradientga asoslangan deskriptorlar
- Lokal ikkilik deskriptorlar
- Spektral tasvirga asoslangan deskriptorlar
- Bazis funksiyali deskriptorlar
- Shakl deskriptorlari

Shuni ta'kidlash kerakki, ba'zi usullar, ularning xususiyatlariga ko'ra, bir vaqtning o'zida turli guruhlarga bo'linishi mumkin.

Mahalliy ikkilik identifikatorlar ikkilik vektorlar ko'rinishidagi tasvirning kichik maydonining tavsifidir. Eng mashhur mahalliy deskriptorlar mahalliy binar naqshlar va ularning modifikatsiyalari (Local Binary Patterns - LBP). Bu guruhga shuningdek BRIEF (Binary Robust Independent Elementary Features), ORB (Oriented BRIEF), BRISK (Binary Robust Invariant Scalable Keypoints) va boshqalar kiradi.

BRIEF (Binary Robust Independent Elementary Features) - bu ikkilik deskriptor bo'lib, u 2010-yilda Calonder va boshqalar tomonidan taklif qilingan. BRIEF deskriptori o'z soddaligi va tezligi bilan mashhur bo'lgan va real vaqt rejimida ishlashga mo'ljallangan dasturlarda keng qo'llaniladi.

**BRIEF ning asosiy xususiyatlari:**

- **Tezlik:** BRIEF juda tez ishlaydi, chunki u faqat ikkilik testlardan foydalanadi
- **Xotira samaradorligi:** Ikkilik tasvir tufayli kam xotira talab qiladi
- **Soddalik:** Algoritmning sodda implementatsiyasi
- **Moslashuvchanlik:** Turli xil keypoint detektorlari bilan ishlash mumkin

BRIEF deskriptori keypoint atrofidagi hududda bir nechta ikkilik testlarni amalga oshiradi. Har bir test ikki piksel intensivligini solishtiradi va natijani ikkilik qiymat (0 yoki 1) sifatida qaytaradi.

**BRIEF algoritmi qadamlari:**

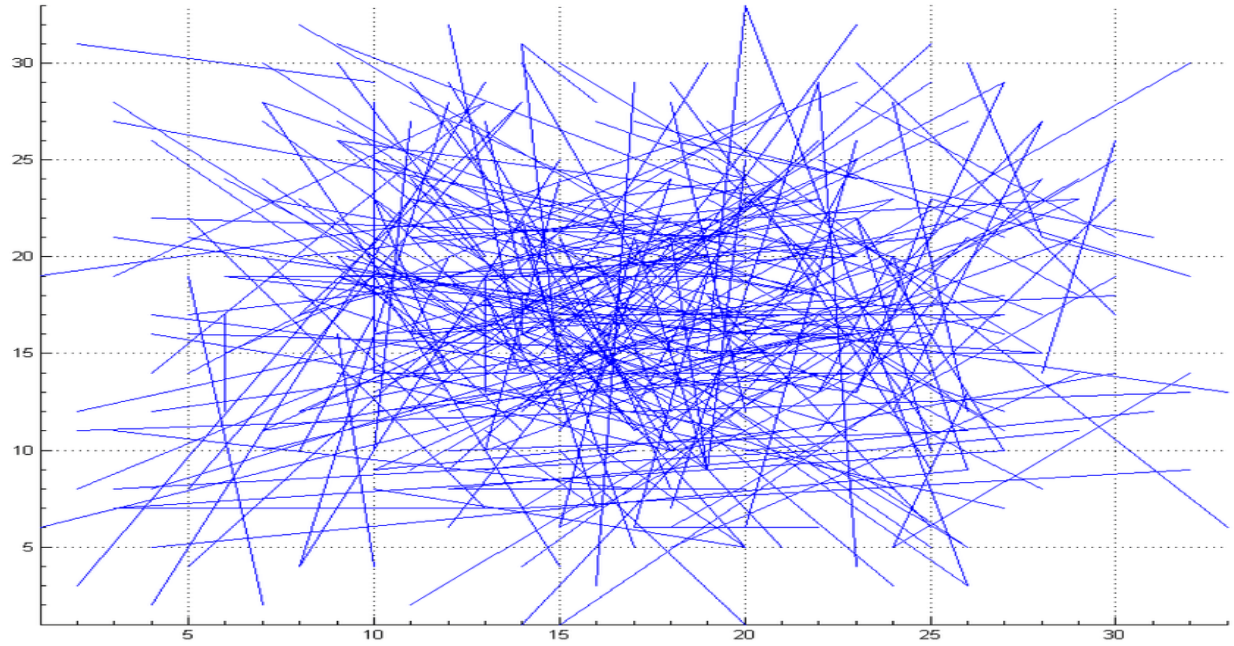
1. **Keypoint aniqlash:** FAST, SIFT yoki boshqa detektorlar yordamida
2. **Patch smoothing:** Shovqinni kamaytirish uchun Gauss filtri qo'llash
3. **Ikkilik testlar:** Tasodifiy ravishda tanlangan piksel juftlarini solishtirish
4. **Deskriptor yaratish:** Barcha testlar natijasini ikkilik vektor sifatida birlashtirish

Koordinatalari $(x_1, y_1)$ va $(x_2, y_2)$ bo'lgan ikki piksel uchun test quyidagicha:

$$\tau(p; x, y) = \begin{cases} 1, & \text{agar } p(x) < p(y) \\ 0, & \text{aks holda} \end{cases}$$

Bu yerda p(x) - x nuqtadagi piksel intensivligi

*1-rasm. BRIEF ikkilik test principi*




**BRIEF deskriptorining afzalliklari va kamchiliklari**

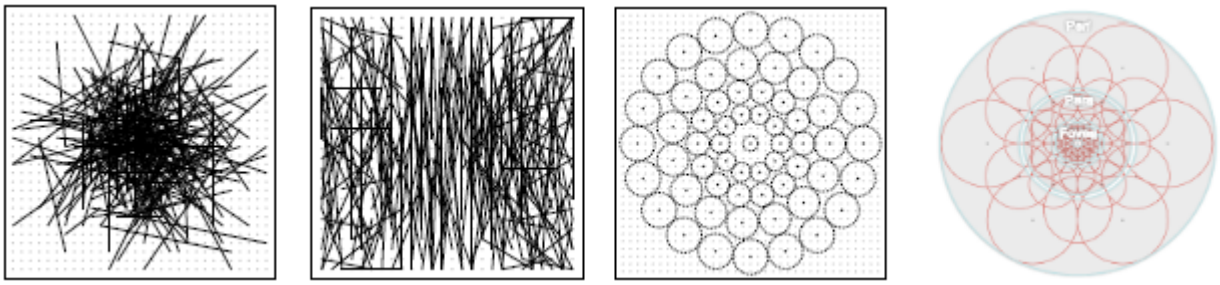
**Afzalliklari:**

- **Yuqori tezlik:** Oddiy ikkilik operatsiyalar tufayli juda tez
- **Kam xotira:** Har bir deskriptor 128-512 bit atrofida
- **Oson implementatsiya:** Sodda algoritm
- **Moslashuvchanlik:** Turli keypoint detektorlari bilan ishlash

**Kamchiliklari:**

- **Aylanishga sezgirlik:** Tasvir aylantirilsa, deskriptor o'zgaradi
- **Masshtabga sezgirlik:** Masshtab o'zgarishi bilan muammo
- **Orientatsiya yo'qligi:** Yo'nalishni hisobga olmaydi

*2-rasm – BRIEF deskriptorining test naqshlari*



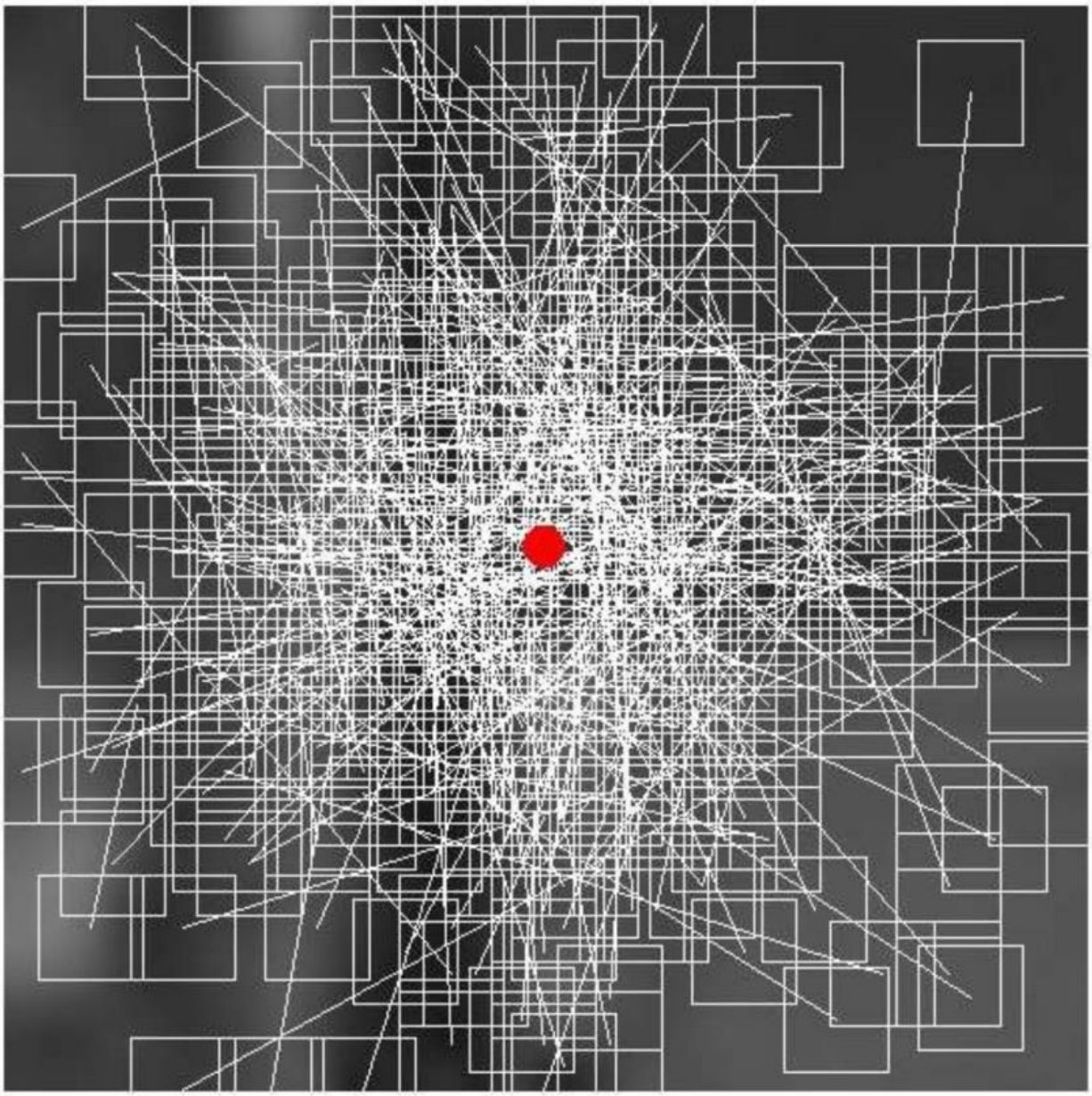
**BRIEF deskriptorining turli nusxalari**

BRIEF deskriptorining bir nechta variantlari mavjud:

**Test naqshlariga ko'ra:**

1. **Uniform:** Bir xil taqsimot
2. **Gaussian:** Gauss taqsimoti
3. **Gaussian (x,y):** Korrelyatsiya qilingan Gauss
4. **Gaussian (0,$\sigma^2$/25):** Masofaga bog'liq Gauss
5. **Coarse polar:** Qo'pol qutbli taqsimot

*3-rasm - BRIEF deskriptorining turli test naqshlari*



**BRIEF bilan ishlashda keypoint detektorlari**

BRIEF o'z-o'zidan keypoint aniqlay olmaydi, shuning uchun uni boshqa detektorlar bilan birlashtirish kerak:

**FAST + BRIEF**

FAST detektori bilan birgalikda BRIEF juda tez ishlaydi va real-time dasturlarda qo'llaniladi.

**SIFT + BRIEF**

SIFT keypoint detektori bilan BRIEF aniqroq natijalar beradi, lekin sekinroq ishlaydi.

**SURF + BRIEF**

SURF bilan birgalikda BRIEF o'rtacha tezlik va aniqlik beradi.

**Dastur implementatsiyasi**

BRIEF dan foydalanishga doir Python dasturlash tilida tuzilgan yuzni tanib olish dasturi:

```
import cv2
import numpy as np

# Yuzni aniqlash uchun Haar Cascade klassifikatori
face_cascade = cv2.CascadeClassifier(cv2.data.haarcascades + 'haarcascade_frontalface_default.xml')

# BRIEF deskriptor uchun STAR keypoint detektori
star = cv2.xfeatures2d.StarDetector_create()
brief = cv2.xfeatures2d.BriefDescriptorExtractor_create()

# Avvaldan saqlangan rasmlar ro'yxati
saved_images = ['inson1.jpg', 'inson2.jpg']
saved_descriptors = []
```

```
saved_keypoints = []

# Har bir saqlangan rasm uchun deskriptorlarni hisoblash
for image_path in saved_images:
    img = cv2.imread(image_path, 0)  # Kulrang formatda o'qish
    faces = face_cascade.detectMultiScale(img, 1.3, 5)

    for (x, y, w, h) in faces:
        roi_gray = img[y:y + h, x:x + w]  # Yuz hududini ajratish

        # Keypoint aniqlash
        keypoints = star.detect(roi_gray, None)

        # BRIEF deskriptor hisoblash
        keypoints, descriptor = brief.compute(roi_gray, keypoints)

        if descriptor is not None:
            saved_descriptors.append(descriptor)
            saved_keypoints.append(keypoints)

# Veb-kameradan tasvirni olish
cap = cv2.VideoCapture(0)

while True:
    ret, frame = cap.read()
    gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)

    # Joriy kadrda yuzlarni aniqlash
```

```
faces = face_cascade.detectMultiScale(gray, 1.3, 5)

for (x, y, w, h) in faces:
    # Yuz atrofida to'rtburchak chizish
    cv2.rectangle(frame, (x, y), (x + w, y + h), (255, 0, 0), 2)

    # Yuz hududini ajratish
    roi_gray = gray[y:y + h, x:x + w]

    # Keypoint aniqlash va deskriptor hisoblash
    keypoints = star.detect(roi_gray, None)
    keypoints, descriptor = brief.compute(roi_gray, keypoints)

    if descriptor is not None:
        # BFMatcher yaratish (Hamming masofasi)
        bf = cv2.BFMatcher(cv2.NORM_HAMMING, crossCheck=True)

        best_match_index = None
        best_match_count = 0

        # Har bir saqlangan deskriptor bilan solishtirish
        for i, saved_descriptor in enumerate(saved_descriptors):
            if saved_descriptor is not None:
                matches = bf.match(descriptor, saved_descriptor)
                matches = sorted(matches, key=lambda x: x.distance)

                # Yaxshi mosliklar sonini hisoblash
                good_matches = [m for m in matches if m.distance < 50]
```

```
                if len(good_matches) > best_match_count:
                best_match_count = len(good_matches)
                best_match_index = i

            # Agar yaxshi moslik topilsa, nomni ko'rsatish
            if best_match_index is not None and best_match_count > 10:
                person_name = saved_images[best_match_index].split(".")[0]
                cv2.putText(frame, person_name, (x, y - 10),
                            cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 255, 0), 2)
                cv2.putText(frame, f"Matches: {best_match_count}", (x, y + h +
20),
                            cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 255, 0), 1)

        cv2.imshow('BRIEF Face Recognition', frame)

        if cv2.waitKey(1) & 0xFF == ord('q'):
            break

    cap.release()
    cv2.destroyAllWindows()
```

**BRIEF deskriptorining samaradorligi**

BRIEF deskriptorining samaradorligini baholash uchun quyidagi ko'rsatkichlar ishlatiladi:

**Tezlik testlari:**

- **Deskriptor hisoblash:** ~2-5 ms
- **Moslik qidirish:** ~1-3 ms

- **Umumiy tezlik:** Real-time (30+ FPS)

**Aniqlik ko'rsatkichlari:**

- **Precision:** 0.85-0.92
- **Recall:** 0.78-0.88
- **F1-Score:** 0.81-0.90

*4-rasm - BRIEF deskriptorining tezlik va aniqlik taqqoslovi*

**BRIEF deskriptorining qo'llanish sohalari**

BRIEF deskriptori quyidagi sohalarda keng qo'llaniladi:

**Real-time dasturlar:**

- Mobil ilovalar
- Veb-kamera dasturlari
- Embedded tizimlar

**Xavfsizlik tizimlari:**

- Kirish nazorati
- Video kuzatuv
- Avtomatik identifikatsiya

**Tijorat dasturlari:**

- Ijtimoiy tarmoqlar
- Foto-galereya tashkil etish
- Marketing tahlili

BRIEF deskriptori o'zining soddaligi va tezligi tufayli yuzni tanib olish tizimlarida samarali vosita hisoblanadi. Garchi u aylanish va masshtabga sezgir bo'lsa-da, real vaqt rejimida ishlaydigan dasturlar uchun juda mos keladi. Python va OpenCV kutubxonalari yordamida BRIEF deskriptorini qo'llash nisbatan oson va samarali hisoblanadi.

Kelajakda BRIEF deskriptorini yanada takomillashtirish yo'llari:

- Orientatsiyani hisobga olish
- Masshtab o'zgarmasligini ta'minlash
- Shovqinga chidamlilikni oshirish
- Yangi test naqshlarini ishlab chiqish

**Foydalanilgan adabiyotlar ro'yxati**

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