in Table 2, our proposed PRC and DPRC obtain the best performance compared with other methods.

Classifier	Accuracy	Classifier	Accuracy (%)
LRC	95.51	CRC	95.95
LLC	80.57	SSRC	96.45
D-KSVD	89.10	SRC	96.53
LC-KSVD	90.40	ProCRC	96.54
ULDA	97.70	DADL	98.30
LLKNNC	93.54	**PRC**	**98.47**
LLNMC	97.45	**DPRC**	**98.70**

Table 2: The recognition rate (RR) of several classifiers on the 15 scenes database.

Object Classification

The Caltech101 dataset (Fei-Fei, Fergus, and Perona 2007) has 9,144 images with 102 classes. Following the common experimental settings, we train on 5 samples per class and the rest images are used as the testing set. In the experiment, we utilize the 3000-dimension spatial pyramid feature provided by (Jiang, Lin, and Davis 2013) to represent the object image. The DNNC (Zhang et al. 2006), SVM (Schüldt, Laptev, and Caputo 2004), FDDL (Yang et al. 2014), D-KSVD (Zhang and Li 2010), LRC (Naseem, Togneri, and Bennamoun 2010), CRC (Zhang, Yang, and Feng 2011), SRC (Wright et al. 2009), SSRC (Deng, Hu, and Guo 2013), ProCRC (Cai et al. 2016) and ULDA (Saeidi, Astudillo, and Kolossa 2016) methods are chosen for comparison. The experiment results are shown in Table 3. As can be observed, DPRC gains the best performance compared several popular methods.

Classifier	Accuracy	Classifier	Accuracy(%)
DNNC	46.60	SVM	47.88
SRC	48.80	SSRC	47.10
FDDL	49.80	ULDA	48.54
D-KSVD	49.60	ProCRC	47.80
CRC	44.68	**PRC**	**50.66**
LRC	47.54	**DPRC**	**50.80**

Table 3: The recognition rate (RR) of several classifiers on the Caltech 101 database.

Action Recognition

The Ucf50 action dataset (Reddy and Shah 2013) has 6,680 action videos with 50 action categories, which was taken from YouTube. For fair comparison, we follow the ref. (Guo et al. 2016): Divide the database into five folds, use four folds for training and one fold for testing. We use PCA (Luo et al. 2016) to reduce the action bank features (Sadanand and Corso 2012) to 5000 dimensions. The CRC (Zhang, Yang, and Feng 2011), SRC (Wright et al. 2009), DLSI (Ramirez, Sprechmann, and Sapiro 2010), ULDA (Saeidi, Astudillo, and Kolossa 2016), SSRC (Deng, Hu, and Guo 2013) , FDDL (Yang et al. 2014), LC-KSVD (Jiang, Lin, and Davis 2013), DPL (Gu et al. 2014), ProCRC (Cai et al. 2016) and DADL (Guo et al. 2016) methods are chosen for comparison. The experiment results are shown in Table 4. DPRC has the better performance than PRC and gains the best performance compared with several popular methods.

Classifier	Accuracy	Classifier	Accuracy(%)
CRC	75.60	DPL	77.40
SSRC	76.40	ULDA	77.60
SRC	75.00	ProCRC	77.40
DLSI	75.40	DADL	78.00
FDDL	76.50	**PRC**	**78.50**
LC-KSVD	70.10	**DPRC**	**79.10**

Table 4: The recognition rate (RR) of several classifiers on the Ucf50 action database.

Compare with Deep Learning based Methods

The Caltech-256 dataset (Griffin, Holub, and Perona 2007) has 30,608 object images of 256 object class, each class has at least 80 object images. To access the performance of PRC and DPRC for object recognition with the deep-learning-based feature, we follow Ref. (Simon and Rodner 2015), randomly select 60 images for training, the rest images are used for testing. Five deep learning based methods are used for comparison. They include NAC (Simon and Rodner 2015), CNN-S (Chatfield et al. 2014), ZF (Zeiler and Fergus 2014), CNN-M (Chatfield et al. 2014) and VGG19 (Simonyan and Zisserman 2014). The experiment results are shown in Table 5. As we can see, the proposed methods with deep feature obtain the better performance than the deep learning based methods. The proposed DPRC has the better performance compared to proposed PRC.

Classification Methods	Accuracy (%)
CNN-S	77.6
ZF	74.2
CNN-M	75.5
VGG19+ SVM	83.9
NAC	84.1
VGG19+PRC	**84.9**
VGG19+DPRC	**85.3**

Table 5: Accuracy of several methods on the Caltech 256 object database.

Conclusion

In this paper, projection representation-based classification (PRC) has been proposed for image recognition. The PRC uses the iteratively projection procedures to obtain a point to closely approximate the 'ideal representation'. The objectives of PRC, SRC and LRC are similar but PRC gains the better representation. Based on PRC, the discriminant PRC (DPRC) is further proposed. DPRC increase the discriminant information for PRC such that it obtains the better performance. The experimental results