



Owl Eyes: Spotting UI Display Issues via Visual Understanding

猫头鹰眼：通过视觉理解发现界面显示缺陷

Zhe Liu, Chunyang Chen, Junjie Wang, Yuekai Huang, Jun Hu, Qing Wang

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联系人：刘哲，王俊杰，王青 联系方式：{liuzhe2020, junjie, wq}@iscas.ac.cn

OwlEye Link: <http://www.owleyes.online:7476/>

Demo video: <https://www.bilibili.com/video/BV1BK411c7sB>

Background

• Mobile Application

- Focus on human computer interaction
- Different system settings
- UI issues impact on user experience
- Manual testing cost is high

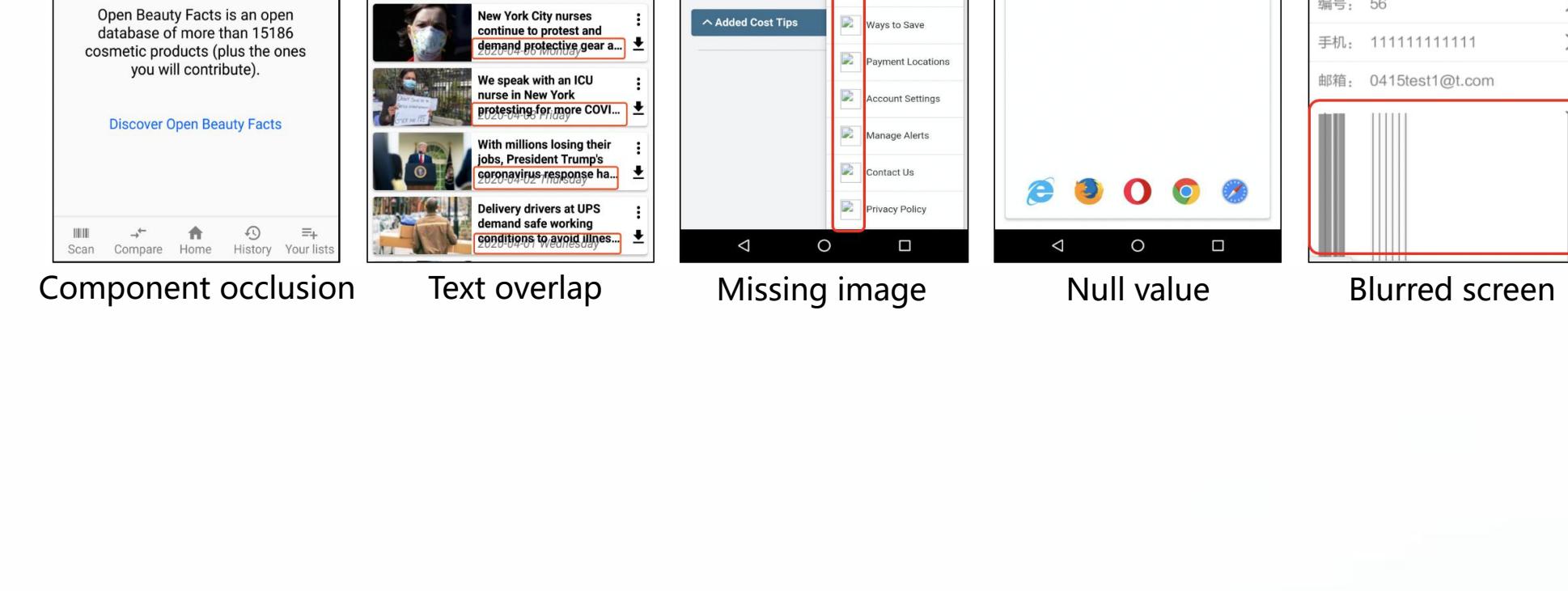
• Automated GUI Testing Tool

- Exploring App with random actions
- Mainly functional testing
- Spot critical crash bugs
- Less attention on UI display issues

Motivation

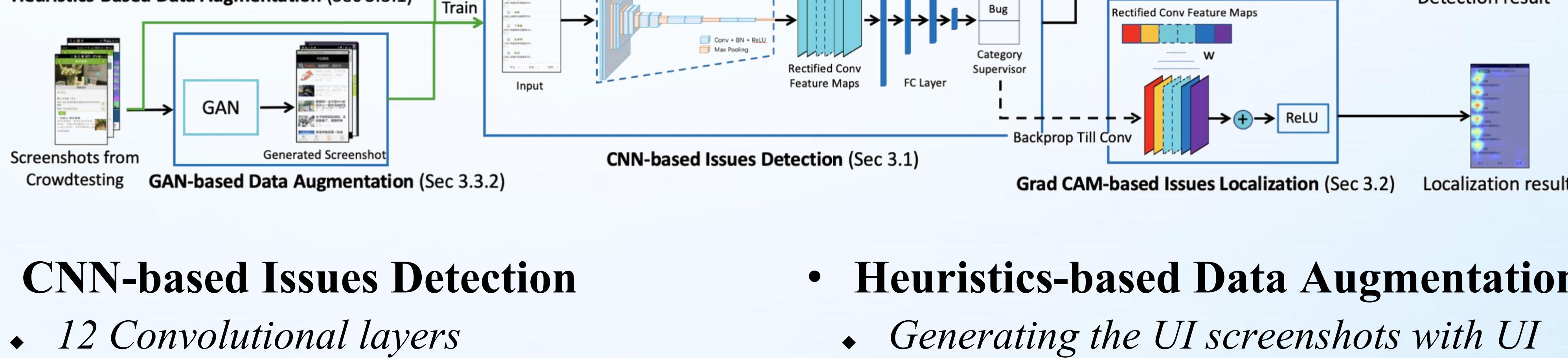
• Five Categories of UI display issues

- Missing image, Null value, Component occlusion, Text overlap, Blurred screen
- Issues don't cause app crash
- Issues can be spotted by human eyes



Approach

OwlEye to model the visual information by deep learning to automatically detect and localize the UI display issues. It builds on the Convolutional Neural Network (CNN) to identify the screenshots with UI display issues, and utilizes Gradient weighted Class Activation Mapping (Grad-CAM) to localize the regions with UI display issues in the screenshots for guiding developers to fix the issues.



• CNN-based Issues Detection

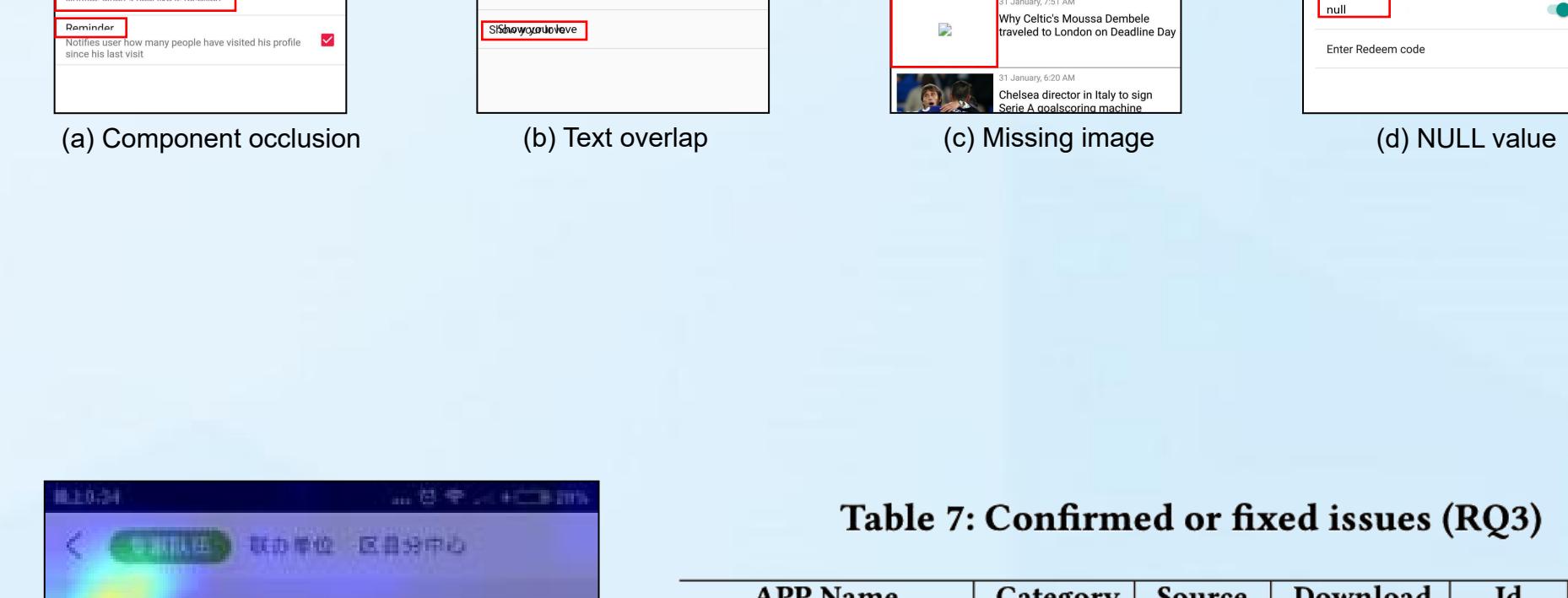
- 12 Convolutional layers
- Each layer with Batch Normalization
- 6 pooling layers
- 4 full connection layers

• Grad CAM-based Issues Localization

- Convolutional layer contains information
- Localization map of the important regions
- Obtain the Grad-CAM positioning
- With the back propagation

• Heuristics-based Data Augmentation

- Generating the UI screenshots with UI display issues from bug-free UI images
- Generate 4 kinds of issues screenshots



Evaluation

• RQ1: Detection Performance

- Precision is 0.85, Recall is 0.84, much better than other baselines

• RQ2: Localization Performance

- UI display issues localization results in an average of 90%

• RQ3: Usefulness Performance

- 57 apps have UI display issues
- 10 fixed, 16 confirmed



Table 7: Confirmed or fixed issues (RQ3)

APP Name	Category	Source	Download	Id	Status
Perfect Piano	Music	Google	50M+	email	confirm
Music Player	Music	Google	50M+	email	confirm
Nox security	Tool	Google	10M+	email	fixed
Degoo Cloud Storage	Tool	Google	10M+	email	confirm
Proxynel	Tool	Google	10M+	email	confirm
Secure VPN	Tool	Google	10M+	email	confirm
Thunder VPN	Tool	Google	10M+	email	confirm
ApowerMirror	Tool	Google	5M+	email	confirm
Mediafire	Product	Google	5M+	email	fixed
Postegu	Community	Google	500K+	email	fixed
Deezer Music Player	Music	Google	500K+	email	fixed
MTG Familiar	Utilities	F-droid	500K+	#512	fixed
Open Food Facts	Health	F-droid	500K+	#3051	confirm
Liphone	Commun	F-droid	500K+	#965	confirm
Paytm	Finance	Google	100K+	email	confirm
Transdroid	Tool	F-droid	10K+	#542	confirm
Transistor	Music	F-droid	10K+	#254	fixed
Onkyo	Music	F-droid	10K+	#138	fixed
DemocracyDroid	News	F-droid	10K+	#121	fixed
NewPipe Legacy	Media	F-droid	8K+	#24	fixed
LessPass	Product	F-droid	5K+	#519	fixed
CEToolbox	Medical	F-droid	500+	#4	confirm
OpenTracks-OSM	Health	F-droid	10+	#26	fixed
Yucata Envoy	Tool	F-droid	N/A	#3	confirm
ClassyShark3xodus	Tool	F-droid	N/A	#3	confirm
VlcFreemote	Media	F-droid	N/A	#24	confirm