Rahul Krishna Yandrapally

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Research Interests

Program analysis, Web testing, Mobile testing, API testing

Work Experience

May 2010-Jul 2010	**Intern at VMWare, Bangalore** Worked as an Intern on the problem of reducing ecological footprint in the company by developing a solution to monitor network print traffic.
Aug 2012-Aug 2017	**Software Engineer at IBM Research Lab, India** Worked on several program analysis and testing projects related to web, mobile and IOT applications. Spent the first four years in *Software Engineering* group, and last year in *Mobile and IOT* group.

Education

2017 - 2023	PhD in Electrical and Computer Engineering, **UBC** Vancouver Thesis: "UI driven dynamic analysis and testing of web applications" | Advisor: Prof. Ali Mesbah Research Interests: Web Testing, Mobile Testing, Program Analysis, Computer Vision
2007 - 2012	Bachelor and Master of Technology (Integrated) in Computer Science and Engineering, **IIT** Kanpur Thesis: "Secure Automatic Teller Machines" | Advisor: Prof. Rajat Moona Major Courses: Software Engineering and Architecture | Embedded Systems | Program Verification and Testing | Advanced Computer Architecture | Advanced Computer Networks

Awards and Achievements

- Recipient of UBC four year doctoral fellowship (4YF) award.

- Recipient of Academic Excellence Award in the Department of Computer Science, IIT Kanpur for the Academic Year 2010-11.

- Won A-Level Accomplishment award for my work on Automating Test Automation (ATA) tool in IBM Research, India. This is given to very few research projects with significant revenue impact.

- Nominated to represent IIT Kanpur as the sole participant from India in the Intel Cup Embedded System Design Contest (ESDC) 2012 held in Shanghai, China.

Publications and Patents

- Rahulkrishna Yandrapally, Saurabh Sinha, Rachel Tzoref-Brill, Ali Mesbah. *Carving UI Tests to Generate API Tests and API Specifications.* ACM/IEEE International Conference on Software Engineering (ICSE 2023).

- Rahulkrishna Yandrapally, Ali Mesbah. *Fragment-Based Test Generation For Web Apps.* IEEE Transactions on Software Engineering (TSE 2022).

- Rahulkrishna Yandrapally, Ali Mesbah. *Mutation Analysis for Assessing End-to-End Web Tests.* IEEE International Conference on SOftware Maintenance and Evolution (ICSME 2021).

- RahulKrishna Yandrapally, Andrea Stocco and Ali Mesbah. *Near Duplicate Detection in Web App Model Inference.* ACM/IEEE International Conference on Software Engineering (ICSE 2020).

- Andrea Stocco, Rahulkrishna Yandrapally, and Ali Mesbah. 2018. *Visual web test repair.* The ACM Joint European Software Engineering Conference and Symposium on the Foundations of Software Engineering (ESEC/FSE 2018).

- Yu Liu, Rahulkrishna Yandrapally, Anup K Kalia, Saurabh Sinha, Rachel Tzoref-Brill, Ali Mesbah. *CrawLabel: computing natural-language labels for UI test cases.* ACM International Conference on Automation of Software Test (AST 2022).

- RahulKrishna Yandrapally, Suresh Thummalapenta, Saurabh Sinha, Satish Chandra. *Robust Test Automation Using Contextual Clues.* The ACM SIGSOFT International Symposium on Software Testing and Analysis (ISSTA 2014).

- RahulKrishna Yandrapally, GiriPrasad Sridhara, Saurabh Sinha. *Automated Modularization of GUI Test Cases.* ACM/IEEE International Conference on Software Engineering (ICSE 2015).

- RahulKrishna Yandrapally, Suresh Thummalapenta, Saurabh Sinha, Leigh Williamson. *System and Method for Creating Change-Resilient Scripts*. Patent filed with US Patent office.

- RahulKrishna Yandrapally, Saurabh Sinha, GiriPrasad Sridhara. *Automated Modularization Of Graphical User Interface Test Cases*. Patent filed with US Patent office.

- William Jacob Cobb, Jr., RahulKrishna Yandrapally, Saurabh Sinha, Suresh Thummalapenta, Adaptation of Automated Test Scripts. Patent filed with US Patent office.

- GiriPrasad Sridhara, Saurabh Sinha, RahulKrishna Yandrapally, Vijay E, *Automatically Detecting Feature Mismatches Between Mobile Application Versions On Different Platforms*. Patent filed with USPO.

- S. P. Venkatagiri, A. K. Sinha, Rahulkrishna Yandrapally, P. Dey and B. Sengupta. *Puppeteer: De-centralized platform for connected-yet-autonomous educational toys*. International Conference on Communication Systems Networks (COMSNETS 2018).

RECENT RESEARCH PROJECTS

Carving UI Tests to generate API Tests and API Specification (ICSE 2023): Enable API Testing universally for all web applications.

Features: Dynamic instrumentation; Graph analysis; Automatic specification generation.

- Engineered a first-of-its-kind API test generation framework which requires neither source-code nor API specification.

- Developed an automatic API specification generation technique which relies only on API traffic analysis.

- Demonstrated the significant test efficiency gains possible by employing carved API tests as opposed to UI tests for server-side code coverage.

- Illustrated the effectiveness of carved API tests in complementing API fuzzing tools.

Fragment-Based Test generation for Web Apps (TSE 2022): Automatically generate UI test suites for web applications by effectively detecting near-duplicates.

Features: Web page fragmentation; Resilient test oracles; Crawl action prioritization.

- Designed a page fragmentation based web page comparison technique that eliminates the need for selecting thresholds.

- Employed structural and visual properties of fragments to determine functional equivalence of web pages.

- Conceptualized the prioritization of state exploration of web applications based on the diversity of fragments extracted from web pages.

- Developed a fine-grained fragment-based test assertion generation technique for reliable regression testing.

Near-Duplicate Detection in Web App Model Inference (ICSE 2020): An empirical study of functional near-duplicate web pages and effectiveness of existing web page comparison techniques in detecting them.

Features: Computer Vision; Image and Text Hashing; Tree Differencing; .

- Performed a qualitative analysis of functional near-duplicate web pages in the wild, where we defined three categories of near-duplicate web pages characterized by the functional differences between the web pages being compared.

- Developed a methodology to manually classify a given pair of web pages.

- Proposed a methodology to determine optimal threshold for any given state comparison technique.

- Illustrated the challenges in determining functional equivalence of web pages through an empirical analysis of existing techniques.

Mutation Analysis for Assessing End-to-End Web Tests (ICSME 2021): Develop a technique to determine effectiveness of UI test suites that is universally applicable for all web applications.

Features: .

- Conceptualized, designed and developed a universally applicable black-box mutation analysis framework for web applications.

- Conducted a first-of-its-kind study on the UI manifestation of real bugs in web applications.

- Designed a set of mutation operators for dynamic DOM to imitate UI bugs in web applications.

- Developed methodology and metrics to determine the stubbornness, usefulness and significance of UI mutants.

Visual Web Test Repair (ESEC/FSE 2018): Automate repair of regression Selenium web tests using Computer Vision (CV) techniques.

Features: Online test adaptation; visual web element relocation; workflow repair through local crawling.

- Developed an approach to visually validate test steps and suggest potential repairs in a regression test run.

- Employed a fast image processing pipeline of 3 CV algorithms (FAST, SIFT and Fast Normalized Cross Correlation) that work synergistically to capture and analyze relevant visual information.

- Implemented the approach in the tool, Vista, which is shown to be superior to the state-of-the-art test repair technique that relies on DOM in terms of both effectiveness and performance.

Automating Test Automation (ATA); Robust test automation using contextual clues (ISSTA 2014): Generate natural language and change resilient web element locators in automated GUI test suites for web applications

Features: DOM Tree analysis; Web Testing; Test reliability; Test Automation.

- Created a cost effective and easily deployable selenium variant of ATA tool.

- Developed a new method called ATA-QV to address script fragility in the ATA caused by usage of UI Element locators like XPath that break with even minor application changes and browser differences.

- ATA-QV infers contextual clues to identify target elements instead and has been compared with traditional tools relying on Element Locators, Image Matching techniques or Programming to showcase its effectiveness.

Automatic Modularization of GUI Test Cases (ICSE 2015): Minimize UI test maintenance for Web applications during regression test runs.

Features: Test maintenance; Program analysis.

- Achieved this by extracting reusable subroutines which reduce duplication of test steps across test cases minimizing the manual intervention required in fixing element locators that break due to application changes.

- Developed a novel approach to define an abstract application state based on the test steps that are part of a subroutine and establish UI Element equivalence across test cases without expensive dynamic trace collection.

Automated Test-Script Adaptation for Mobile Apps (IBM Project 2015): Develop a Test Adaptation tool that enables creation of a robust and adaptive test script which it can automatically repair or modify to test the same functionality when run on other variants.

Features: Android Testing; Test repair.

- Employed a combination of heuristics and learning techniques to aid targeted local crawling with backtracking for state exploration performed while adapting the test script to the new variant.

- Enabled flow repair of test scripts through addition and removal besides modification of test steps.

- Ensured the correctness of modified test script by using certain verification steps as test oracles.

Test Selection for IOS Mobile Applications (IBM Project 2017): Develop a Test selection tool for IOS Application Test cases (XCTest and XCUITest) that are written using XCode IDE Test recorder or Swift/Objective-C programming.

Features: Program Analysis; IOS; XCUI Tests.

- Surveyed IOS Application Development processes and XCode Test framework to design a Test Selection approach for XCTests (Test Case Classes written in XCode).

- Evaluated the effectiveness of language tools like Antlr for analysis of Swift and Objective-C programs.

- Experimented augmenting traditional Program Analysis techniques with Information Retrieval techniques to derive dependencies between XCTests, the application source code and resources.

Cloud-based Automation of Robust Intelligible Tests (IBM project 2016): Develop a cloud-based solution that offers web testing as a service

Features: Web Development; Testing as a service; Test management.

- Provisioned the features of Automating Test Automation (ATA) such as its algorithm for robust test script creation and playback for individual test cases as part of a web testing service.

- Developed a tool capable of handling challenges of a multi-user test management tool.

- Built a batch execution portal for regression testing with a grid manager and a grid with multiple platform and browser combinations which can scale up on demand

Secure ATM (Masters Thesis 2012): A cost effective and Trusted Money Dispenser that can work with intermittent network connectivity.

Features: Cryptography; Smart Cards.

- Employed Smart Cards in place of Magnetic Strip cards which gave protection against skimming attacks.

- Enabled scope for offline authentication and elimination of a fake outlet by designing a protocol based on Public Key Cryptography (PKI), which establishes the authenticity of both ATM and User before a transaction.

- Supported usage of keypad and screen of personal electronic device eliminating the keypad overlay attack and shoulder surfing attack.

Sign language interpreter for speech handicapped (Course Project 2011): Develop an embedded system to assist speed handicapped individuals.

Features: Computer Vision; Machine Learning.

- Used the OPENCV library for image processing in the application development.

- Employed Image processing techniques to isolate the region of interest and the machine learning technique of decision tree classification to classify the symbols and display/output corresponding English alphabets.

- Presented in Grace Hopper Conference 2011 and Intel Cup Embedded System Design Challenge (ESDC) 2012

Mobile Test Dependency Detection (2017): Show existence of test dependencies in Mobile GUI test cases and a practical approach to identify them.

Features: Android AOSP instrumentation; program analysis; source code instrumentation.

- Instrumented android API to capture application state changes caused by GUI test cases.

- Automatically detected data dependencies between GUI test cases that impact the test result.

- Showed that unlike test dependency detection in Unit tests, for GUI test cases, app specific domain knowledge is required to correctly tag reads and writes in network communication.

COMPUTER SKILLS

Language:	JAVA (10+ years), PYTHON (5+ years), JAVASCRIPT, C
Operating Systems:	MAC OSX, UBUNTU, REDHAT, WINDOWS