中国科学院软件研究所
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新闻动态

软件所在开源智能家居系统设备集成缺陷研究方面取得进展

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在人机物融合的信息物理系统（CPS）中，设备集成缺陷是影响系统质量的重要因素。中国科学院软件研究所软件工程研究开发中心团队针对人机物融合的典型应用系统——智慧家庭（smart home）系统中的设备集成缺陷首次开展了实证研究分析。

工作以开源系统Home Assistant和OpenHAB为目标，以收集的330个设备集成缺陷(iBug)为研究对象，主要从缺陷根因、修复模式、缺陷触发条件及其对设备的影响几个方面进行研究。工作从设备、生命周期管理、异常处理等维度构建了设备集成缺陷根因分类体系，抽象归纳了25种缺陷修复模式，发现了6类缺陷触发条件。这些缺陷能够导

致设备不可用、错误的设备状态、非预期行为等严重影响。最后，工作从开发人员、设计人员以及缺陷检测人员几个不同视角对如何处理和应对IoT设备集成缺陷提出了若干建议。

　　该工作被软件工程顶级国际会议ISSTA 2022录用，成果有助于从设备集成角度加深对系统缺陷的认识和理解，能够辅助相关人员提高集成组件开发质量或有效处理缺陷问题，构建的开源IoT设备集成缺陷集合可以为后续工作提供数据支撑和基准（https://github.com/tcse-iscas/iBugs (https://github.com/tcse-iscas/iBugs)）。
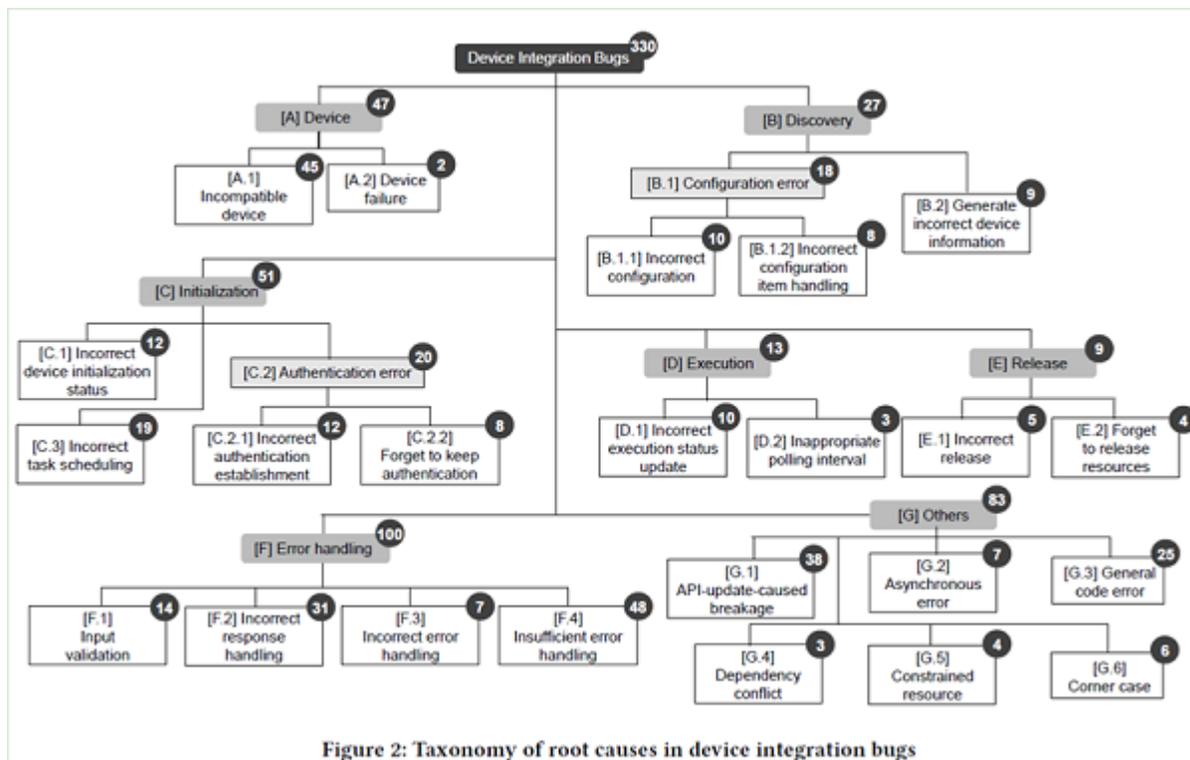

Figure 2: Taxonomy of root causes in device integration bugs

Table 1: Frequent fix patterns for each root cause

Dimension	Root cause	Fix pattern description	#Issues
[A] Device (47)	[A.1] Incompatible device (45)	Improve the device integration and adapt to incompatible modules of the device.	24
		Prompt a warning to indicate that the device is unsupported contemporarily, waiting for the corresponding integration.	21
	[A.2] Device failure (2)	Use new device instead.	2
[B] Discovery (27)	[B.1.1] Incorrect configuration (10)	Add default configurations.	3
		Fix corresponding configurations.	6
	[B.1.2] Incorrect configuration handling (8)	Correctly handle conflicting parameters.	6
	[B.2] Generate incorrect device information (9)	Generate unique ID.	9
[C] Initialization (51)	[C.1] Incorrect device initialization state (12)	Fix corresponding state.	8
		After restart, load the original data from the cache.	4
	[C.2.1] Incorrect authentication establishment (12)	Update correct authentication information.	3
		Correct authentication logic.	5
	[C.2.2] Forget to keep authentication (8)	Add watchdog or set timer to maintain the authentication.	8
	[C.3] Incorrect task scheduling (19)	Remove heavy tasks from the event loop.	13
		Modify synchronous (asynchronous) tasks to asynchronous (synchronous) tasks.	6
[D] Execution (13)	[D.1] Incorrect execution state update (10)	Correct state processing logic.	5
	[D.2] Inappropriate polling interval (3)	Adjust polling interval.	3
[E] Release (9)	[E.1] Incorrect release (5)	Release the wrong part correctly.	5
	[E.2] Forget to release resources (4)	Release relevant resources.	4
[F] Error handling (100)	[F.1] Input validation (14)	Check before use.	14
	[F.3] Incorrect error handling (31)	Add retry & timeout setting.	9
	[F.4] Insufficient error handling (31)	Adjust retry & timeout setting.	9
[G] Others (97)	[G.1] API-update-caused breakage (38)	Fix API usage.	38
	[G.2] Asynchronous errors (7)	Waiting for synchronization.	7
	[G.3] General code error (25)	Fix corresponding errors, including illegal argument, null reference, syntax error, undefined object.	25
	[G.4] Dependency conflict (3)	Choose appropriate third-party library versions.	3
Total (330)			240

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