Self-Adaptation in Smartphone Applications: State-of-the-Art Techniques, Challenges, and Future Directions

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SWOT Analysis

Table presents the conducted SWOT analysis of the selected studies.

Table: SWOT analysis of the selected studies

No.	Study ID	Strength	Weakness	Opportunity	Threats
1.	[S1]	Proposed decentralized algorithm and it monitors social interaction.	Performed on small scale social graphs analysis. The algorithm works online on every user node.	Create macro-level social structures and consider Twitter social network in paper, work on other platforms is opportunity.	Threat in case of mobile exchange/ snatched because it stores ego behavior and it is completely decentralized.
2.	[S2]	Proposed adaptation policy that determines adaptation need before going to an unusable state.	Lacks in developing an adaptation algorithm.	The algorithm impact can be enhanced by implementing proactive detection.	Threat is in security criteria, as the medical data is very sensitive is not discussed.
3.	[S3]	Proposed software architecture for collaborative mobile learning that	Authors consider very small scale scenarios to perform. Their mechanism	Opportunity of working in medium and large scale scenarios. Need to add a separate dashboard for the teacher work.	Set plenty to irregular user and detection of suspicious node according to the security point of view lacks.

		support mobile-based learning activities.	have not demonstrated all the failure instances are correctly addressed.		
4.	[S4]	Proposed context-aware software platform for self-adaptive mobile application development.	The major focus of the authors is on fragmentation.	Proposed algorithm should be optimized and also evaluated for different other ubiquitous application environments.	Secure web applications and browser compatibility/capabilities.
5.	[S5]	Proposed non vehicle bound application. The proposed mechanism is battery friendly.	Authors explain simple steps for the detection. Algorithm activation and speech reorganization process are not well explained.	Modification/improvement need in this work. There is an opportunity for the development of such a self-adaptive algorithm and application as well.	Consider the internet connection issue. what kind of other things to be done after the successful detection of the accident (i.e. services)
6.	[S6]	Proposed framework that supports context-aware applications development and deployment for vehicular social networks (VSNs).	Limited resource of mobile devices. Unstable networking connections. Cost is a major concern in such type of applications.	Three applications idea based on VSNs: Safety improvements, Traffic management, Entertainment (streaming, downloads).	Privacy, trust and security are common concerns for VSNs. In their current version of the S-Aframe, work on security mechanisms lacks.
7.	[S7]	Automatic application configurations generation approach and reconfiguration plans at runtime. Authors specify a case study and use it in the evolution of their approach.	Authors considering just one resource, which is the battery level.	A general approach that utilizes other different resources simultaneously. Algorithm optimization is also another opportunity.	Evaluation of the approach is by simulating the execution of an application on a mobile phone. A threat to validity is the comparison of their results and real users results

8.	[S8]	Proposed Cosmapek which is an adaptive deployment infrastructure. Implement BUSCAME which is a self-adaptive Android application.	A big application has several feature models, due to which a lot of reconfiguration plans are made by the planner component.	Enhance performance: Work can be done on the performance area, which lacks in work.	Sensors of the monitoring module are always in the active state, and the analyzer module is activated to analyze, there will be battery drain issues.
9.	[S9]	The energy metabolism self-adaptive model was developed to estimate daily changes in insulin resistance and fat mass.	Focus on a specific area, rural American areas. Network, application optimization, and performance issues lack in work.	Can develop an application like this, globally. The opportunity of working in performance, app optimization, and network context in current context.	Threat in case if the user performs some unusual activities in his/her routine which need to be handle as the app is containing all the history of the patient.
10.	[S10]	Presented GCA. Authors use the Nokia MDC dataset in their simulations.	Their concept is complex in terms of computation.	Battery optimization is an issue. Need of hybrid technique which may use for performance and time efficiency as well.	Integration of context adaption features in application is difficult as achieving good context predictions is complex.
11.	[S11]	Proposed framework based on reinforcement learning.	A small image dataset for the experiment/ test is used.	Learning could be extended to the model itself. Security and privacy requirements can be modeled before making a decision.	Security and privacy are not handled which is a threat.
12.	[S12]	Authors conduct two literature reviews in AUI domain and design 8 principles for adaptive user interfaces.	No evaluation is done in work. The expert's opinion lacks regarding their principles of the adaptive user interface.	Application on these defined principles.	Methodological evaluation is not done.

13.	[S13]	Proposes a hybrid feature recommendation method. Experimental results show that the proposed method is more effective than the classical method.	Focus on feature recommendation (Application side), while hardware features are missing (battery optimization).	Explore more the relationship between functional feature and API to improve functional feature recommendation and also the quality of App classification.	The functional tightness of the classified APIs with similar functions and Apps will have an impact on their proposed method.
14.	[S14]	Proposed a self-adaptive step counting algorithm to improve the accuracy of step counting.	Less focus on power consumption.	Their application consumes more power than an android native application.	Still, some inevitable measurement errors occur during the time of condition change.
15.	[S15]	Work on adaptive interface.	Basic idea about adaptive interface. It may not applicable on applications having lot of widgets on a single screen.	Develop a deep and high-level model that supports most of the android widget's well.	If an activity (single screen) has a lot of widgets then widgets might be merged, lacks in work.
16.	[S16]	Proposed framework for energy efficiency based on the self-adaptability of mobile applications.	It's simulated work. A basic and simple idea about self-adaptation in the energy consumption area.	May practically implemented and discuss results about the battery consumption.	Need to focus on security based features.
17.	[S17]	Proposed cloud aware. It supports automated context-aware self-adaptation techniques.	Limited network coverage. Lack of centralized infrastructure. Lack of incentive models.	Resource discovery. Partitioning and task scheduling. Lack of standards.	Security issues.
18.	[S18]	Developed an environment that allows the crowd to observe the earlier version work plan.	Support in the richer scenarios for example one person responds to a	Using machine learning algorithms to enhanced event selection formulas. Create guidelines for feedback collection	Dealing with richer scenarios and richer heterogeneous data lacks.

		The purpose is to achieve affecting program structure and process.	sequence of system events to a user event rather than by just one event.	points and also including dynamic changes to such feedback collection.	
19.	[S19]	Proposed an adaptive security model.	Solution for local apps, not cloud-based applications. Not discuss the response time, which is an important factor in security applications.	Use adaptive security in DSPL to develop cloud computing secure Applications, this will provide efficient mechanisms to manage and dynamic characteristics of the security in mobile cloud computing.	Need to realize the expected security needs, response time, and reconfiguration overhead to make the decision when the reconfiguration must be carried out.
20.	[S20]	Proposed adaptation strategy to investigate how users understand and perceive the security and satisfaction of context-aware applications.	Their app focused on elderly people (over 60 years). The authors test the model on just two volunteers.	Develop app for all age group users. Experimental study needed to assess the adaptability of services	The threat is related to the change of emotions, which has been observed and discussed.
21.	[S21]	Propose the ADMDM and improve the Apriori algorithm.	Detection rate vary with android versions due to hardware compatibility.	Improvements need to be done in their current work for better detection.	Still some limitations in ADMDM in the detection of the hidden anomaly.
22.	[S22]	Propose DAMPAT which makes decisions at runtime on how to adapt multimedia presentations.	Authors assume infinite resources of application and do not consider that the other applications also running on the same device.	Opportunity to work on performance area, multiple applications simultaneously.	Resource management issue.
23.	[S23]	Proposed application based on meeting minutes. Speak recognition,	Speaker classification capability was dependent on noise effect reduction and the duration of per-speaker audio.	Opportunity to work on overlapping conversation.	Sentiment analysis at the sentence-level for opinion mining is incomplete which

		text summarization algorithm is used and perform sentiment analysis.			may change the sense of work, and effect the determined agreed actions.
24.	[S24]	An improved version of a speech source localization method is presented. Proposed new VAD.	Work on battery optimization lacks. Computation time and efficiency discussion lack.	Opportunity to work on battery optimization and on current algorithm in case if noise is huge and the voice is low.	There is a need to present output in more visualization form, because of the eyesight issues in overage persons.
25.	[S25]	Authors present RA. Conduct a case study to evaluate their RA.	Architecture does not enable end-users domain experts to create their applications.	Conduct some more case studies intending to evaluate RA. RA can be used in industry for evolution when applied to a larger real environment.	Conduct more case studies as mentioned in the Opportunities section and figure out threats related to security issues.
26.	[S26]	Describe the framework (CAMeL) to improve context-aware middlewares by machine learning capabilities.	From their case study, it is difficult to conclude that it can be applied to every possible application, few general principles can formulate from it.	Consider more case studies and experiments to evaluate their architecture.	They discussed a case study and explain architecture accordingly, there is a need for more case studies or experiments to evaluate accuracy.
27.	[S27]	Propose four different adaptation engines in terms of energy consumption and evaluate them. The authors show that it is possible to reduce the applications' energy consumption.	They used two scenarios, which cover a large number of applications. However, there are some other applications, which lacks in their scenarios.	Consider more scenarios to cover the maximum number of the application for evaluation.	Energy consumption cannot be isolated for application to be tested from all the other system processes and background running apps.

28.	[S28]	Work on malware detection in android phones.	Focus on android phone and less number of experiments performed.	May also work on other smartphone operating systems.	Model validation lacks, needs more experiments that help in the evaluation.
29.	[S29]	Work on the detection of the user environment. Data collected from a large crowdsourcing campaign, collected from different mobile devices, and sent to the mobile network.	Computation time on a large amount of data.	Can be work on proposing a classifier that detects more user context-based components and not only just the environment types.	In case of low network connection, collected data will not be timely send to the network.
30.	[S30]	Perform SLR focusing on self-adaptability in mobile applications context. According to the authors, it is the first study conducted in this field.	Consider only one electronic database Google Scholars.	Less work is done in this area, there is a need to highlight the advantages of adaptation in mobile application applications.	N/A.
31.	[S31]	The focus is on providing an approach for application designing, operation of the application, and service-based applications based on run-time adaptation.	Data-driven composition requirements, Monitoring of unexpected events, Further adaptation mechanisms and strategies implementation, User involvement, and flexible adaptations are few weaknesses mentioned.	Use their approach to real applications that are coming from industrial experiences. Study the usability of their approach.	Presented results obtained from case studies modeled by authors. The author's approach is represented by the Process Engine which operates in a centralized manner currently.