Usability Heuristics Redefined for IoT Based Interfaces

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Abstract

Internet of Things (IoT) has dominated the world since last couple of years and a lot of development is being done around it. So it is very important to develop IoT based products/interfaces in a manner that they are useful and usable. In this paper, usability heuristics are revisited in terms of IoT devices. First section of this paper contains introduction to IoT and its applications. Introduction is further described with Literature Review in the next section. After this, usability heuristics for software development are described. In the same section, new heuristics relevant to IoT based interfaces are proposed which are elaborated in the later part. Mini Drone is chosen as object of research and corresponding case study is presented in the next part of this paper. The paper is concluded with the methods for evaluating the usability of IoT based interfaces.

Keywords: Internet of Things, Usability Engineering, Software Usability Heuristics, Heuristic Evaluation, IoT based interfaces, Usability simulation

1. Introduction

Evolution of software during 80s provided the world with completely new ways of doing things. Later, Internet revolutionized the vision and action of people, influencing non-technical folks as well. Technology was still revolving around cloud when the idea of ‘Internet of Things’ (IoT) popped up.

Washing machines doing intelligent laundry, refrigerators automatically alarming when stuffs inside need refill, cars reducing speed on their own in traffic area, smartphones operating all domestic mechanisms and many more! All these are petals of IoT flower [1].

Motive behind IoT is to transform non-living objects into ‘smart’ and connected objects so that they can intelligently communicate using data, software, sensors and network [2]. To manage and control these objects, we have smart devices with software interface. Interface can be part of smart phone app or embedded software inside any hardware or a simulator. With IoT, a software is no longer just a piece of code being used by human brain but it has grown beyond that level. It has evolved with artificial intelligence granted by developer.
So analyzing the usability of such interfaces is significantly different from traditional software interfaces. In this paper, usability heuristics relevant to IoT have been proposed with reference to Jakob Nielson’s heuristics. To strengthen proposed heuristics, Mini Drone designed by Parrot SA has been studied and presented.

2. Literature Review

With the rapid rate of growth in Human Computer Interaction, Usability Engineering of software systems is becoming increasingly important. Jakob Nielson, a well-known practitioner in the field, has been writing and publishing his illustration on usability engineering, web usability and mobile usability since 1993 [3]. Other researchers namely; Deborah Mayhew and John M. Carroll have also presented their works for usability and human computer interaction [4].

IoT is a theory, technology and vision. Even though the concept was first discussed way back in 1982 [1], it is still being researched and implemented upon by different researchers, developers and organizations as per their own interests. It has been emerging since then with experts in the industry presenting their works from time to time. The concept of IoT first became popular and got its name in 1999 [5]. With the technology revolving around technical sensations such as machine to machine communication, virtual reality, wireless networking etc, IoT is nothing less than the future of computing.

3. Background

There are 10 usability heuristics for UID suggested by Jakob Nielson [6]. Below is their analysis and corresponding heuristic for IoT based interfaces.

Visibility of system status: This characteristic analyses the system for its ability to keep users informed about its internal processing well in time. ‘Smart’ objects are programmed to behave similar to human beings. These devices are expected not only to keep users informed but also suggest them smart decisions in doubtful situations. Majority of things use wireless network to connect to device interface in real time. Thus simultaneous visibility and timeliness of system’s happenings through device interface becomes crucial. Hence Prompt Visibility and Accessibility stands as the first heuristic suggested for analyzing usability of smart things.

Match between system and the real world: This property bounds systems to behave in a logically defined way with natural and familiar terminologies. Idea behind IoT is ‘Internet of Everything’, which suggests to make every system intelligently responsive. When refrigerators start intimating about the stock refills or when driverless cars roam around on streets, systems ought to match thoroughly with the terms and terminologies of user. So, the second heuristic suggested is System is the real world.

User control and freedom: Software must support undo and redo. User should be given privilege to avoid unintentional mistakes. With the boom of IoT, devices are being made smart and people gradually people are getting more and more dependent on them. Instead of informing user about any mistake he is committing, such devices are expected to stop him from making any such mistakes at first place. Even the smartest of devices must be configured with appropriate User control and freedom.

Consistency and standards: This usability heuristic mainly focuses on consistency and promotes a standard for development. Consistency and standards are of high importance irrespective of
software application category. Whether it is traditional SDLC based software or any latest technology based application, it ought to maintain consistency and follow standards. So Consistency and standards heuristic also remains intact.

Error prevention: With the evolution of usability engineering, error prevention has become more important than error correction. Misdeeds and false moves are very much likely if machines are smarter than human brain so inhibiting mistakes before they happen is of great concern. Still network errors, human errors or unwanted occurrences must be taken care. Well-judged handling of errors leads to smooth functioning of overall system. Error prevention and handling is the fifth proposed heuristic.

Recognition rather than recall: This usability heuristic relates to software development in a way that features and functionalities are easier to find, learn and remember. Users should not have to hunt for simple and obvious functionalities within the software. Smart things are nothing but normal machines programmed to behave instantly and cleverly in dynamic circumstances. Interfaces designed to manage smart things must offer full user control. These things must be embedded with precise logic and acute action settings in standard format that user can conveniently figure out. So, Rationally methodical and patterned can be sixth heuristic for usability analysis of things on Internet.

Flexibility and efficiency of use: According to this heuristic, system should work efficiently for experienced users as well as for novice users. Now, IoT is an emerging concept and a vast section of people is unfamiliar with technicalities involved. In order to create and enhance usability of IoT based things, interface design must be Progressive, impromptu and efficient. This stands as the seventh suggested heuristic.

Aesthetic and minimalist design: It suggests that design and functionalities of system should be clear without any irrelevant information. This heuristic is the backbone of any software and smart devices are no exception. User must be appropriately informed and not misguided. IoT based devices and interfaces must be mindfully developed so that they are usable for one and all. Hence, Compatible and robust design is proposed as eighth usability heuristic.

Help users recognize, diagnose, and recover from errors: Users should be able to understand, resolve and recover from errors. Precisely this heuristic has been taken care in ‘Error Prevention and Handling’. With devices based on IoT, attribute that is of extreme importance is security. When smartphones act as remote control for so many basic processes, the data inside them is required to be preserved efficiently. Also privacy needs to be taken care so that any user’s personal information is not vulnerable to accidental damages. So, Data privacy and security is the ninth proposed usability attribute.

Help and documentation: This usability heuristic promotes the developers to incorporate appropriate and sufficient guide for system usage. In addition to documentation that traditional software provides, looking at vicinity and operability of smart devices, they should be incorporated with real-time support through calls/instant messages/emails. This makes Documentation and support as last usability heuristic for IoT based interfaces.

4. Case Study

In this section, above proposed heuristics have been elaborated with an example of Mini Drone. Mini Drone is a flying quad copter embedded with camera to capture and record aerial views.
It lies in the category of smart devices as it can sense dangers, has self-defense mechanism and operates in real time via some smart phone application [7, 8, 9, 10].

Prompt Visibility and Accessibility: Mini Drone is operated using a smartphone app that access the drone via device motion sensing and control panel both of which account for visibility and accessibility. While drone is working underwater or is struck somewhere, user can manage it through app sitting at some place within the range.

System is the real world: Mini drone is equipped with sensors and propellers to safe guard it from accidental damages which can be operated through interface. It does not only match the real world but also replicates it. While drone in itself has been built smart, interface lets user operate it as if he is piloting in real.

User control and freedom: The interface for Mini Drone app allows user to control any request, lets him cancel/force stop ongoing process and permits him to navigate to any task smoothly. It provides some automatic controls to stabilize trajectories thus preventing user from committing any unusual error. It also allows user to control speed, adjust camera setting and perform other basic features during ongoing video capture.

Consistency and standards: Mini Drone app adheres to pre-established standards and is consistent throughout its functionalities. It follows same conventions and standards as previously launched apps for drones. It also complies with smart phone app related rules and requirements.

Error prevention and handling: For error handling, there is a complete mode in Mini Drone i.e. rescue mode. User can unblock the drone that is stuck in a tree right from his app!

Rationally methodical and patterned: Mini drone interface just like other drone interfaces has a pattern. For a naïve user, it is easy to anticipate the location of any feature in app and any user who is coming back, can recall the same.

Progressive, impromptu and efficient: Interface for Mini Drone is launched in different modes such as beginner, piloting, rescue etc. that gives full access to users for adjusting the flight controls. Beginners can work with basic functionalities and with growing expertise, can later adjust the controls.

Compatible and robust design: Mini Drone interface has been designed in a way that strongly supports user control and access to device. Features such as motion sensing, flight adjustments, map integration, altitude setting etc have been implemented keeping in view the user’s state of mind while governing the movement of drone. It is compatible with majorly used mobile operating systems that are iOS and android.

Data privacy and security: There is no such sensitive data in Mini Drone interface which needs protection but basic level security features such as login are incorporated. Permission based functionalities and views such as view history must be designed.

Documentation and Support: Application is equipped with a complete academy where one can watch video tutorial, seek any specific help or search frequently asked questions. Also the recorded videos can be viewed and transferred from there [10].

5. Usability Evaluation

Usability evaluation is a process to determine existence of degree of usability within any software system. There exist several Usability Evaluation Methods (UEMs), tools and algorithms which
can be used to evaluate usability of any system. UEMs is a broad term that includes various other generic methods for usability evaluation categorized into four major categories namely: Formal Methods, Automatic Methods, Empirical Methods and Informal Methods. UEMs such as Cognitive Walkthrough, Review Against Standards, Formal Lab Testing etc can be used for evaluating the usability of IoT based interfaces. Tools for usability evaluation of IoT based interfaces range from creating navigational but nonfunctional wireframes such as Invision [11] to simulating entire on relevant device such as AT- EASE [12]. Such tools are highly effective as they provide evaluator with nearly realistic view of the system. Usability of IoT based interfaces can also be evaluated using algorithms such as Ēvolvere [13] which takes into account various usability attributes of interest and their corresponding desirability weights to calculate the usability of any software system.

6. Conclusion

Rather than smart devices, there should be smartly controlled devices. Smart technology must ease our approach rather than changing the way work is done. Hence, considering above heuristics while developing interfaces for IoT based devices will result in enhanced usability. They will give user a better vision for designing and planning and are generic so can be applied to any interface such as for remote health monitoring systems or emergency notification systems. Implementing any of the suggested methods for usability evaluation will lead to quantitative measurement of usability of system with respect to real world. With advancements in technology, these heuristics are likely to be altered and redesigned at some point in time later on but the foundation will always remain same.

References