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A Tangible Product to Enhance Real Time User Experience of Enjoying Music

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Abstract

As digital entertainment applications evolve, there is a need for new kinds of platforms that can support sociable media interactions for everyday consumers. While the present emphasis in media products has been on individual user, group of users that form a collective cultural unit has been addressed in this paper. Entertainment and Music are found to be very effective tools for bringing people together. We have therefore tried to utilize the synergistic amalgamation of the two - Entertainment and Music, through the design of a multi-user interactive tabletop device for playing music.

This paper demonstrates an extensible research method which records the lifecycle of music devices existing in different era, with respect to their compatibility with the then persistent lifestyle of the target users, which is Indian youth. The study has been further extended to project the future expectations as well as usage patterns of the user's living environment. It also delineates product development for real-time tracking of multiple objects on an interactive table with an embedded music system and display.

1. Introduction

The use of the tabletop as an input/output device is an exciting and emerging research area. This cross-disciplinary domain brings together experts from augmented reality, user interface technologies, multi-modal interaction, input and sensing technologies, CSCW, and information visualization.

This paper will elaborate the development of group interactive table top device for Indian youth, along with the background research. We describe modeling of user's lifestyle to understand, analyze and extract information from the trends that are followed. It provided us useful insights about preferences aspired by users which we incorporated as interactive and adaptive features during designing our new product (an interactive music device).This is a novel approach for new product design and development. The proposed tabletop platform can support many different applications, and is designed to overcome the commercial obstacles of previous single purpose systems. The design requires precise and dynamic positioning of multiple objects in order to enable real-time multi-user interactions with media applications.

Technical analysis shows the approach to be robust, scalable to various sizes, and accurate to some acceptable limits of tolerance. A qualitative user evaluation of our product within real-world setting demonstrates its usability in the consumer entertainment space for enjoying music and other entertainment activities.

The paper suggests that by providing a general purpose method for shared tabletop display platforms we give application designers the freedom to invent a broad range of media interactions and applications for everyday social environments, such as homes, classrooms and public spaces. One such recent example where developers have liberty to develop new applications for existing hardware is App Store. The App Store is a service for the iPhone and iPod Touch created by Apple Inc. which allows users to browse and download applications from the iTunes Store that were developed with the iPhone SDK and published through Apple. They are available to purchase or free of charge, depending on the application. The customers are using it extensively as developers come up with novel applications for the existing devices frequently. It is predicted that the app store can generate annual revenue of $1 Billion for the Apple Inc [1].

The main contributions of the paper includes: describing the approach we adopted to model customer expectations by understanding their lifestyle patterns, formulation of an extensible method for developing media table platforms; development of a detecting and processing approach for dynamic object tracking on acrylic surface; a taxonomy of interface design considerations.

3. Background Research

Our product development was bolstered by a systematic research. We initially did a semantic modelling of lifestyle patterns existing during the aeon of various musical devices from gramophone till iPod, to predict the features of next generation music device [2]. The research helped us in deciding upon the features to be integrated in the product as per the expectations of the users. We then studied and incorporated the aspect of localization into the device, to improve its adaptability [3]. Existing table top interfaces for tangible interactions were also studied along with alternative ways of capturing the same for conjugating the backend technology with user experience of the product.

In the subsequent sections we would describe the research methodology as per the above mentioned phases which sequentially guided finalization of interactions and feature derivation for our table top device; followed by elucidation of product development.

3.1. Lifestyle and Lifestyle modelling

Lifestyle is the outward expression of a consumer's needs, desires and values, reflected through patterns of demographics, purchasing behaviors, activities, interests and opinions [4]. Consumer lifestyle can change dynamically under social environmental influences [5].

The behaviours and practices within lifestyles are a mixture of habits, conventional ways of doing things, and reasoned actions. A lifestyle typically also reflects an individual's attitudes, values or worldview. Therefore, a lifestyle is a means of forging a sense of self and to create cultural symbols that resonate with personal identity.

3.1.1. Lifestyle modelling

Analyzing, understanding and extracting information of expressed lifestyle aspirations is termed as Life style modeling. It gives us useful insight about the preferences of users which in turn helps to incorporate them as interactive features thereby building in usability within the engineering process.

Lifestyle Modelling investigates the changes in peoples' lifestyles to model

the future expectations and aspirations of the people in effect to their living environment and usage patterns along with, how deviation from generic and from personal lifestyle models play a role [4]. It has gained a great importance in market and industry in the view of existing competition level as it helps in deriving the customer expectations.

3.1.2. Lifestyle modelling for musical devices

In our efforts to model user's lifestyle for music devices, we studied the generic evolution of these devices ever since the invention of gramophones till the current generation device, iPod. The considered product features for this study were divided into two domains – Tangible and Intangible. The tangible features included Storage Size of the device, Basic Interaction Mode, predominant way of Interaction (e.g. group or individual), Device Size, Ratio of Screen size with Device size and Connectivity. The intangible features included Social Aspect of the device and its Adaptation to the prevalent lifestyle. Along with these features the Lifetime of each of these devices and their drawbacks giving way to a new device were also reported to observe a device's acceptance.

The trend followed with respect to these tangible and intangible product features across the lifecycle of music devices of different era, was used to predict the features of the Next Generation music device. It was assumed that features of the products studied, reflect the preferences of the respective generation of the users, as products evolved. To further support this assumption, lifetimes of these devices from gramophone to iPod along with their respective drawbacks giving way to the new product were reported to derive a pattern.

The tangible features of these devices were measured and reported by us based on the available factual data. The intangible features (Social Aspect and adaptation to prevalent lifestyle) were rated by a set of 52 users through a questionnaire hosted online. The users were asked to rate these ten devices (from gramophone to iPod) on a 20 point scale (20 being most social) for the social aspect feature of the respective products. The feature of adaptation to prevalent lifestyle was to be rated by the users on a 4 level scale- Poor, Average, Good and Excellent. The age group of users was 16-30 years which mainly included Bachelor students, Masters and PhD students, young professors and lecturers, matching the target user group for the development of our device. The motive of this study was to recognize the fluctuations and trends that have been followed since the origination of music devices, with respect to these intangible features.

To comprehend the results from user study and our research, a table was developed in the form of matrix with all the devices listed along the x-axis and features along the y-axis. The matrix was augmented to state the derived features of the next generation device based on the trend followed by respective features. Please find the complete lifestyle modeling table on the link: http://sites.google.com/site/musicinspirationproject/Home/lifestyle-modeling.

3.1.3. Observations

It was reported from the user study that the social aspect feature has been following a fluctuating trend [2]. The results from rating of the feature 'adaptation to prevalent lifestyle' reflected overall compatibility and acceptance of the device amongst the people of its respective era. Also it conjugated with the data obtained for lifetime of the device. For example, a device having short lifetime was not very well accepted by the people, hence reducing its adaptability and vice versa. The reported drawbacks of a device giving way to new product helped justifying the above stated relationship. Kindly refer the Lifestyle modeling chart for details (http://sites.google.com/site/musicinspirationproject/Home/lifestyle-modeling).

To get the essence of lifestyle modeling we have summarized the trends observed

for different device features followed by the predictions made for the next generation music device. This table is available in Appendix I.

Based on these observations we can say that the next generation music device should be a personal device which is small, slim and has a good connectivity with other devices along with ample inbuilt storage capacity. A novel interaction which can keep the users engaged in constructive exploration for long is preferred.

The interaction should be simple and engaging. A good way to make the interaction simplistic is to keep the architecture of the product, single layered (avoid jumping to new menus and features) to reduce complexity. The device interaction should be designed such that it's both Intuitive as well as explorative. The intuitive aspect invites the user by generating a sense of familiarity and connection with the product features. With the explorative aspect user feels victorious on successful accomplishment of a task. Both these aspects should be effectively merged while defining interaction, for firstly inviting the user to interact with the product and then keeping him interested and engaged. Mapping of features and function attributes should be culturally contextual.

While deriving the features of musical device, the lifestyle modeling helped us to decide on the important product features individually. But for the Product which is assembly of the derived features, to appeal desired market, studying usage habits and social aspects of targeted users is inevitable. So the aspect of localization was taken into account during deciding of features, choosing the technology, interface design, application development, product design and manufacturing.

3.2. Localization of the device being developed

In the view of the importance of localization [3], we need to stress upon extracting appropriate device features and to implement them suitable while designing interactive products. The features should allow easy adaptation of the product which in turn would account for its success or failure in the targeted market which is Indian youth in our case.

India has a culturally bound society. There is a strong sense of community in the Indian culture. Indian festivals, weddings and other celebrations along with its high collectivism ratio [6] are evident examples of this. Considering social aspect in Indian context during collaboration, size of the device (control area and sequence initiation) should accommodate for errors as Indians at large are not very comfortable with small touch based interfaces [7]. To account for the limitations of precise movement and speed accuracy trade-off, tangible block based interactions are more favourable.

Indian people are very value conscious [8]. It is not just interaction and excitement, novelty and other product related factors which can tempt them to buy a product but also value for money. Lastly the cost of the device should be economized to improve participation and large scale commercialization.

We as a result of our study developed a list of features which should be incorporated in first generation surface computing devices to allow a smooth transition. As this is a big shift from vertical screens to horizontal table tops, making the features of first generation of these products close to the existing habitual traits of users is very crucial, especially considering the high Uncertainty Avoidance ratio of India [6].

3.3. Feature finalization of musical device for the Indian youth

In the view of observations from our Lifestyle modeling in conjunction with the crucial aspect of localization of devices, we get to know the features that should essentially be present in the Next Generation music device to meet user

expectations and the ones which can be further experimented with and need innovation. The essential features includes good connectivity (wifi, bluetooth) along with very large storage size, sleek and appealing form, small device size and proportionately bigger screen size. The features which can be experimented with include social aspect of the device and the ones which need further innovation include novelty and surprise element of a device along with exciting interaction pattern.

Taking into account the collectivist nature of Indian society [6] and with personal devices having largest share in the market we perceive the necessity of a product which will help in establishing better social interactions. The features for this device have been extracted from the studies discussed in the previous part of the paper. So we have incorporated all the essential features as desired for a next generation music device. Along with this we have used table top interaction unlike the traditional button or wheel interface used in music devices. We had to compromise with the small device size desirability to accommodate social aspect of the product. So the major features of our device includes Social device (considering the Collectivist Indian society), Multi user interaction (considering Collectivist nature and to infuse excitement in interaction), Tangible/ Haptic interactions (to instil excitement in users) and Single layered information organization (for ease of use).

Further we will discuss product development process in details.

4. Product development- an interactive group table top tangible device to play music

Extracting the customers' stated and perceived expectations from our research and user study we move forward to incorporate these into a new design configuration of the product. The derived final features for the product have been mentioned in the previous section.

4.1. Technology

A simple technological platform is developed to support the suggested interactive applications on table top device. The factor of ease of installation and setup has been considered. The structure and operation is described in the following part.

4.2. Structure

Blocks are installed with LEDs and batteries. Switch is used to turn LEDs on/off. Batteries are placed inside the blocks whereas LEDs are arranged at bottom surface of the blocks. Each block has different number and arrangement of LEDs. Webcam, Projector and Processing unit are installed below the table top.

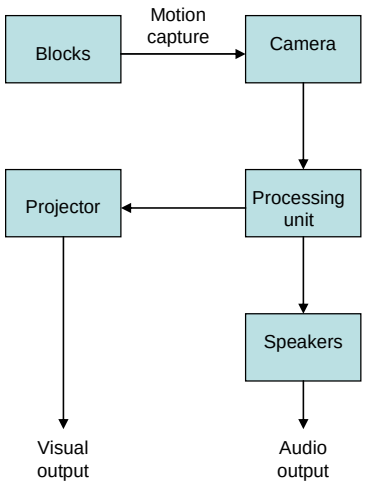

Figure 1. Technology setup

4.3. Operation

Image recognition technology is used to identify the blocks and their positions over the table. The image is captured using a webcam located inside the interactive table and is further processed to decide upon the action. Processing involves converting the image into grayscale, filtering using a median filter, and labeling areas. The final outcome is a black and white image with black region being the background and

white region representing the blocks (LEDs).

Depending upon the number and position of white regions, block and its position is identified. Translational motion is detected by continuous video capture processing. Projector displays the video output on screen and speaker gives the audio output. The Webcam operates in the visible range.

The benefit of this structure and organisation is that it is not application dependent. So many other applications can be developed to fit this technology setup, reducing the burden of developing and testing the application platform by interaction designers.

4.3.1. Table top interaction using blocks as a medium

We derived the principle of simplistic design from the recommendations and devised an interaction such that the user could relate his/her previous learning to the product. But at the same time we took care in giving the user enough space to explore new functions and interactions further adding on to his/her learning and keeping him interested in the product. So we defined an exciting interaction where blocks serve as a medium for interacting with the device. The users can relate to their previous learning of using a mouse, with just a change that the surface on which the user will be moving his metaphorical mouse (blocks) will give him the outputs. Also the orientation of the interaction surface will be horizontal instead of vertical as in case of computer monitors. The interaction we defined is – Three blocks of different shapes and sizes are provided to the user. The motion of blocks serves as a parameter to control the functions of the product. Each block is linked with a different music which changes according to its location on the circular interactive surface. User can play several variations of music by using different combinations of blocks and different positions of blocks on the table surface. Each permutation gives a harmonious set of music. As it is a multi-user activity many users can come together exploring different variations of music generated via combination of blocks and positions. So the interaction provides sufficient space for both shared and collaborative learning and exploration.

4.3.2. Music

To encourage a user to play with a device it is very important to take care that the mistakes he commits earlier should not instill in him, fear of using the device. So each interaction must result in some constructive outcome. Reflecting this in our product its interaction has been designed such that any interaction happening between the block(s) and the table produces a harmonious variation of music.
To accomplish this task it becomes important to select the exact instruments which can play independent of each other so that every combination of block(s) and its position on the table surface is a success.

So three independent musical instruments have been chosen—
Guitar which deals in chord progression, Drums which deals in beats and Piano which deals in loops.

We developed different sets of music for all the different possible combination of blocks at different locations on the table.

4.3.3. Navigation Structure of the product

The Navigation structure defined for the product has been kept very simple and easy to understand. It has been observed that multi-layer or multi-menu interactions are confusing and make users lose interest in the device. So, in the structure proposed by us the user does not need to jump from one menu to another to perform any function.
To support this and take care of the speed accuracy theory, the table was divided into three regions which were three concentric circles as shown in Figure. 5. This way the initialization was not dependent on activation by one spot but rather than a region. The functionality of divisions was

such placing block on the outermost concentric area gives the slowest variation of beat/chord of the instrument associated to that block and the innermost concentric circle gives the fastest variation.

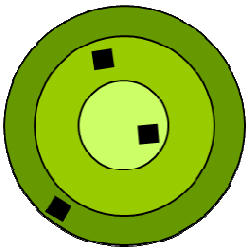

Figure 2. Image displaying the division of interactive surface of product. The black squares represent blocks.

4.3.4. Designed Interaction

To change the beat/chord speed of the instrument(s): Move the required block (associated to the instrument whose beat/chord speed is to be increased) towards or away from the center of circular interactive table top. The three different concentric regions, as explained above, give different beat/chord variation of the instrument.

To control the volume of an instrument: Keeping the position of block fixed, rotate it in clockwise direction to increase the volume of instrument associated with it. To decrease the volume, rotate it in anti-clockwise direction. The volume has been given four levels of control. Each rotation of 45 degrees increases/decreases the volume by one level depending on the direction in which it has been rotated.

To play different combination of music instruments:Add or remove block(s) from the interactive table top area depending on which instruments you wish to play

As described above each function requires just one single action making the process very easy for the users.

4.3.5. Form Design and generation

Product experience is influenced by experiences from all the senses. Experiments provide insight into how sounds contribute to the overall experience of a product's expression [9]. So the mapping between the sound a product produces, its form and its function should be in congruence with each other. Even a slight mismatch in these can spoil the experience of the product. Further more in some cases it is found that the expression of a product's sound influences the overall expression of that product. This aspect was taken care of while designing the table and the blocks. Also as it is a device being designed based on Indian scenario, suitable forms were considered.

4.3.6. Block design

Each block was associated with an instrument. Square: Piano; Overlapping circles: Drums; Star: Guitar.

To avoid the perceived mismatch between a product's visual and auditory expression appropriate semantic mapping is done [9]. The top surface of each of the blocks is covered with a picture of the device whose sound it produced, see Figure 6. Such mapping also confirms with the fundamental of recognition rather than recall, as by just viewing the shape of the block user can identify which instrument it is linked to.

Figure 3. Photograph of actual blocks.

4.3.7. Table design

The shape of the table is triangular which gives an expression of dynamism. A circular hole on the top surface serves as the interactive area of the table. A hexagonal green acrylic sheet has been used to cover the hole. Projection is done on this surface from under the table. The table has been also given a slight rugged look to diminish the feel of sophistication and delicacy from the product. Derived from recommendations, this will help in reducing

the fear factor in using the device, hence inviting users to interact with it.

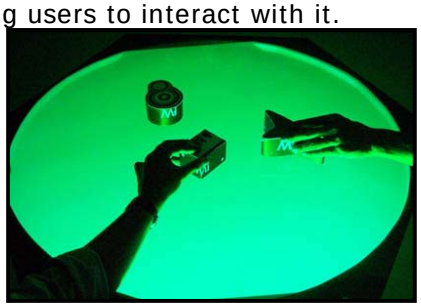

Figure 4. Photograph of table top with blocks.

4.4. Cost Effectiveness of the device

A major plus point of the device is its cost effectiveness in our price sensitive Indian social environment. Both the technology and material used in construction of the device are cost effective making it a low cost but highly interactive and socially collaborative product.

A simple process of image recognition and processing has been used which requires a webcam, a processor and a projector to project the output on the surface. LEDs have been fixed at the base of the blocks in different patterns to recognize their motion and position on the surface.

5. Conclusion

Designers endeavour to carry out product design and development as a systematic, integrated and managed process. Such methodologies recommend a systematic process from user needs to feature finalization to product development. With this comes the breakdown of the development process into relevant phases.

Life style modelling is an innovative user study method which helps in predicting the features of the next generation device. There are alternative methodologies that designers employ for user study, but they have differences in terms of applicability and underlying philosophy. As Life style modelling focuses more on social acceptability of a device, it is exercised appropriately while designing multi-user products.

To ensure easy adaptability of a device by users, considering cultural compatibility of the device is must. For designers to explore and support the richness of human actions in the design of future social devices, localization of product is inescapable. The localization of device is not limited to feature finalization. The process should be extended while deciding the underlying technology and product form.

6. Acknowledgements

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Appendix I: Table summarizing Lifestyle modeling of music devices

S.No	Product Feature	Trend observed	Prediction made
1.	Storage size	Continuously increasing trend followed	Should increase
2.	Interaction mode	Has been one to one (individualistic) since last three eras of music devices. But has observed a fluctuating trend over the period of evolution	Cannot be strongly predicted
3.	Predominant way of interaction	Has changed from buttons to touch based interaction leading to sudden peak in the engagement level and acceptance of the device over the last generation of music device (iPod)	Should follow tangible interaction mode or any other innovative mode to get users attracted
4.	Device size	Continuously decreasing trend	Should decrease
5.	Connectivity with other devices	Has been an attempt to provide good connectivity to other devices, but it's still in developing stages	Should provide good connectivity to create a differentiating factor and excite the users
6.	Screen size with respect to device size	Has been following a sudden increasing trend since the era of last music device	Should provide big screen size to provide users with an additional surface for not just information but also interaction
7.	Social aspect	Fluctuations observed	Cannot be strongly predicted