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Multi-media based Workout Assistance For Obese Adolescents

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ABSTRACT

With the increasing prevalence of obesity among teenagers, it becomes crucial to promote their health and fitness. This paper presents an innovative approach that utilizes multi-media and augmented reality (AR) technology to enhance physical activity and combat the issue of adolescent obesity. The proposed method involves creating an interactive fitness environment through a smartphone application that seamlessly integrates AR elements. This software offers guidance to overweight adolescents during their workouts to ensure they maintain proper form. To keep users motivated and engaged, interactive content like videos and visuals has been incorporated. The objectives of the study involve the identification of functionalities within fitness apps aimed at helping overweight teenagers exercise more efficiently. It also entails the creation and deployment of a multimedia prototype application, along with the evaluation of user satisfaction on the system usages. The methodology involves several key stages, including requirement gathering, application design and development, and conducting assessments based on the Technology Acceptance Model (TAM). The evaluation results have demonstrated the potential of AR-enhanced training applications to combat adolescent obesity. This study showcases the potential of AR-enhanced training application as a promising path for improving health and well-being.

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1. Introduction

Obesity is a significant public health issue globally [1], and Malaysia is no exception, as indicated by recent studies [2]. Numerous factors, including genetics, lifestyle decisions, and cultural influences on dietary habits, have collectively played a role in the rise of adolescent obesity. Diverse cultural perspectives regarding what constitutes a healthy diet can impact an individual's overall well-being, physical activity levels, and even life expectancy.

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In Malaysia, as in many other countries, the imbalance between calorie consumption and physical activity has been identified as a major contributor to adolescent obesity, making it an urgent issue. Particularly adolescents ingest more calories than they burn, resulting in weight gain and subsequent health problems. Teenagers have a notable propensity to consume high-calorie, high-fat, and high-sugar foods, such as cheese, meats, chocolates, and rapid foods. Notably, the constant advertising of these unhealthy foods on television and prominent online platforms such as YouTube reinforces these unhealthy eating habits. Often focused on immediate gratification, adolescents may overlook the long-term consequences of their decisions. Notable health hazards associated with obesity include an increased risk of diabetes, cardiovascular disease, and certain types of cancer [2], [3]. Moreover, it can impede mobility and hinder daily functioning, with weight-bearing joints such as the knees and ankles being particularly vulnerable to musculoskeletal injuries [4], [5].

In light of these challenges, innovative initiatives have emerged with the use of augmented reality (AR) to improve the engagement and efficacy of exercise programs designed specifically for adolescents [6]–[8]. As an example, AR presents a dynamic and engaging fitness experience, offering users step-by-step guidance and immediate feedback to ensure accurate exercises. By integrating multimedia elements like videos and images, this technology heightens the appeal of physical activity for adolescents, particularly those with limited fitness proficiency.

As a result, this paper presents an innovative and optimistic strategy for tackling the urgent necessity of encouraging healthier lifestyles and greater physical activity among adolescents. This approach effectively deals with the growing issue of obesity within this demographic. This paper makes a valuable contribution by showcasing the entire mobile application development life cycle, elucidating the system architecture, and presenting evaluation findings through the TAM assessment approach. This comprehensive insight into the development and assessment process serves as a replicable model for other researchers interested in creating AR-based mobile applications, facilitating further advancements in this promising field of technology.

2. Literature Review

Physical activity and exercise are fundamental elements in maintaining overall physical well-being. The Centers for Disease Control and Prevention (CDC) emphasize the importance of physical activity in promoting and maintaining physical health [5], [9]. While physical activity incorporates a variety of daily movements, structured exercise, also known as workouts, serves a specific purpose, whether it be weight loss, muscle gain, or overall fitness enhancement. Adolescence is a developmental phase characterized by the transition from childhood to adulthood. This phase can be further divided into three stages: early adolescence (ages 10 to 13), middle adolescence (ages 14 to 17), and late adolescence (ages 18 to 21) [10]. Regular exercise is of paramount importance for adolescents coping with obesity. Aerobic exercises, such as brisk walking, jogging, and swimming, have been extensively studied and recommended as an effective method for combating obesity [11]. These exercises promote weight loss, cardiovascular health, and fitness in general [1]. Moreover, it is emphasized that stretching exercises are crucial for increasing flexibility and preventing injuries.

Globally, the prevalence of adolescent obesity is a developing concern, especially in Asia and the Pacific Island nations. Obesity rates are on the rise and have nearly doubled in certain regions, according to recent statistics including Malaysia [2], [12]. Alarmingly, obese adolescents now outnumber underweight adolescents. This rise in obesity among adolescents has severe implications for long-term health, including an increased risk of cardiovascular diseases and diabetes. Despite the documented benefits of exercise, encouraging adolescents to adhere to recommended exercise levels is a significant challenge. According to research, approximately 80% of adolescents worldwide fall short of the recommended 60 minutes of moderate to vigorous exercise per day, particularly aerobic activities [2]. This disparity between recommended and actual levels of physical activity highlights the need for novel approaches to engaging adolescents in physical activity. The use of technology such mobile application has been known as one of mechanism in enhancing fitness [13]. Augmented reality (AR) technology offers a promising answer to the problem of adolescents' exercise adherence. AR creates an interactive and enhanced perception of reality by fusing digital content with the real-world environment [7], [14]. This research integrates augmented reality (AR) technology into a mobile application to transform the exercise experience for obese adolescents. AR, specifically AR based on markers, plays a crucial role in this endeavor [15], [16]. Users are required to assess body mass index (BMI)-related markers in order to access interactive workout guidance [17]. The application's incorporation of interactive videos and images enhances

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user engagement and comprehension significantly. This novel strategy seeks to bridge the gap between conventional exercise routines and interactive, immersive workouts.

In light of the alarming rise in global adolescent obesity rates, this concludes that exercise is of critical significance in the fight against adolescent obesity. While adolescent exercise adherence challenges persist, augmented reality (AR) technology emerges as a potent instrument to enhance the workout experience, thereby making exercise more engaging and effective.

3. Methodology

3.1 Mobile Application Development Lifecycle

The development of the workout assistance application embraced the Mobile Application Development Lifecycle methodology as illustrated in Figure 1. Implementing this strategy requires meticulous planning and adherence throughout the entire development process. The Mobile Application Development Lifecycle provides a well-structured framework consisting of specific tasks, essential tools, and essential resources that collectively guide the planning, development, and eventual release of mobile applications. The selection of this methodology was deliberate, driven by its capacity to offer a comprehensive and methodical process for constructing an application designed to support adolescents in their exercise routines, aligning seamlessly with the primary objective of our project.

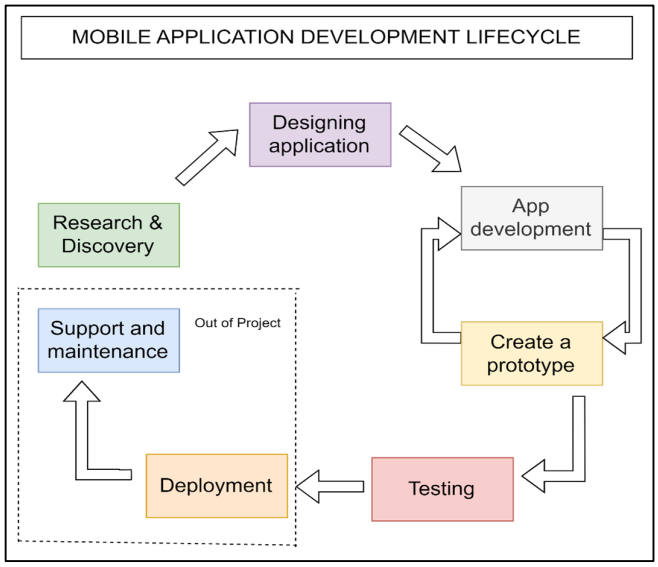

Figure 1. Mobile Application Development Lifecycle

The Mobile Application Development Lifecycle consists of six distinct stages, each playing a pivotal role in the holistic development of an application. These stages encompass research and discovery, designing the application, creating a prototype, application development, testing and deployment, and support and maintenance [18]. Adobe Illustrator was the principal tool for designing buttons and scene layouts.

3.2 System architecture

Figure 2 illustrates the system's architecture, describing its distinct modules, including marker detection, workout initiation, and image and video display components. Marker detection is the process of identifying and tracking specific markers within the camera images from users' mobile device. The markers identified by the system fall into one of three categories: Overweight, Obese Level 1, or Obese Level 2. These markers indicate different levels of body weight or obesity based

on the analysis of the user's body size detected by the system. This information can be used to tailor fitness or health-related guidance and interventions according to the user's specific weight category.

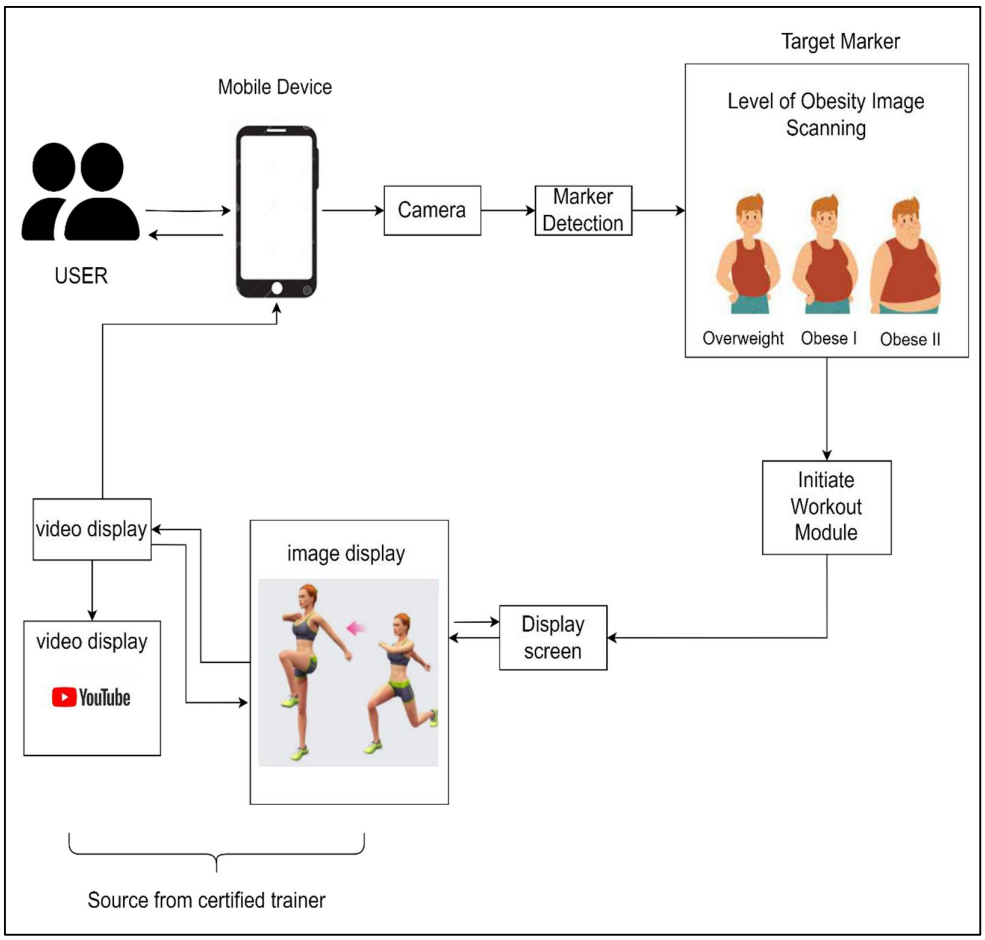

Figure2. System Architecture

Once the user's obesity level is determined, the "initiate workout" module customizes a workout plan that is appropriate for that specific level. The system may recommend workouts that focus on gradual weight loss and improving overall fitness and health for overweight bodies. Contrastingly, for users falling into the categories of Obese Level 1 and Obese Level 2, the module may initiate workouts geared towards more aggressive weight loss goals. In the case of Obese Level 1, the workouts may be intensified to facilitate a greater degree of weight loss, and for those in the Obese Level 2 category, the workouts may be even more rigorous and intensive to address the more severe obesity conditions.

3.3 User Acceptance

To measure user acceptance, questionnaires were constructed based on the Technology Acceptance Model (TAM) to evaluate users' perceived utility and usability [18]. The study sets inclusion criteria for participant selection as follows:

i. Individuals who fall within the age range of 10 to 21 years old and are commonly referred to as adolescents [10].
ii. An individual whose body mass index (BMI) exceeds 25 is classified as being overweight or obese [19].
iii. The individuals living on Tapah Road, Tapah, Malaysia.

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iv. Individuals who possess an Android device, such as a smartphone or tablet.
v. The participant willingly consented to partake in the research investigation.

A total of 31 participants were engaged in the application testing process, which was carried out in a face-to-face setting. Initially, each participant installed the application on their personal smartphone. Subsequently, during the testing phase, adolescents were given the autonomy to explore the application independently. Once they had interacted sufficiently with the application, they were prompted to provide feedback through a Google Form survey.

4. Results and Discussion

4.1 Application Interfaces

A well-designed interface architecture is essential for providing a seamless user experience. In the context of a workout application, simplicity and user-perceived usability are key determinants of users' propensity to engage with the application further. Consequently, the interface design prioritized aesthetics and usability, ensuring that users could comprehend and navigate the application with simplicity. The main interface contains a single icon labeled "Scan" which redirects the user to the scanner page to identify the target marker as depicted by Figure 3. After the system can identify the level of obesity, another page as depicted in Figure 4 will be displayed to allow them to choose three different sets of exercises; Push Up, Jumping Jack and Lunges. The applications offer two ways to display the exercise steps: as a sequence of images (Figure 5) or as a video (Figure 6).

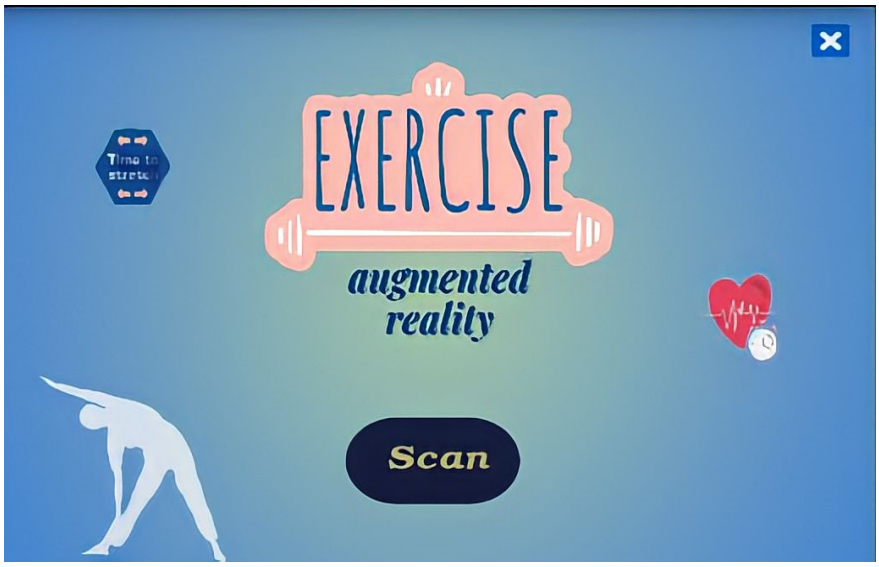

Figure 3. Main interface

Figure 4. Interface after image scanning

Figure 5. Workout steps in image mode

Figure 6. Workout steps in video mode

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4.2 User's Acceptance Evaluation

The results of the users' acceptance evaluation indicate that the augmented reality (AR) features of the application have received overwhelmingly positive feedback. The majority of adolescents strongly concurred that augmented reality technology enhanced their workout experience, while others agreed. Table 1 provides an overview of the feedback received from the respondents through questionnaires. A small percentage of respondents remained neutral, highlighting the need for continuous development.

Table 1. Result of User Interface Testing

Question	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
Simple and interactive interfaces	0	0	4	5	22
Suitable font size and readable	0	0	1	4	26
Easy to navigate and interact with the apps	0	0	0	8	23
Videos play smoothly without any buffering or interruptions	0	0	2	4	25
Easy to understand and follow the instruction on exercises with images	0	0	0	9	22
The application can be access at anywhere and anytime	0	0	0	9	22

Figure 7 depicts the aggregate reactions of the participants. Using the Technology acceptability Model (TAM) in the questionnaire enabled a structured evaluation of user acceptability and satisfaction with the application, as demonstrated. This model, which takes into account factors such as perceived utility and usability, provides a framework for evaluating an application's success in meeting user needs and expectations.

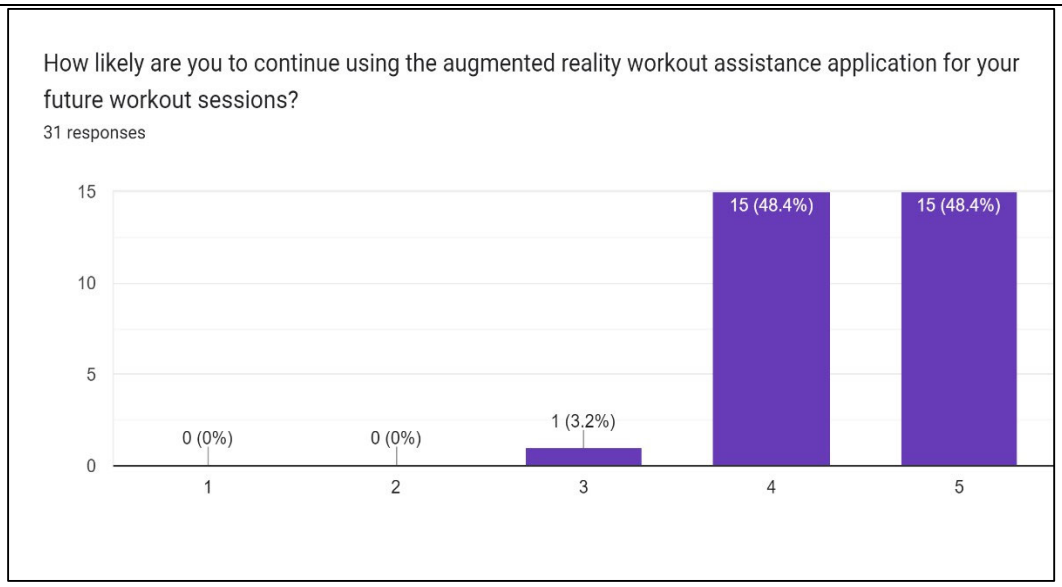

Figure 7. Overall Reaction of the Workout Application

5. Conclusion

This innovative application offers a flexible approach to exercise guidance, providing users with mobile access to workout routines at their discretion. Users have two options for accessing exercise routines they can watch instructional videos or follow detailed step-by-step instructions accompanied by informative images. This flexibility distinguishes our solution from other applications, as it accommodates to the diverse preferences and requirements of its adolescent target audience.

In light of the objectives outlined in the project's introduction, can confidently assert that all three objectives have been met. The first objective was to identify essential features tailored to the requirements of overweight adolescents, a task that was accomplished and integrated into the design of the application. The second objective was to develop prototypes for engaging exercise regimens for young users using multimedia solutions. These solutions take the form of user-friendly video instructions and illustrative images, enhancing accessibility and user engagement. Using the Technology Adoption Model (TAM), our third objective was to assess the user adoption of these prototypes, which yielded overwhelmingly favorable results. The functionality and user-friendliness of the application were well-received, with users finding its interfaces to be intuitive and uncomplicated, which are key factors in fostering sustained usage.

In conclusion, this effort has produced an effective solution to the urgent problem of adolescent obesity. Through the "Multimedia Solution on Workout Assistance for Obese Adolescents," we have enabled young people to proactively manage their health and fitness, thereby promoting a healthier lifestyle through an accessible and user-friendly approach. This achievement demonstrates the potential for innovative technology to positively influence public health and well-being, especially among vulnerable demographic groups such as obese adolescents.

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Conflict of Interest

The authors declare no conflict of interest in the subject matter or materials discussed in this manuscript. Additionally, the authors declare no conflict of interest related to authorship or editorial responsibility for this manuscript.

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