2021

الأكاديمية العربية للعلوم والتكنولوجيا والنقل البحري
Arab Academy for Science, Technology & Maritime Transport

AUGMENTED REALITY AND INTERACTIVE ANATOMICAL MODELS FOR LOCAL ANAESTHESIA TRAINING OF PRECLINICAL DENTAL STUDENTS

PROJECT PROPOSAL

COLLEGE OF DENTISTRY – COLLEGE OF ARTIFICIAL INTELLIGENCE

AAST | Alamien Campus

Contents

Proposal Details

Title: *Augmented reality and interactive anatomical models for local anesthesia training of preclinical dental students*.

Short Title or Acronym: *LA training*.

Keywords: Anesthesia, Local; Augmented Reality; Surgery, Oral; Models, Anatomic; Digital Technology.

Funding and Duration:

200,000 to 500,000 pound per proposal and period of 6 to 12 Months for the CRP, and 500,000 to 1,000,000 pound per proposal and period of 12 months to 24 months for CIP.

Total cost: 1,000,000 pounds.

Research Theme: Medical sciences (dentistry) and Educational application

Proposal Summary: English and Arabic (max. one page each)

Local anesthesia is an important aspect of the dental education, however, the current methods in teaching the local anesthesia techniques have ethical, moral, and legal implications due to the use of colleagues for practice. Even the few universities using simulators and virtual reality couldn't conclude satisfactory outcome form the currently available designs.

Moreover, purchasing such technologies is not only expensive but also requires costly updating & maintenance. Additionally, the customization of such systems to fit our needs is not feasible or more costly. Hence, creating our own education system is the right choice. For these reasons and following the recent trend in implementing the AI into the teaching methods, came the idea for this project. This will also follow the ongoing trend to declare the Alamein Smart Campus.

Our project aims to produce an educational system comprising of two components: an interactive anatomical physical 3D model and an augmented reality simulation. The system aims to present the dental students with the anatomical knowledge needed for performance of the procedure together with the motor skills that was gained before from peer training. This will be the 1st system for local anaesthesia training custom developed to fulfil all the educational requirement without the need of patients and peers. This project will be performed by the collaboration between College of Dentistry – AASTMT Alamien and College of Artificial intelligence – AASTMT Alamien.

The plan of the work will be divided into 4 main tasks to develop the final prototype by the end of the project. The work in both models; interactive anatomical physical model (model 1) and the augmented reality model (model 2), will be performed simultaneously.

التخدير الموضعي هو جانب مهم من تعليم الأسنان ، ومع ذلك ، فإن الطرق الحالية في تدريس تقنيات التخدير الموضعي لها آثار أخلاقية وقانونية بسبب استخدام البشر للتدريب. وحتى الجامعات القليلة التي تستخدم المحاكاة والواقع الافتراضي لا يمكن أن تستنتج نتيجة مرضية بمواصفات التصاميم المتاحة حاليا.

وعلاوة على ذلك، شراء مثل هذه التكنولوجيات ليست مكلفة فحسب، بل يتطلب أيضا تحديثاً وصيانة مكلفة. بالإضافة إلى ذلك، فإن تكييف مثل هذه الأنظمة لتناسب احتياجاتنا ليس ممكناً أو أكثر تكلفة. وبالتالي، فإن إنشاء نظامنا التعليمي هو الخيار الصحيح. لهذه الأسباب، وبعد الاتجاه الأخير في تنفيذ الذكاء الاصطناعي في أساليب التدريس، جاءت فكرة هذا المشروع. كما سيتابع هذا الاتجاه المستمر لإعلان حرم العلمين الذكي.

يهدف مشروعنا إلى إنتاج نظام تعليمي يتكون من عنصرين: نموذج ثلاثي الأبعاد المادي التشريحي التفاعلي ونموذج محاكاة الواقع المعزز. ويهدف النظام إلى تزويد طلاب طب الأسنان بالمعرفة التشريحية اللازمة لأداء الإجراء إلى جانب المهارات الحركية التي كان يتم اكتسابها من قبل من تدريب علي الأقران. سيكون هذا النظام أول نظام للتدريب التخدير الموضعي المخصصة التي وضعت لتلبية جميع المتطلبات التعليمية دون الحاجة الي المرضى والأقران. وسيتم تنفيذ هذا المشروع من خلال التعاون بين كلية طب الأسنان – العلمين وكلية الذكاء الاصطناعي – العلمين.

وسيتم تقسيم خطة العمل إلى 4 مهام رئيسية لتطوير النموذج النهائي بحلول نهاية المشروع. العمل في كلا النموذجين؛ سيتم تنفيذ النموذج المادي التشريحي التفاعلي (النموذج 1) ونموذج الواقع المعزز (النموذج 2) في وقت واحد.

Introduction/Background (max. three pages)

Local anesthesia (LA) is frequently used during dental treatment. It facilitates a painless treatment, so that the patient's comfort is maximal during the treatment and the dentist is able to work calmly with concentration and precision.[1] Therefore, gaining an understanding of the background of anesthetics and the ability to deliver anesthetic injection techniques correctly is an important aspect of the dental curriculum.[2] However, learning the techniques for the administration of LA is a complex process, and transition to the first injection of a patient is often difficult for dental students.[3]

Many dental students feel insufficiently prepared for their first injection in a human. Knowledge of anatomy and complications of anesthetics have been mentioned frequently as areas in which students feel insufficiently prepared.[4] This feeling may still be present after graduation as a dentist. Freshly graduated dentists indicated that LA courses do not provide adequate preparation for the initial demands of a general practice. Nineteen percent of dentists in the United States reported that administration of LA caused them distress; six

percent considered this problem serious. A recent study indicates that didactic courses may decrease the anxiety of dental students in relation to administration of a LA injection.[5]

The administration of LA injections by dental students to each other has historically been considered a necessary rite of passage in dental schools. The majority of U.S. dental schools are teaching students how to provide oral injections by asking them to perform the procedure on classmates.[6]

Although the administration of LA is considered to be a relatively safe procedure, reports have found that patients who receive LA for a dental procedure experience tachycardia 0.6–3.9% of the time and dizziness 1–1.9% of the time.[7, 8] In addition, reports of complications, including syncope and persistent paresthesia from student-to-student injections, have raised ethical, moral, and legal concerns surrounding the student-to-student injection model.[7, 9] Furthermore, another study found only 10% of the 49 European dental schools reported that they required permission of a medical ethics committee for the practical instruction on fellow students.[10] Only four of 42 schools surveyed in the United States routinely obtained written informed consent from the dental students participating in the student-to-student injection model. Administering LA on a fellow classmate may have educational benefits, but the receiver of LA in this situation is not in need of LA for a dental procedure and may be at risk for complications. These risks are compounded by the fact that consent was most likely not obtained prior to the student-to-student injections but was instead completed as a standard requirement.[11]

These ethical, moral, and legal concerns have challenged educators to improve LA training in dental schools. Other methods of teaching LA have been proposed, including administering LA on human cadavers[3] and, more recently, in simulation models.[5, 12] The desire of dental educators and students for a smoother transition from preclinical education to the clinical setting has warranted the implementation of simulation technology in the predoctoral dental curriculum.[13]

Any method that can increase student confidence before administering LA for the first time should be explored.[11]

Electronic training models that indicate the accurate site of injection have been available for three decades. Currently, only a minority of dental schools use these models before students' initial injections on humans, but several additional schools have reported plans to introduce them into their curricula. Those students who used a preclinical training model considered it a useful preparation for their first injection in a human, and many students proposed the introduction in the dental curriculum.[5]

Simulation tools have been used in medicine for more than 15 years,[14] and one of the first studies of the possibility of using computers in dental education was published in 1998 by Grigg and Stephens.[15] There are various methods for LA teaching, including demonstration on anatomical model of jaw and practice on plastic simulation models.[16, 17] One of the drawbacks of simulation models is poor presentation of soft tissue and reference points in the oral cavity.[5] AR techniques have been introduced in the fields of oral and maxillofacial surgery and dental morphology, but are not yet widely used.[18-20]

In a recent study, the students who used an augmented reality mobile simulator carried out an anesthetic procedure for inferior alveolar nerve block (IANB) in a shorter period of time and had greater success rates in completing the anesthesia than the students who did not use the simulator. Their findings suggest that this technology contributed to a better knowledge of reference points and procedure of LA for IANB.[21]

Anatomic models are a promising tool for LA education and are being introduced in some dental schools.[10, 22] Sensor-embedded models have been shown to be a valuable addition in familiarizing students with the ideal injection site locations and orientations, but these models are not in widespread use.[12] Although students have requested such models and many educators reported planning to implement them, their efficacies remain unproven.[4, 9] The reviewed surveys of students' experience with anatomic models found that students perceived them to be helpful,[12, 23] and Marei and Al-Jandan demonstrated experimentally that they enhanced learning.[24]

Moreover, after the declaration of the pandemic, the learning process in educational institutions was left to e-learning, and it was necessary to apply all the resources provided by digital technology in order to provide students with the best possible distance education.[25]

Furthermore, the education techniques described in the published literature possessed numerous methodological weaknesses in regard to their efficacy.[26] The inconsistency of the available evidence left us unable to make any curriculum recommendations.

The current project aims to combine the benefits of both Augmented reality and simulation models bridge the gap between knowledge of the technique and the tactile skills needed to perfect the procedure. The combination of augmented reality and anatomical models will ensure that students are sufficiently prepared for their first injection in a human.

Questions and Objectives (Max. three pages)

Local anesthesia training is of paramount importance in the dental training. Most of the dental procedures are preceded with LA (figure 1). As a part of the oral and maxillofacial surgery curriculum, the dental students learn the techniques of LA. Therefore, it is of extreme importance to master the local anesthesia procedures without any risk to the student or the patient.

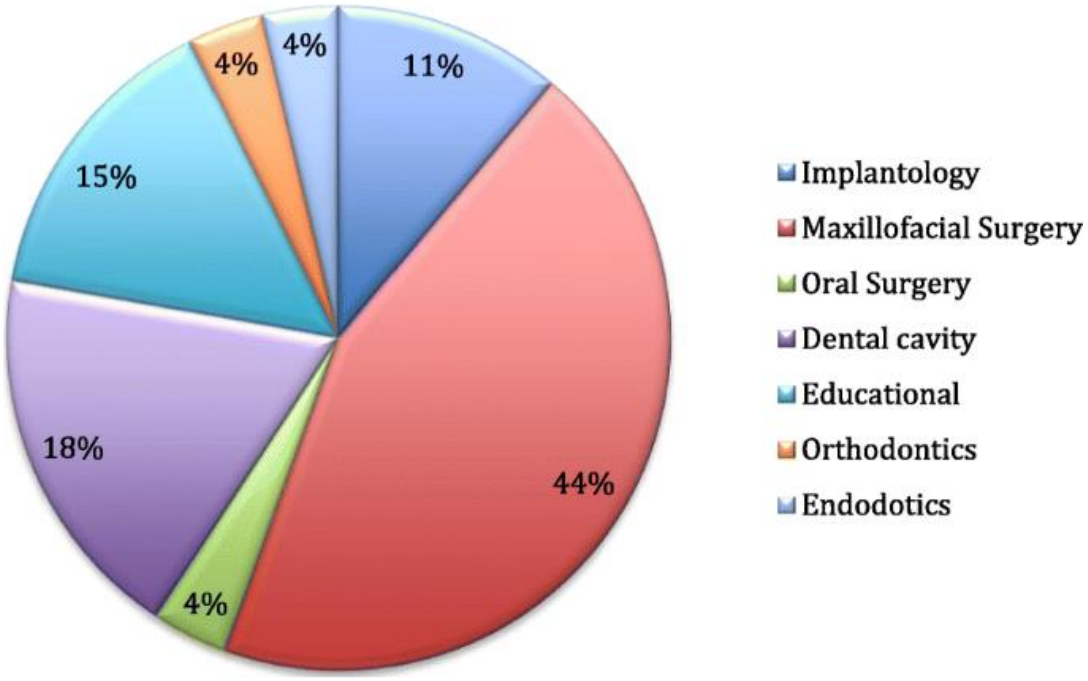


Figure 1: Most practiced dental procedures.

The currently available simulation models (figure 2) and augmented reality models lacks the real-life simulation, where all the models are just a representation of the mandible and maxilla and the overlying soft tissues with no interaction from the other relevant organs as the tongue of the patient.

Figure 2: Currently available Simulation models

The goal of the current project is to develop an interactive fully anatomical model as well as an augmented reality model of the human face, hands, and the syringe to teach and train students during the LA course in a safe risk-free environment.

The augmented reality model will provide the students with real-life experience of the anatomy and landmarks of the oral cavity and the face, needed for LA injections while the interactive anatomical models will allow the student to further LA and gain the necessary motor skills and tactile sensations that is not available in the augmented reality models.

The currently available manikins have only sensors for the right injection spots while our own manikins will contain different sensors to allow student to learn not only the right spots for injection but also learn the complications of the wrong spots thus learning the complications that could arise.

The proposed teaching models will allow smoother transition from preclinical education to the clinical setting, better knowledge of reference points and procedure, more confidence, in addition to the omission of the ethical, moral, and legal concerns.

Project Description (max. six pages)

The project will take place in several stages that will run simultaneously to finally develop the educational program required.

One workflow will be the augmented reality model to all the student to gain full knowledge and understanding of the anatomy and landmarks required to perform LA. In addition to the knowledge, it will allow the student to learn and practice the LA techniques.

The other workflow will be the interactive fully anatomical model. This model will allow the student to gain the motor skills and tactile sensations that was missing in the augmented reality model.

The following techniques for LA will be included in the models:

1. Mandibular anesthesia
    a. Inferior alveolar nerve block
    b. Vazirani-Akinosi (closed mouth) mandibular block
    c. Gow-Gates mandibular nerve block
    d. Buccal nerve block
    e. Mental and incisive nerve block
2. Maxillary anesthesia techniques
    a. Supraperiosteal injection (infiltration)
    b. Maxillary nerve block
    c. Greater foramen approach
    d. Posterior superior alveolar nerve block
    e. Middle superior alveolar nerve block
    f. Anterior superior alveolar nerve block
    g. Greater palatine nerve block
    h. Nasopalatine nerve block
    i. Anterior middle superior alveolar nerve block
    j. Palatal anterior superior alveolar nerve block

The proposed solution has main characteristics with adaptive parameters:

1. It is required to identify the causes of the student fault and give the chance to re-try the operation without any human interaction.
2. The required solutions involve changes in attitudes and approaches to deal with the model (not human patient).
3. The student training process must be analysed, and the student accuracy is improved.
4. The training is repeated for the student many times till he did it as required.
5. The require experimentation and adaptation (which takes time) will take place in this project.

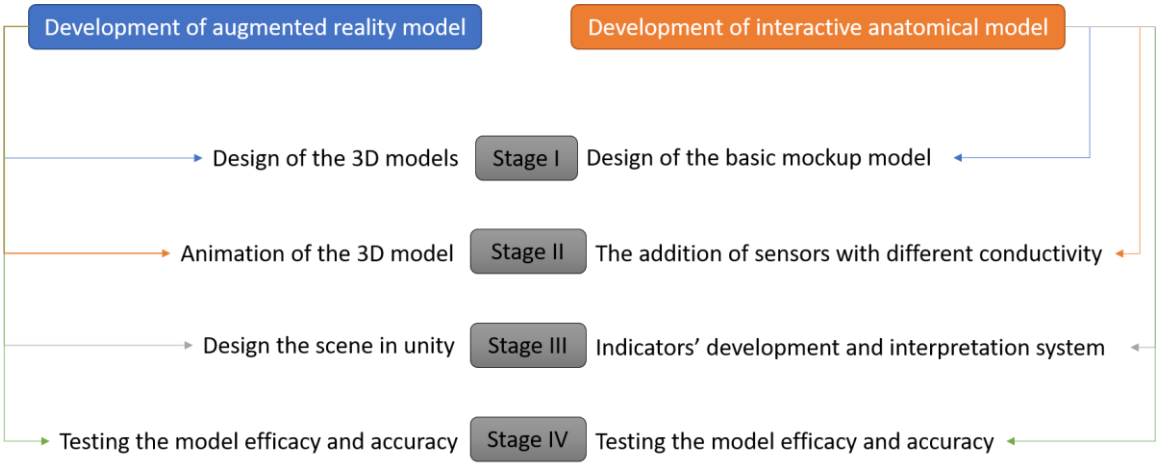
This smart learning and training systems approach has the following steps:

1. Identify the required properties of the training system. This contains the main skills required from the students and how to train them to do these skills repeatedly without any human/patient harms.
2. The systems must be adaptive and predictable. The model must adapt the natural differences between gender skulls.
3. Explain the student behavior and adapt the suggested way to improve the dental student actions with the model.
4. This system focuses on the whole dental process while keeping track of the different required skills.

Research Design and Methods (max. four pages)

The current project will be conducted in 2 simultaneous workflows to develop an interactive fully anatomical model as well as an augmented reality model.

The following chart is summarizing the stages of the project:



The first stage, for both tracks, will include the design of the 3D models for the use virtually and physically. The models should follow the anatomy and landmarks in the face and intraoral area. The measurements of the model will be the average measurement of the Egyptian population obtained from literature or from a survey of available scans in different dental centres. Additionally, planning for the required spot for LA according to the techniques will be performed in this stage. Example of the different shapes of the face and dental arch is presented in figure 3 and 4.

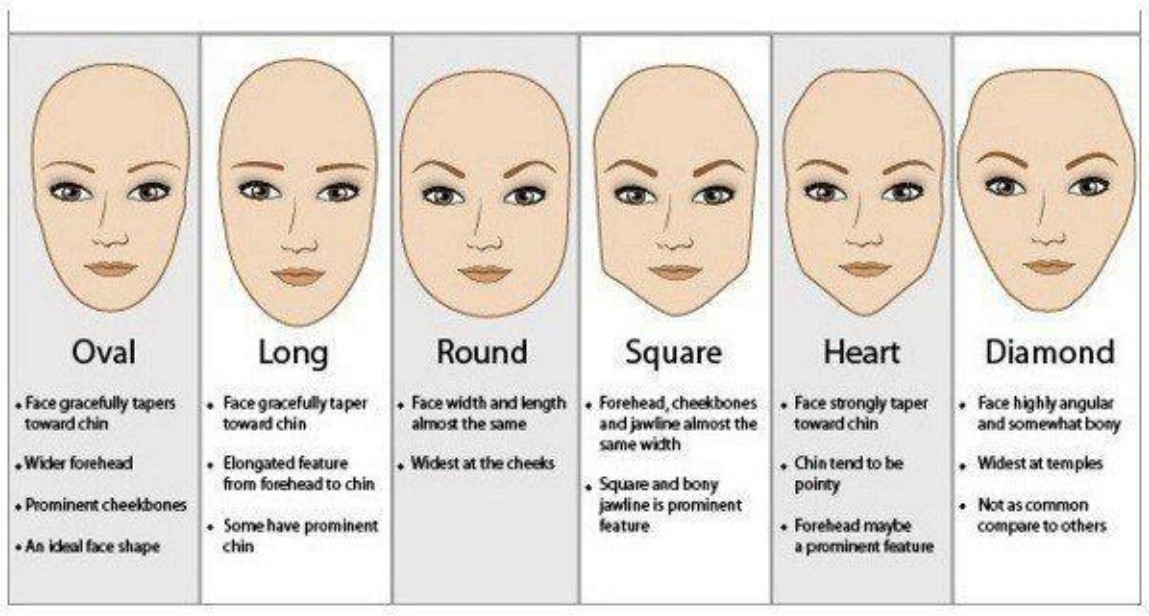


Figure 3: Face type and the jaws style.

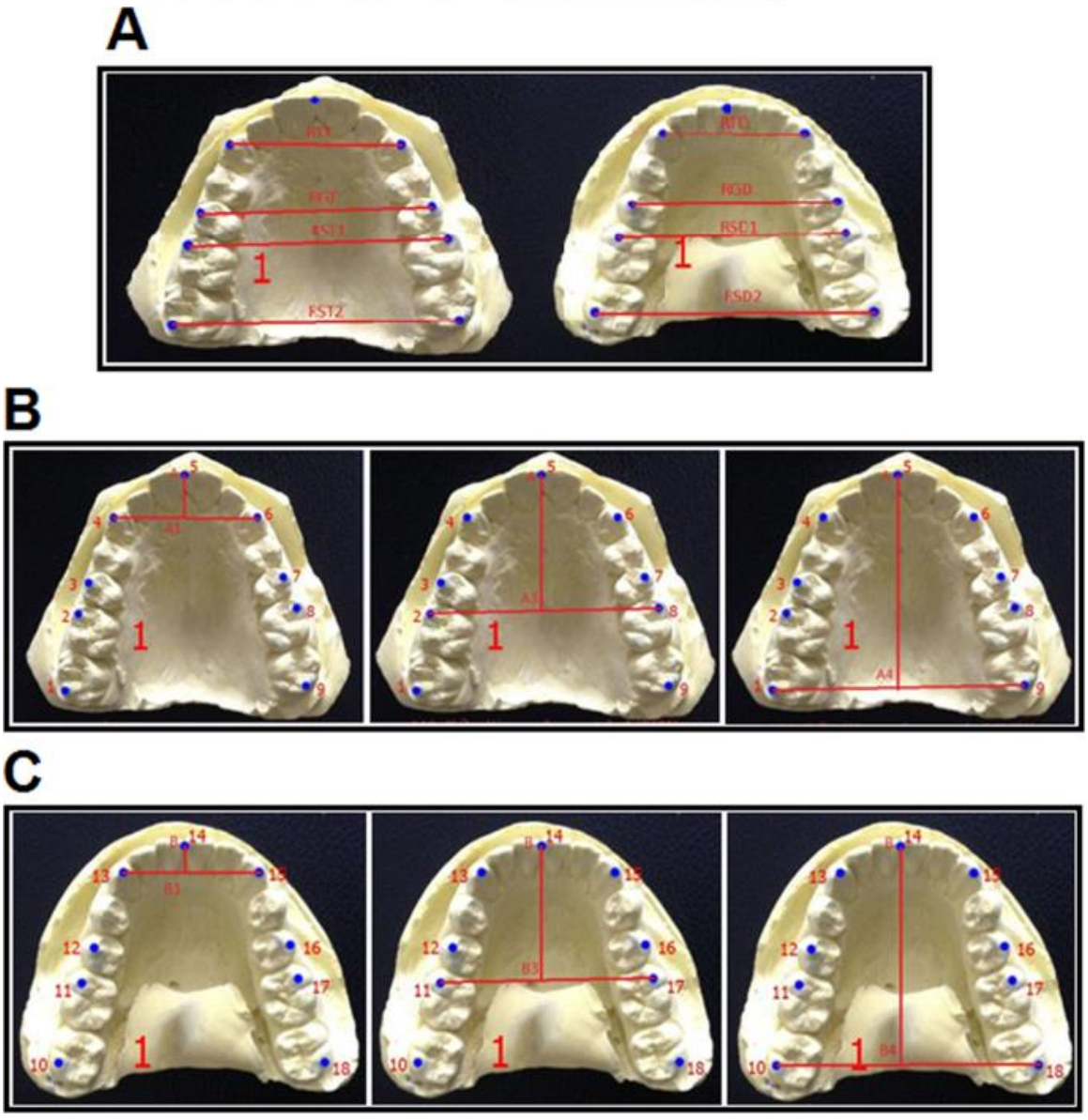


Figure 4: - The evaluation of dental arch dimensions

Regarding the interactive anatomical model, the research design is demonstrated in figure 5. It will be a closed loop till the production of an efficient prototype fulfilling all the required criteria for the educational process of LA.

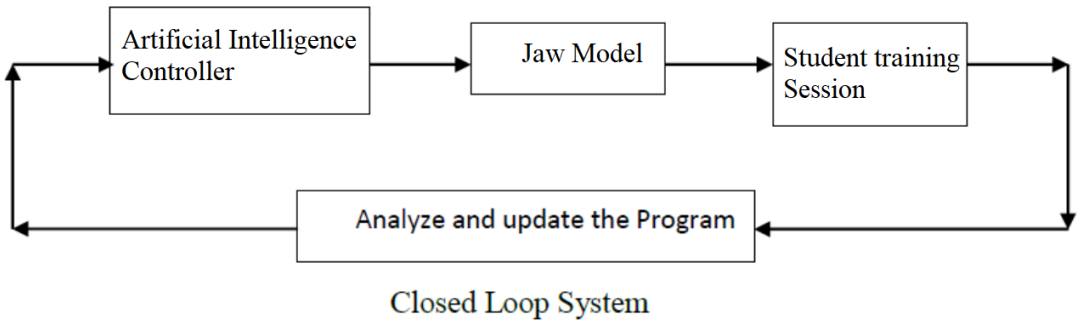


Figure 5: Research design for the interactive anatomical model

As for the augmented reality model, the following scheme (figure 6) will be used during the stages of development.

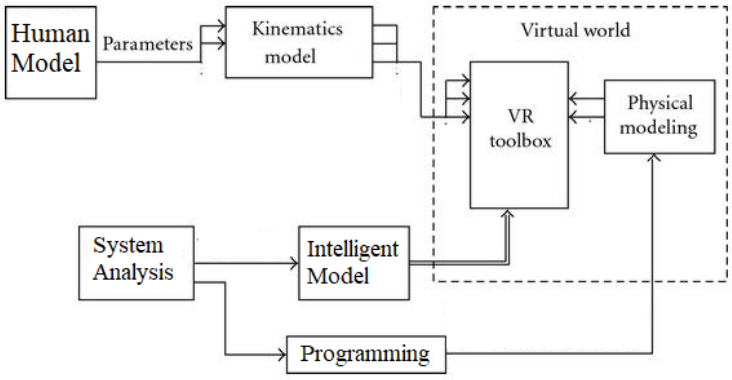


Figure 6: research design for augmented reality model

Anticipated Results and Evaluation Criteria (Max. three pages)

The resultant models will be tested for efficacy and efficiency by the AI team and dentistry team, in addition to a volunteer group of students. The obtained data will be statistically analysed using the appropriate statistical test.

The anticipated result will be a full educational system for LA teaching that provide the student with the required knowledge and skills to perfect the LA techniques without the need for actual human for training at this stage.

Expected Project Outcomes and Impact to AASTMT (Max. two pages)

I- Technical output and Impact:

The technical output of this project is expected to be an educational system comprised of Two stages: an augmented reality stage and an interactive anatomical model as the other stage. It's expected to enhance the outcome of the LA training module compared to the traditional way of teaching this module.

II- Financial feasibility & Socio-economic Impact:

AASTMT will be the 1st educational institute to apply this model in the dental training in the middle east. Moreover, AASTMT will be able to market for selling one of the models or the whole educational system to other dental schools in the region to expand this unique educational system.

III – Publication:

Since we are targeting a CIP project, the expected outcome is two outcome requirements are expected before the end of the grant's tenure: (1) At least one peer-reviewed original research paper accepted for publication (received a DOI) in a Q1 journal or its equivalent. (2) Minimal Viable Product (MVP) report for consideration by the Incubation Hub

Resources (Max. two pages)

The resources currently available at the AASTMT, as well as resources that are planned to be obtained in order to carry out the proposed research project, are as follows:

- Laboratory Space: currently the innovation center at AASTMT – Alamien is under construction, therefore, a temporary workspace will be assigned at College of Dentistry and College of Artificial Intelligence to accommodate the working teams. Initially Room 011 will be used for the project work in its initial stage and production of the physical parts of the interactive model.

- Personnel: in the development of the model, the following are key PIs for each team

  - Prof. Ahmed Rashad Kotb: he is a professor of oral and maxillofacial surgery since 1990 and currently he is the vice dean for education affairs at College of Dentistry at Arab Academy for Science and Technology

  - Prof. Aly Fahmy; he is a Professor of Artificial Intelligence and Machine Learning. He was the Ex-Dean of the Faculty of Computers and Information, Cairo University. Currently, he is the Dean of the Artificial Intelligence College affiliated to Arab Academy for Science and Technology

- Facilities: the main facilities needed in completion are:
    - A virtual reality tool kit for the augmented reality model
    - 3D scanner and printer for design and fabrication of different parts of the model
- Office and Computer Facilities: currently the innovation center at AASTMT – Alamien is under construction, therefore, a temporary workspace will be assigned at College of Dentistry and College of Artificial Intelligence to accommodate the working teams. Initially Room 110 will be used for the project work in its initial stage. The room is equipped with desktop computer and printer, in addition to the offices and office supplies.
- Major Equipment:
    - virtual reality kit.
    - 3D scanner and printer

Team Information (Max. of one page per team member)

The current project will be performed by the collaboration between College of Dentistry – AASTMT Alamien and College of Artificial intelligence – AASTMT Alamien.

The dental team will be conducted by Prof. Ahmed Rashad Kotb, professor of oral and maxillofacial surgery and vice dean for educational affairs. While the AI team will be conducted by Prof. Aly Fahmy, professor of Artificial Intelligence and Machine Learning, and dean of the college. The project will be coordinated by Dr. Heba Youssef, a holder of PhD in material science and currently a teaching assistant at College of Dentistry – AASTMT Alamien.

The dental team will be responsible for the design of the models and will be also participate in the testing process for each stage and the final testing stage. Dental team has expertise in the techniques of local anaesthesia, material science and curriculum development.

The AI team will be responsible for execution of the design models either for model 1 or model 2. The expertise of the AI team are toward Artificial Intelligence, Machine Learning and game development.

Both teams will produce the final report for the project in addition to joint and single publication(s) if possible.

Research Team Information Table

Name of Res. Team Member in English	Name of Res. Team Member in Arabic	University / Institute In English	Position / Title	% of time spent on project	No. of months	Incentive per month (LE)	Number of other projects and their IDs	Total % of time spent on other projects	Contact No
Ahmed Rashad Kotb	احمد رشاد قطب	AASTMT(PI)	Professor of oral surgery and Vice dean of educational affairs, college of dentistry – Alamien	25%	6	8000	_	_	01227312259

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Name of Res. Team Member in English	Name of Res. Team Member in Arabic	University / Institute In English	Position / Title	% of time spent on project	No. of months	Incentive per month (LE)	Number of other projects and their IDs	Total % of time spent on other projects	Contact No
Aly Aly Fahmy	علي علي فهمي	AASTMT (Co-PI)	Professor of Artificial Intelligence and Machine Learning and Dean of College of Artificial Intelligence	25%	6	8000	_	_	01223420162
Ahmed A. AbouEl Farag	احمد أبو الفرج	AASTMT (member)	Professor of Computer Systems	25%	6	5000	_	_	01006009722

Name of Res. Team Member in English	Name of Res. Team Member in Arabic	University / Institute In English	Position / Title	% of time spent on project	No. of months	Incentive per month (LE)	Number of other projects and their IDs	Total % of time spent on other projects	Contact No
Heba Abdel-Wahab Youssef	هبة عبد الوهاب يوسف	AASTMT (project coordinator)	Assistant lecture of dental biomaterials – College of Dentistry	50%	12	3000	_	_	01009997976
Osama Hesham El-Sayed	أسامة هشام السيد	AASTMT (member)	Demonstrator of Robotics and Programming - College of Artificial Intelligence	62.5%	15	1000	_	_	01128808326

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Name of Res. Team Member in English	Name of Res. Team Member in Arabic	University / Institute In English	Position / Title	% of time spent on project	No. of months	Incentive per month (LE)	Number of other projects and their IDs	Total % of time spent on other projects	Contact No
Mahmoud Khaled Mahmoud	محمود خالد محمود	AASTMT (member)	Demonstrator of computer science - College of Artificial Intelligence	62.5%	15	1000	_	_	01111848356
TBD			Dental technician	25%	6	1000	_	_	_

Project Management (Max. three pages)

During the current project, 2 tracks will be conducted simultaneously to achieve the required outcome. Each track will be performed in 4 main tasks. The 1st task will be the development of the 3D model including design of the model and its dimensions (by dental team) and the execution of the designed model by (AI team)

The second task be the integration stage which include integration of the sensors for Model 1 and the animation for the designed model for model 2. The AI team will be responsible for the integration while both teams will be responsible for testing the outcome from this stage and advice for changes (if any is needed).

The third task will be interpolation system development (model1) and integration of different parts (model 2). Same as stage 2, The AI team will be responsible for the integration while both teams will be responsible for testing the outcome from this stage and advice for changes (if any is needed).

The fourth task will be the finalization of the project where final testing of the final product of each track for efficiency (by dental team), and report writing and publication by both teams.

The exact timeframe is illustrated below in the GANTT chart. It givies the time schedule of the tasks and mark their interrelations; add milestones where important goals will be reached and/or decisions on further approach will have to be made; indicate a critical path marking those events which directly influence the overall time schedule in case of delays

The communication within the project will be facilitated by the presence of both teams in the same campus which will ensure ease of communication. Periodic meetings (Zoom or physical) will be scheduled to follow up on the project progress.

Allowable Project Costs (Max. two pages)

Allowable project costs are grouped into categories.(Table of Eligible Cost)

i. Personnel costs of the research staff and other personnel (as per the efforts assigned in the timeline), should not exceed 20%, which will be received at the end of the project after the delivery of all the project outcomes and approving the final technical report.(research team table)

ii. Mobility costs (only internal travel / subsistence expenses), should not exceed 5%.

iii. Costs related to organizing seminars and workshops within the project

iv. Acquisition of material and small-scale research equipment

Breakdown of Costs Other Grant(s) (Max. two pages)

The cost breakdown is summarized in the eligible cost table below.

Plans for Disseminating Research Results / Sustainability of the action (Max. three pages)

The collected research data will be utilized in future studies to advance research in AASTMT. Include a data/results dissemination plan that details how the results and data created as an outcome of this project will be disseminated to the public. We will provide updates on the progress of following the plan in each progress report each three months. In the case that data cannot be shared from a particular project due to any confidentiality concerns, proper justification should be provided. Further development of the educational system (the product of this project) could be performed based on this project results. Additionally, the data from this project can be used as a base line to develop other educational systems in different fields.

Key Publications and references (Max. two pages)

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Declaration of original submission and Other Grant(s) (Max. one page)

We hereby declare theta this proposal didn't and will not be will not be submitted in whole or part for funding; twice within the same cycle, or to other funding programs within AASTMT, or other funding agencies. This is to avoid any possible double-funding.

As an emerging campus, there has been no previous or ongoing research funds for the key invistegator over the last 3 years

Acknowledgement form

By signing below, I acknowledge that I have read, understand and accept to comply with all the terms of the foregoing application, mentioned in AASTMT general conditions and guidelines for submitting a research proposal, including, but not limited to:

- The total number of the application pages should not exceed **30 pages** excluding a cover page, as well as all sections of the proposal (as mentioned in AASTMT General Conditions and Guidelines for Submitting Research Proposal).
- At any time, a contracted AASTMT project team member should only be participating in a maximum of one project.
- Allowable budget maximum limit should be strictly adhered to in the project proposal. In all cases, requested budget has to be justified in detail.
- AASTMT guidelines, IPR rules, code of ethics, etc. (www.aast.edu), should be read carefully and adhered to. These are integral parts of the contract.
- All proposals – in addition to PI and other data - must be uploaded to the AASTMT website by the designated deadline. Uploaded PI data should conform to the corresponding data in the application form.

Applications will not be considered eligible and will be discarded in the following cases:

- Proposals submitted by e-mail or sent as hard copies or uploaded to the AASTMT website after the deadline.
- Proposals not conforming to the designated format.
- Proposals whose uploaded PI data does not conform to PI data in the proposal file.
- Proposals in which the allowable budget maximum limit has been exceeded.
- Proposals in which maximum allowable contracted AASTMT project participation limit has been exceeded.
- Proposal letter does not include a scanned copy of the signed and stamped PI institution endorsement letter in case of team member work outside AASTMT.
- Proposal does not include a scanned copy of the signed acknowledgment form.

Date & Signature: 15/3/2021 Ahmed Rashad

Table of Eligible Cost

Eligible costs	Break downs		AASTMT support (L.E.)
(A) Staff Cost	Ahmed Rashad Kotb (PI)		48000
	Aly Aly Fahmy (Co-PI)		48000
	Ahmed A. AbouEl Farag (member)		30000
	Heba Abdel-Wahab Youssef (Project Coordinator)		30000
	Osama Hesham El-Sayed (member)		15000
	Mahmoud Khaled Mahmoud (member)		15000
	Dental technician (TBD) (member)		6000
	Consultation fees		--
	Total		198000
(B) Equipment	Equipment		460000
	Spare parts		--
	Total Equipment		460000
(C) Expendable Supplies & Materials	Stationary		10000
	Miscellaneous Laboratory, Field supplies, Materials		90000
	Total expendable Supplies & Materials		100000
(D) Travel	Internal Transportation		10000
	Accommodation		12000
	Total travel		22000
(E) Other Direct Costs	Services	Manufacture of specimens & prototypes	100000
		Acquiring access to specialized reference sources databases or computer software	10000
		Computer services	--
	Report preparation		10000
	Publications & patent Costs		70000
	Workshops organization or Training		30000
	Others (explain)		--
	Total other direct costs		220000
(G) Total Costs			1000000

الأكاديمية العربية للعلوم والتكنولوجيا والنقل البحري
Arab Academy for Science, Technology & Maritime Transport

DETAILED PLAN ON PROJECT'S ACTIVITIES (*GANTT CHART*):

Activity Name	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24
Main 1: development of 3D models (both models)																								
Sub 1.1: determine the dimensions needed for the model																								
Sub 1.2: design of the model and the required injection sites																								
Sub 1.3: Application of the designs of the models																								
Main 2: integration of sensors (model 1) and animation (model 2)																								
Sub 2.1: integration of the sensors and animation																								
Sub 2.2: testing of the sensors and evaluation of animation																								
Sub 2.3: adjustments and retesting																								
Main 3: interpolation system development (model1) and integration of different parts (model 2)																								
Sub 3.1: interpolation system development (model1) and integration of different parts (model 2)																								
Sub 3.2: testing of the integration and interpolation																								
Sub 3.3: adjustments and retesting																								

Main 4: finalization																								
Sub 4.1: testing of the system as a whole																								
Sub 4.2: publication																								
Sub 4.3: report writing																								