


An Integrated Remote Control-Based Human-Robot Interface for Education Application

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ABSTRACT

Portable interfaced robot arms equipped with mobile user interactions are significantly being utilized in the modern world. The application of teaching robotics is being used in the challenging pandemic situation, but it is still challenging due to mathematical formulation. This article utilizes the augmented reality (AR) concept for remote control-based human-robot interaction using the Bluetooth correspondence. The proposed framework incorporates different modules like a robot arm control, a regulator module, and a distant portable smartphone application for envisioning the robot arm points for its real-time relevance. This novel approach fuses AR innovation into portable application, which permits the continuous virtual coordination with actual physical platform. The simulation yields effective outcomes with 96.94% accuracy for testing stage while maintaining error and loss values of 0.194 and 0.183, respectively. The proposed interface gives consistent results for teaching application in real-time changing environment by outperforming existing methods with an accuracy improvement of 13.4.

KEYWORDS

Augmented Reality, Human-Robot Interaction, Portable Interface, Real-Time Changing Environment, Real-Time Relevance, Virtual Coordination, Virtual Reality

INTRODUCTION

In the current era of information technology progression, the appearance widely used remote innovation for portable correspondence is presently being utilized frequently in the modern education system and numerous other advancing areas. The versatile frameworks are being utilized these days for the computerization and education development (Dahir et al., 2016). There are a few uses of modern robotization in different areas like reconnaissance in armed force (Yan and Hu, 2017; Akçayır et al., 2016), distinctive mechanization industry (Madhayan, 2010), other mechanical areas and modern education system (Sukla and Karki, 2013; Lazăr et al., 2020). The advancement in the traditional teaching methodology has improves the learning experience by enhancing the intellectual level of

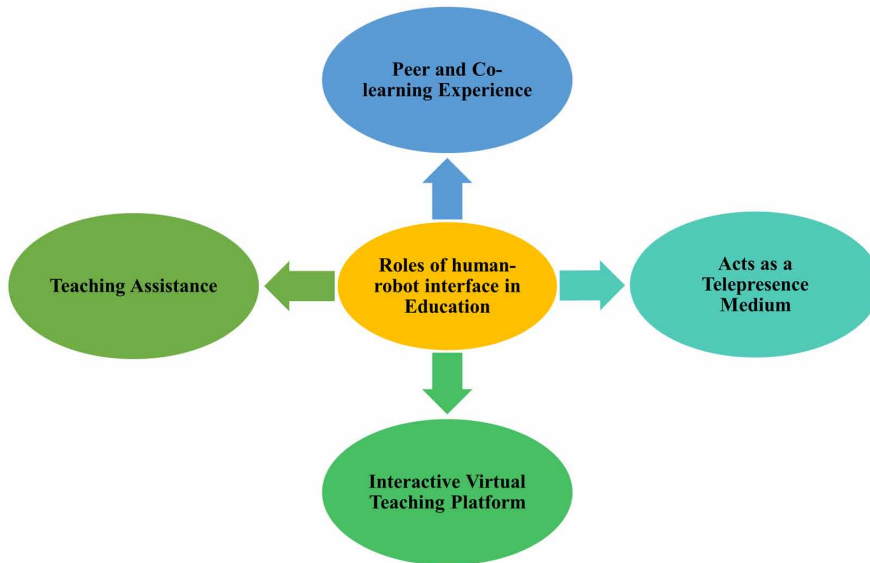
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individuals. With the growth in the usage of tablets and mobile phone, the technological evolution can be seen in the development of Augmented Reality (AR) in the teaching domain (Stavinoha et al., 2014). This technology has removed the barrier between the real and the virtual world objects and this can be used in many equipment, like mobile phones, computers and many other. The various scenarios of roles of human-robot interface in the modern education system are shown in Figure 1.

Figure 1. Roles of human-robot interface in the modern education system



The modern education system includes the role of robotics in different domains like these technological advents provides the teaching assistance, indulge in peer learning experience, provides a telepresence platform for student interaction even when the teachers are not present physically and it builds an interactive virtual environment for human-robot interactivity. The teaching scenario has also been affected by the pandemic situation prevailing around the world. Thus, the e-learning scenario provides better interactivity which is further enhanced by the virtual interaction using robot interface. The e-learning platform is improved involving robotics and the adaptability for flexible working of human robot collaboration. In case of emergency, the platform built using AR or VR technology provides promising outcomes for communication between teachers and students. The enrichment of this technology can be enhanced using various personal computers, mobile phones and smartphone devices as they are portable. This can enrich the application domain of e-learning platform by providing an improved teaching-learning experience for the classroom as well as laboratory scenario by creating a 3D perception for robotics implementation. This enables much understandable educational platform that is more interactive and technology friendly.

Apart from education system, different areas using the advanced robotics in everyday application are surveillance applications, pipeline health monitoring, automation in industry, modern education and many more (Anisi et al., 2010; Dhiman et al., 2021). These domains significantly utilize the human-robot based interaction for creating an interactive platform for various applications. The utilization of mechanical robotics technology in the modern research areas demonstrates that the education system makes use of robots in the current scenario. For usage of robots in gas checking and oil pipeline, tiny robot systems are utilized which can easily fit inside the pipelines and move

around to screen the pipeline issues (Zhang et al., 2020). In the automobile and manufacturing inventories, they are used for assembling reason and at the sequential construction system to get high exactness and rapid assembling. Use of the advanced remote innovation for the control activity of assembling, cell phones are utilized for sending the orders to machine via a PC or a portable smart phone (Karaman and Frazzoli, 2011).

The latest advent has come up with the robot arms or hand controller devices for the controlling purpose in order to regulate the robot activities by human trained professionals. These experts train and regulate the robot movements for doing various previously organized tasks (Pachtrachai et al., 2019). For the new era of industrial revolution 4.0, the robot related technology is being used for industrial manufacturing and efficient working of the assembly line. The robot manipulator-based systems are efficient and provides high accuracy for optimizing the tasks. The robot learning and motion planning is done based on the changes in the joint angle and manipulator learning of human experts. The massive learning involved in it incorporates the quick changes in the robot arm joint position, so as to regulate any obstruction during the task (Spong et al., 2006; Xue et al., 2021). However, these human expert-based training scenarios are only applicable for specific tasks and explicit environment, but when the work space changes then learning has to be done once again.

Thus, the requirement of dynamic learning has evolved the need for an automated robotics based advancement for adapting the changing environment (Han and Seo, 2017). There is a need for progression in the field of robot arm regulatory to improve its optimality and insufficiency in finding an ideal path for robot regulator in the dynamically changing environment (Dianatfar et al., 2020). Several new strategies are being involved in significant robot learning using the neural techniques and reinforced learning methods are being used for complex environments (Qureshi et al., 2016; Qian et al. 2020).

This article proposes an automated portable robot arm strategy for controlling the education application with mobile user interface, augmented reality (AR) platform and Bluetooth correspondence for education application. A novel robot-human interaction-based application is specifically designed in this article for enabling the information technology and robotics advent along with AR for the education system. The portable robot arm interface is designed and implemented using mobile phone for controlling the application of teaching robotics enabling AR. The novelty of this research work like in exhaustive integration of a robot arm control, a regulator module and a distant portable smartphone application for envisioning the robot arm points for its real-time relevance in the changing environment. The innovation of this article is the integration of AR technology for portable application permitting the continuous virtual coordination with actual physical platform. The reference profile is made for programming the robots and the regulator module is used for giving direction way to the robot angle development. The practical directional paths are produced for the robot arm utilizing the proposed approach and an experimental investigation is done between the ideal and actual paths. These modules contribute in acquiring the robot point data utilizing AR module in the real-time applications like education, assembling industry, data innovation, web-based technology and different other fields. For web technology oriented-education application, the proposed stage gives the feasible and consistent results in the real time changing environment.

The remainder of this article is organized as: survey of literature is portrayed in section 2 which is followed by the proposed methodology depicted in Section 3. The experimental analysis and results are provided in section 4 which are followed by the conclusion of the article along with the future exploration direction in section 5.

LITERATURE REVIEW

The use of advanced mechanics and robotics for the different applications in system administration and other modern areas started from the idea of tele-advanced mechanical robotics. Tele-advanced mechanics have been advanced with the improvement of web and systems administration skills. There

are a few systems administration robots created by the analysts and different advancement have been done in the field of education (Yeole et al., 2015). There are a few mechanical applications which are being used for the public utilization and investigation (Saqib et al., 2013). The robot extension has advanced the degree for coordination in different areas like education, manufacturing industry, smart cities and many more. Nowadays, augmented reality concept has extended its area to the field of education, medical science as well as automated machinery.

In the field of education, various advents are witnessed for providing the e-learning teacher-student interaction. Flanders and Kavanagh, (2015) developed a human-robot interface for helping the students in understanding the robot arm kinematics. This built-in application can help in visualizing the 3D simulation of robot arm in a specific environment. A specialized e-learning system was presented by Hernández-Ordoñez et al., (2018) for creating a graphical interface for AR integration. The robot control can easily be accomplished through internet and the system is capable enough for remote path planning while utilizing AR. Ibanez et al., (2014) helped in the experimental analysis of student-teacher interaction using the AR module and the students can easily accomplish the learning of various fundamental topics. Wei et al., (2015) studied the attitude of students during the learning process and the learning tools with AR interaction provided good potential in building a good e-learning atmosphere for higher education. Martin-Gutierrez et al., (2015) proposed an application-based system for the student learning in the electrical labs using a virtual collaborative engineering platform promoting independent learning. A push manipulator-based methodology for prediction of regression and density estimation was proposed by Kopicki et al., 2016. The object prediction and density estimation were done to model various objects with novel shape and action features. This transferred model matches the performance of rigid body dynamics and can be used for various applications. A flexible obstacle avoidance platform using manipulator learning was implemented by Wei et al., 2017, which deals with the integrations of sampling enabled path planning. This methodology uses the strategy of motion planning for movable obstacles using learning-based prediction mechanism. The simulator and real time-based experimental analysis provide efficient outcomes for solving various traditional problems.

There are different utilizations of robots in clinical science field. Quero et al., (2019) managed the robots for accomplishing high exactness for liver medical procedures for 3D picture representation. The improvement is observed in the specialist insight is seen by the usage of 3D representation strategy and advanced robots. Qian et al., (2019a) made use of robotics for obtrusive laparoscopic medical procedures and x-ray visualization. The robotics technology is also used by Qian et al., (2019b) for the implementation of automated medical procedure and robot interfaced processes in the complex clinical situations. AR has grown revolutionarily in the domain of manufacturing development and modern assembling field. Mourtzis, (2020) expanded a reality-based interface to accommodate support and plan as well as prepare the assembling cycle for manufacturing. The robotics combined with the mechanical technology plays a vital part in modern manufacturing and programming stages in the industry background (Mourtzis and Zogopolos, 2019). Such utilizations of mechanical technology in the modern manufacturing domain improves the arrangement of assembly line by using the robots while reducing the human labour (Ong et al., 2020a). Ong et al., (2020b) interfaced the mechanical technology and robotics in welding industry which can be used for simplicity of workload. This utilization leads to the simplicity of programming and to finish the unpredictable work limited human skill and minimized administration. This methodology can be cultivated by including the robot-based item control for real time working environment. The recent different applications and findings of robot-based systems are summarized in Table 1.

Table 1. Different applications of robot-based systems

Technique	Methodology	Sensor Device	Application
Chadalavada et al., 2015	Robot based human interactive communication	Safety scanner	Robot based mobile navigation
Moniri et al., 2016	Dual reality	Camera based sensor	Assembly line collaboration for picking and placing
Matsas et al., 2016	Virtual reality	Kinect device	Industrial manufacturing application
Frank et al., 2016	Reality based object manipulation	Camera	Arm based robot for manipulation
De Giorgio et al., 2017	Robot manipulation using Virtual Reality	Virtual Reality based Head-mounted display	Industrial manufacturing application
Gammieri et al., 2017	Robot manipulation using Virtual Reality	Virtual Reality based Head-mounted display	Assembly line manipulating robot
Huy et al., 2017	Spatial Augmented reality	Augmented Reality based Head-mounted display	Mobile robot for navigation
Bolano et al., 2018	Robot Transpiration	3D camera	Assembly collaboration
Palmarini et al., 2018	AR interface	Tablet camera	Assembly line collaboration for picking and placing
Hietanen et al., 2018	Depth sensor and AR projector based system	Kinect device	Assembly collaboration
Kausi et al., 2019	Robot based flexible assembly collaboration	Head-mounted display camera	Industrial manufacturing application
Bambussek et al., 2019	AR interface for Robot programming	Kinect device	Assembly collaboration
Wang et al., 2019	Virtual Reality for welding	Industrial Camera	Welding collaboration

Among these robot-based researches, De Giorgia et al., 2017 utilized the VR based adaptive simulation technology for demonstrating the gaming advantages for industrial robots. This methodology utilized the head mounted display (HMD) camera for virtual robot interaction and the controller buttons are used for exploring its movements. The corresponding robot reachability evaluation is done using kinematic calculations and different degree of freedom are analysed for the analysis of movement of the robot. Gammieri et al., 2017 implemented a bidirectional industrial robotics system utilizing the virtual reality based technology. The forward and inverse kinematics systems are modelled for coupling the VR and robot control and the interface. This system also contains an instant player mechanism that provides integration to the new device and further for collision detection monitoring, inverse kinematics is involved for joint angle computation. A clear and precise interface is provided by this methodology for the removal of unnecessary code translation. Matsas et al., 2016 developed the industrial interface for performing the collaborative job in order to observe the movements of robots. The VR assistance is implemented for handling and manipulating various tasks. Frank et al., 2016 used a tablet camera for generalizing AR integration for robot interfacing. The gesture recognition method is used for object manipulation and estimate robot location. The location and orientation of the relative coordinates are considered for robot interaction in this methodology. Huy et al., 2017 provided an AR based solution for mobile communication using the cameras and projector based approach. The AR platform can detect the movements of robots using laser projection technology. The tasks of robot trajectory choice and laser based movement control is done using the semi-autonomous

experience. Hietanen et al., 2018 explored the sensor based projection and integration for robot based safety. The danger chances and robot monitoring systems are visualized using dynamic projection and the captured images are analysed for various extraction scenarios.

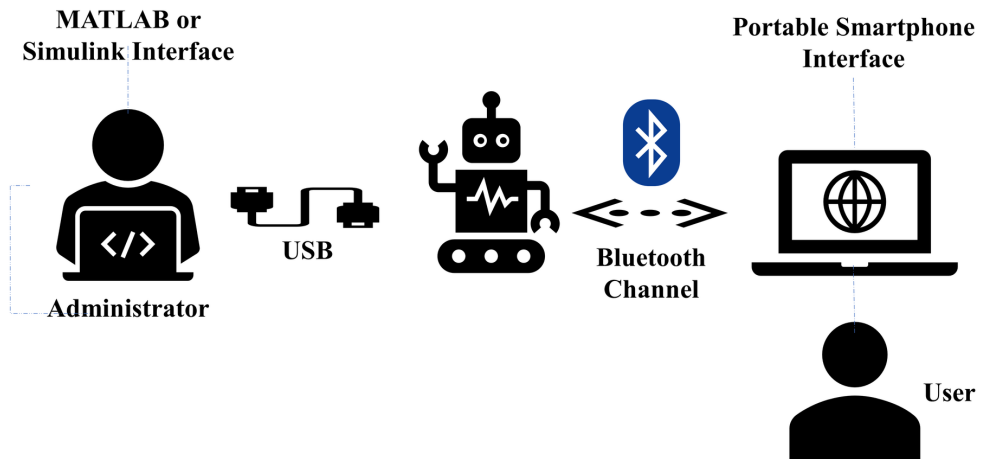
Kousi et al., 2019 presented an AR based approach for assisting the operations of mobile robotics and improve the flexibility of the production system. In case of unanticipated errors, this methodology proves beneficial in controlling the robot re-programmability for the new tasks. The robots in this case can navigate easily and the assembly tasks are executed without any further delay. The operability of the framework was tested and it was revealed that significantly better stability outcomes are achieved using this approach. Bambušek et al., 2019 investigated the spatial characteristics for robot operation and programming using the kinematics of robot trajectory. Kinect device was used for image capturing and the virtual detection is done using AR platform. Wang et al., 2019 utilized the robot based operation for welding process and virtual reality based interfacing is used for monitoring the status of arc length, current. The manipulator path is controlled via 3D modelling and the moves of the robot are analysed to improve the accuracy of welding devices.

By reviewing the current literature in the field of robot manipulation some of the challenges in VR and AR based methodologies are revealed. The major issue with the cameras for capturing continues images is that the battery life of these cameras is limited. Such limited battery life possesses a challenge in providing VR camera-based solutions. Dust and light issues may also arise in 2D cameras for the detection of objects during image processing. Also, the loss of track is another issue with locating the object in real time environment as the object moves in between the camera as the located marker points. However, this issue can be resolved using multiple markers at the same time but utilization of multiple robots simultaneously is still an issue. Another issue with the creation of real time virtual environment is that it is time consuming. All these issues must be addressed in order to obtain an accurate and precise robot manipulation mechanism which is time and cost effective at the same time.

PROPOSED METHODOLOGY

This section gives the layout of the proposed framework for web technology oriented-education application, including three significant modules namely; the robotic arm control, a regulator module and a portable smartphone application. The robotic arm is accountable for the development in the path direction and the regulator module gets the sign from the application stage and afterward send it to the robotic arm encoder for successful operation. The versatile portable smartphone application demonstrates the continuous representation and distant access of robot points utilizing the AR interfacing. This stage delivers the distance education to the students and develops a human-robot interface for the improving the teaching-learning experience. The whole work process of the proposed framework is portrayed in Figure 2 which is further detailed below.

Figure 2. Work process of the proposed human-robot interface



- i. The administrator sends an order to the robot arm utilizing a physical interface and a USB sequential convention.
- ii. The robot arm regulator encodes the order and returns as the precise developments for each enunciation which are plotted as graphical diagrams at the MATLAB or Simulink interface.
- iii. The association demand is sent by the client from the portable interface utilizing the Bluetooth correspondence channel. The control unit of the robot arm acknowledges the request and permit the versatile smartphone interface to set up the distant access association.
- iv. Using this association, the versatile smartphone interface can distinguish the robot arm positions which can be indicated by the regulator module. The level of robotic arm regulation is distinguished and shown on the far-off located portable smartphone interface.

ROBOTIC ARM CONTROL AND THE REGULATOR MODULE

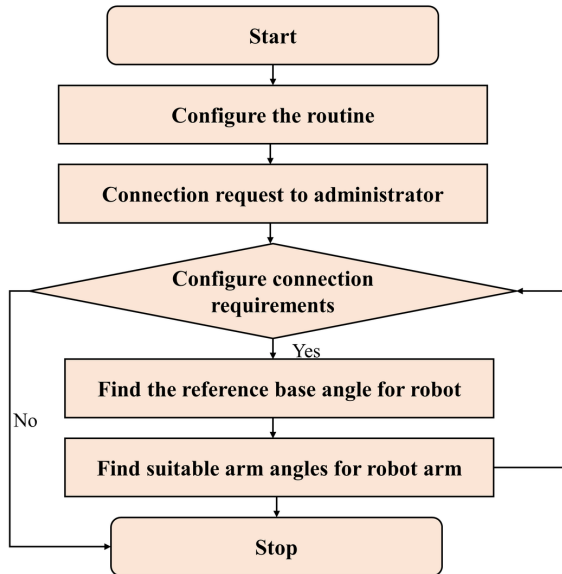
This article uses the robotic arm control and regulator module equipped with a mobile system in order to provide the real time connectivity and improve the robot based interaction of teacher and students using a real-time scenario for connection control. When the server admin domain receives the message for manual connection. The connection requirements are fulfilled and when the server receives a command for robot operation, the following operations are carried out.

1. The robot interfacing component connected to the mobile network are prepared initially.
2. The robot is thereby enabled for reading and writing the ports of the robot in order to prepare it for various manipulation and stopping operations.
3. The manipulation and control operation is performed by the robot and various human-robot interactions are done.
4. The suitable robot arm angle is thus chosen, depending upon the configuration of connection requirements and regulation operations is performed.

5. After performing the desired operations, the robot interface is then enabled to disable the reading and writing operation for robot ports.

The complete flowchart of mechanical robotic arm and the regulator module specifically dedicated to the online teaching system is provided in Figure 3.

Figure 3. Flowchart of mechanical robotic arm and the regulator module



The flowchart demonstrated in Figure 3 creates a setup for utilizing the USB association in outer correspondence between the teachers and students to create a human-robot interface during study. The association demand is made by the setup administrator and it identifies whether any solicitation is made either by the portable or the physical interface. The setup association necessities are confirmed and the base plot for the robot is produced. The robot arm point is acquired and articulated into advanced structure and these point details are further provided to the portable smartphone interface utilizing the Bluetooth network.

PORTABLE SMARTPHONE INTERFACE MODULE

The third module of the proposed human-robot interface comprises of a portable smartphone interface whose primary stages are image acquisition, arm point location, angular level articulation, wireless connectivity and AR integration. The significant stages in the versatile interfacing module are described below:

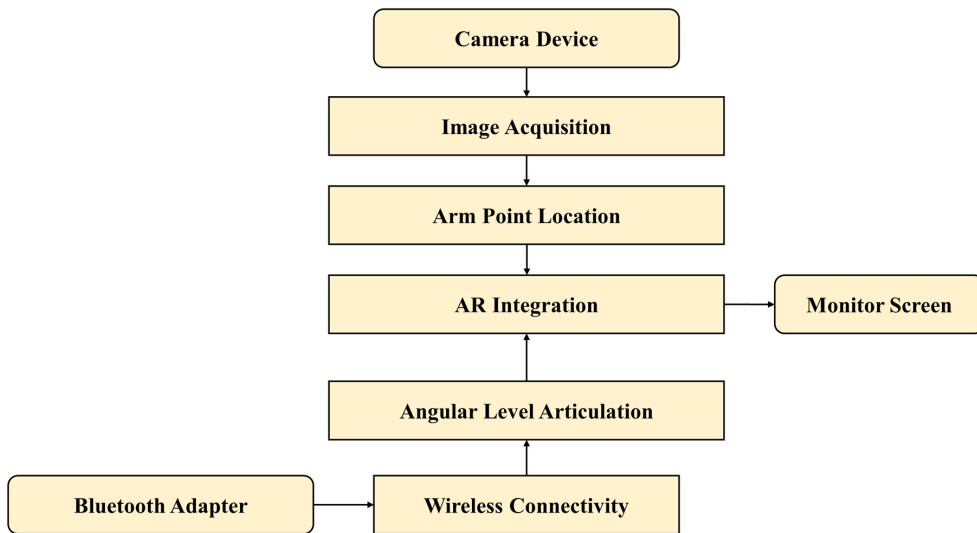
- i. **Image acquisition:** This stage is used to create an association between actual optical sensor and the application module. The image acquired using a camera-based method for the identification of robot arm position.
- ii. **Arm point location:** This stage is accountable for getting the robot arm marker point locations from the acquired image or video obtained during the image acquisition. The acquired image is

utilized in the training/learning stage for getting the particular marker points and these points are stored so that can be used in the testing stage.

- iii. **Angular level articulation:** It identifies the robot arm angular level position using the marker points characterized by the arm point location stage. For every marked point, this stage determines a precise angular level which is to be transferred to AR integration stage.
- iv. **Wireless connectivity:** This stage can recognize the robot configurability with the Bluetooth module and connects the robot gadget with the complete smartphone interfacing platform. The remote linkage through wireless connectivity can interface the information from the application platform to the further stage and further triggers the remainder functionalities of the smartphone integration module.
- v. **AR integration:** This stage gets the input from the arm point location and angular level articulation stages and afterward produces the projection image which can be seen on the screen of the smartphone gadget.

All these primary stages of the portable smartphone interface module are shown in Figure 4.

Figure 4. Primary stages of the portable smartphone interface module



EVALUATION METRICS

The evaluation metrics are evaluated for the ideal and the actual class and dependent on that metric, the conduct of the proposed human-robot interface is evaluated. The actual and the false indicated of the robot arm path are evaluated and on the basis of corresponding true and false incidents, true positives (TP), true negatives (TN), false positives (FP) and false negatives (FN) are computed. The various metrics used for this experimental demonstration are provided in Table 2.

where Sen. indicates sensitivity, Sep. indicates specificity, Pr. indicates precision and Acc. indicates Accuracy.

Table 2. Evaluation metrics for the proposed human-robot interface

Evaluation Metrics	Formulation
Sen.	$Sen. = \frac{TP}{TP + FN} \quad (1)$
Sep.	$Sep. = \frac{TN}{TN + FP} \quad (2)$
Pr.	$Pr. = \frac{TP}{TP + FP} \quad (3)$
F-measure	$F - Measure = \frac{2 \times PR. \times SN.}{PR. + SN.} \quad (4)$
Acc.	$Acc. = \frac{TP + TN}{TP + FN + TN + FP} \quad (5)$

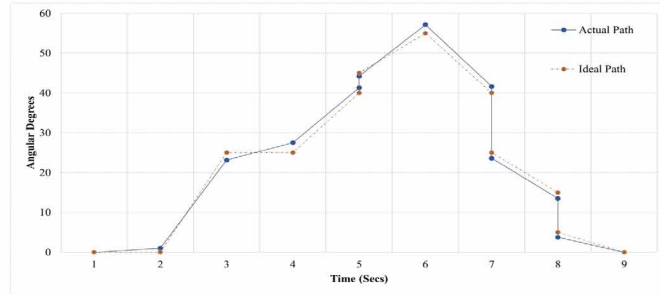
RESULTS AND DISCUSSION

This article conducts various experimental implementation and analysis procedures for validating the performance of the proposed approach. The experimental operations involve the optical encoders with 12V DC engine, a Bluetooth module for conveying message to the robot arm. The AR application interface comprises of a robot arm and a portable interfacing gadget with a screen camera output module. The test set operation involves, a at the rear of the gadget. A few exploratory tests are performed and a comparative examination is also accomplished for approving the direction restriction and to check the adequacy of the robot arm-based methodology for education-oriented applications.

Investigation of the Robot Arm Direction

An examination is done for comparative investigation utilizing the MATLAB environment. The graphs between the actual and the ideal robot arm paths are also realized. The desktop interface is utilized at the administrator end for generation of robot arm development and then robot arm regulator is used for controlling the directional ways for testing. The investigational study of actual and the ideal direction way is depicted in Figure 5.

Figure 5. Actual and the ideal direction way



The learning of the robot arm is accomplished utilizing the data obtained from the examination of desired and the real directional ways. The regulation and planning of control activities is done using the learned directional data. This information is used for planning the required actions during the occurrence of difficult environment in the testing stage.

The evident negatives and positives are compared from the training and testing stage and then based on the information obtained, a confusion matrix is computed. Further, the performance of the different evaluation metrics is assessed to validate the usefulness of the proposed methodology.

Performance Assessment Using Evaluation Metrics

The performance assessment outcomes for the proposed teacher student interactive robot-based methodology are obtained for both the training and the testing stage. The training results are used for managing the E-learning platform and to deal with the difficult conditions. The results acquired are given in Figure 6.

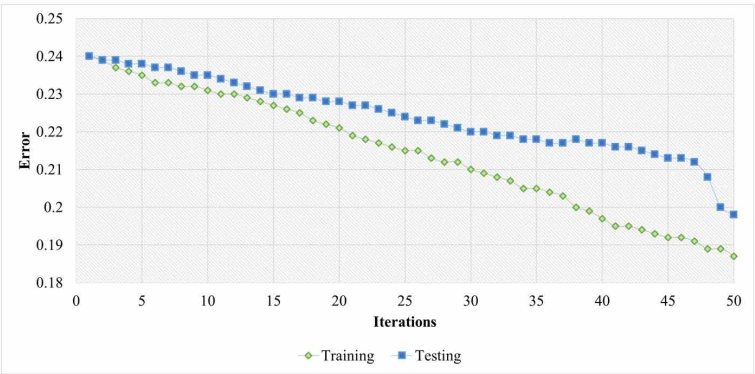
Figure 6. Performance assessment using evaluation metrics



For uncovering the practicability of the proposed system, some of the performance metrics used are sensitivity (Sen.), Specificity (Sep.), Precision (Pr.), F-measure and Accuracy (Acc.). During the training stage, 97.72% of Sen., 97.74% of Sep., 98.36% of Pr., 96.89% of F-measure and 97.73% of Acc. values are obtained. However, during testing, 96.72%, 97.30%, 99.56%, 96.26% and 96.94% are observed for Sen., Sep., Pr., F-measure and Acc., respectively. It is observed that the outcomes obtained establishes the applicability of the proposed methodology in the unreceptive web technology based-education environment and effectual solution is achieved using this approach.

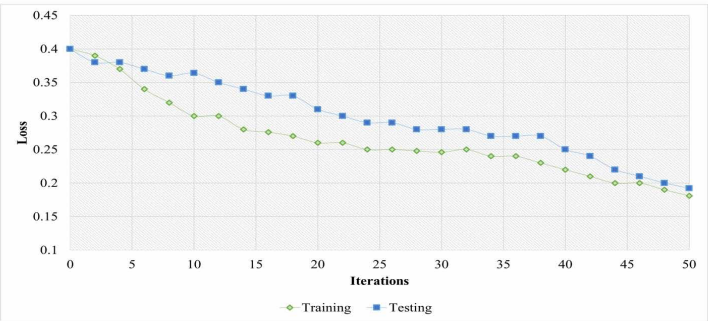
Further, some of the cost functions are also evaluated like error and loss function to assess the performance of the proposed method during the system coordination with the internet. The error and loss are shown in Figure 7 and Figure 8, respectively.

Figure 7. Error values obtained for both training and testing phases



The errors values are indicated in Figure 7 along with the increasing number of iteration cycles for both training and testing stages. The minimized error rate of 0.183 is observed for the training stage and the comparative error value of 0.194 is achieved for the testing stage at the iteration count of 50.

Figure 8. Loss values obtained for both training and testing phases

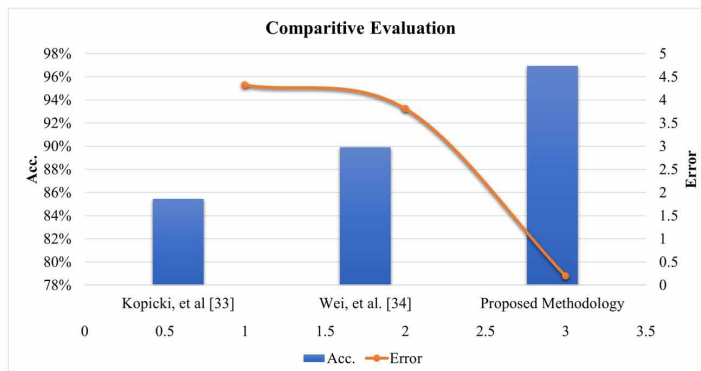


The loss values are analysed in Figure 8 for both the training and the testing stages. It is seen that the loss value diminished essentially with the increment in the number of iterations. The minimized loss value of 0.181 is observed for the training phase along with the 0.192 of loss observation for the testing phase, without prompting overfitting. The loss as well as the error values during the training and the testing phases provides the cost analysis-based perspective of the proposed approach and it can be revealed that along with the good performance in terms of various performance assessment evaluation parameters, this work provides feasible outcomes from the cost investigation as well.

Comparative Evaluation with the Existing Methods

Various research works have been investigated and compared for assessing the viability of the proposed approach over various other literary works in this domain. A comparative evaluation was done in order to obtain the state-of-the-art comparison for analysing the feasibility and reliability of the proposed approach. In order to assess the reliability of the proposed system, it is examined with the other existing methods. The comparative analysis of the proposed method with the existing ones is done in Figure 9 for clearer depiction.

Figure 9. Comparative analysis of the proposed methodology with the existing methods



The automated robotic platform provides the viable outcomes in terms of both the accuracy as well as the error value. The proposed methodology outperforms the other existing methods by providing the maximum accuracy value improvement of 13.45% with the minimized error value of 0.194 during testing. The investigation of the control and monitoring actions of automated robotic platform provides the favourable outcomes for varying distinctive educational situations. For the emergency conditions and pandemic situations during which classroom interaction of teachers and students become difficult, the proposed system can prove beneficial. The task-oriented robot motion planning and execution may provide an inexpensive robot guiding solution for manual task control. This work proves to be an explicit contribution in the field of education system as the proposed system can provide a reliable and flexible robot-based alternate for providing application-oriented e-learning solution.

CONCLUSION

In this work, an automated robotic platform is proposed for controlling the education application for improving the E-learning teacher-student relationship. The proposed methodology uses an

augmented reality (AR) application for robot control, a regulator module and a portable smartphone-based interface for robot perception in the complex environments. The explicitly reliable robot path directions are obtained for the proposed technique and an examination is made between the ideal and the actual directional ways. The portable interfaced robot arms equipped with mobile user interface proposed in this article make use of augmented reality for controlling the modern teaching robotics application. The experimental outcomes are perceived utilizing different evaluation metrics which gives efficacious results to varying distinctive natural situations. The training stage provides the metrics values of 97.72%, 97.74%, 98.36%, 96.89% and 97.73% respectively for the sen., sep., pre., f-measure and accuracy. However, the error and loss values of 0.183 and 0.181 are observed for this stage. For the testing stage, sen. of 96.72%, sep. of 97.30%, pre. of 99.56%, f-measure of 96.26% and acc. of 96.94%. 0.194 with 0.192 of error and loss value is observed for this stage. The ideal results are obtained with an outperformance of 13.45% in terms of accuracy from the existing methods in this domain. This work explicitly contributed in the education sector by providing a robot-based E-learning solution. In addition, the practicability of the proposed platform will be tested for its acknowledgment capacities in various other exploratory applications, utilizing a built-up learning concept for much complex conditions. The future scope of this research work will be specifically oriented towards the considerable usage of sensors and Internet of Things (IOT) based android devices for the purpose of robot control. Such applications will be beneficial in industrial, manufacturing and wireless control using accelerometer and other wireless devices.

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