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# Design and analysis for robotic arm position for automatic electric vehicle

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**ABSTRACT**

Nowadays electric vehicles (EV) utilization is increasing. Because of charging issues, EVs are troubling people at the time of the journey because of the lack of charging stations. Therefore, to overcome these issues, robotic arm position for automatic electric vehicle is introduced in this analysis. This vehicle is operated through solar, so charging issues are overcome. The robotic arm position for automatic electric vehicle is fully automated by 4 infrared radiation (IR) sensors, which are placed in variations, back and other sides with particular speed limit variations, so that accidents can be avoided. The Flux in hand gloves can operate without manual operation while driver is sleeping. This analysis uses Raspberry Pi, python software with machine learning (ML) algorithm (support vector machine). Hence, this robotic arm position for automatic electric vehicle shows better results in terms of charging issues, accident ratio and driver presence.



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## 1. INTRODUCTION

Nowadays, every type of transportation based on combustion engines, which release green gases into the atmosphere as the power vehicles. Despite this, the world's transport system has seen significant changes, shifting from complex fuels to electric vehicles (EVs). Many individuals have doubts about the new transportation technologies because of their expensive cost and the accuracy of electric vehicles [1]. For solar-powered electric vehicles (SPEVs), the sun is the primary energy source. With SPEVs, pollution can be zero. The primary benefits of SPEVs include their ability to generate energy, reduce mechanical losses, utilize regenerative braking to recycle energy, produce no emissions, are easy to infix, and, because of their higher energy efficiency, are critical-fault [2]. Since EVs require to be charge after every 60 to 70 km of driving, their market standing is lacking and their personal usage is quite limited. Currently, a lot of electric vehicles are charged at parking lots and by roadside chargers. Recharging an electric vehicle's battery typically takes two to three hours, depending on the battery's capacity. It is the primary factor affecting the use of EVs. In reference [3], the issue is solved by adding a novel technique that allows the system to automatically charge the battery system. By 2030, all internal combustion engine vehicles will eventually be replaced by electric vehicles. Recently, a number of DC solar-based electric vehicles are produced and researched. The issue of where to store solar energy is brought on by the usage of solar panels on a vehicle. Thus, electrical energy storage technologies require examination [4].

In terms of daily life and economics, driven vehicles are essential to humans. However, people can make mistakes or errors that put persons in the vehicle or outside of it in danger. The national highway transportation safety administration (NHTSA) states that speeding, distraction, and a lack of traffic is the main causes of most of these errors, which are avoidable or preventable. According to recent studies, driver assistance or autonomous vehicles can lower the number of crashes or accidents provided on by human error. The issue of a driver scarcity should also be taken into consideration [5]. The Financial Times website predicts that as truck drivers become less in number across Europe, there may be serious economic consequences. Therefore, in addition to enhancing traffic control and helping in eliminating all types of human error, autonomous vehicles may also be able to address the driver shortage problem.

Over the past twenty-five years, intelligent or robotic vehicles have grown in importance within the field of service robotics. Today, around 1 billion passenger cars are to be on worldwide roadways and streets. Given the volume of traffic, it is obvious that the driver must respond quickly in number of scenarios. The use of automatic systems in cars is necessary because drivers are frequently unable to respond [6]. These automatic systems handle a number of responsibilities that the driver performs while operating the car regularly. A vehicle that displays perception, reasoning, and an intelligent vehicle is one that has actuators to automate driving functions such as route planning, safe lane following, obstacle avoidance, passing slower moving traffic, spotting and avoiding dangerous situations. The development of intelligent vehicles is generally motivated by the need for more convenient, safe, and effective road traffic. Realistic conditions are the main focus of current intelligent vehicle research. Thus, the ultimate goal of research teams is not to develop a fully autonomous car, due to legal issues. The automotive industry recognizes that its purpose is to conduct supervisor and assistance system research [7]. Furthermore, worldwide transportation authorities make no effort to address autonomous transportation systems, specifically with regard to reducing vehicle fuel consumption, expanding the network of highways and extending the life of vehicles and roads. These days, numerous microcomputers are installed in vehicles. The field of information technology is expanding quickly, and vehicles are now internet. For smart vehicle monitoring, all of the microcomputers are connected to one another in real-time through the controller area network (CAN-Bus) using state-of-the-art technology. Because of this, not only passengers feel happy and safe while travelling, but drivers also feel that all other equipment is operating.

There are social, environmental, and financial advantages to the development of intelligent vehicles. Ninety percent of the time, intelligent vehicles that can predict driving situations and react when in danger can help prevent accidents caused by human error. In ultimately, this helps to save lives. Road capacity can be increased and fuel consumption and pollutant emissions can be decreased by vehicles that can run quickly and closely behind one another [8]. Understanding traffic limitations could help vehicles avoid misinterpreting them and participating in antisocial driving behavior. Because no driving license is required to operate a fully autonomous vehicle, the population will be able to move around with more mobility and quality.

The vehicle's localization is the primary responsibility of an intelligent vehicle. Since the vehicle follows a specific route, determining the position of the vehicle is crucial for control. If the exact position of the vehicle is unknown, it is not possible to its location to desired values [9]. Understanding the vehicle's dynamics and kinematics is essential for intelligent vehicle control. It is hard to operate the vehicle to change lanes or avoid obstacles without this knowledge. The intelligent vehicle's localization can be supported by tracking an object placed in the pavement, such as a bar code, passive radio frequency identification (RFID) transponders, magnets, and antennas. A vehicle is provided with an intermittent navigation system and an absolute positioning system for global navigation satellite systems like global positioning system (GPS) and Glonass. The vehicle's relative positioning system for visible markings in the environment [10]. In order for the vehicle to be intelligently controlled, it must be loaded with an electronic control unit that can be used to direct acceleration (engine torque, gearbox, clutch), brake (electric or electrohydraulic brake), and control rotation (electric power steering).

The authors propose a cascaded nonsingular terminal sliding mode (NTSM) proportional integral-derivative (PID) method, whereby the NTSM controller's anti-disturbance and tracking accuracy performance are enhanced by taking consideration the limitations of the sensors and processors. In order to simultaneously optimize the motor output error and the vehicle yaw error, a combined PID controller is developed, eliminating motor output imbalance and reducing NTSM controller deviation [11]. Finally, comparative studies are carried out, the results show the benefits of the proposed methodology by reducing tracking error by around 80% when compared to the dynamic model predictive control (MPC) method and by more than 30% when compared to the pure NTSM method.

With the use of modern technologies, autonomous robotic vehicles (ARVs) can navigate without the need for human involvement. They are used in a number of applications, including logistics, transportation, exploration, and surveillance. For vehicles and pedestrians to travel in the most effective and secure manner, route planning (RP), is essential [12]. To solve problems with route modeling, the Dijkstra algorithm (DA) and the particle swarm optimization (PSO) method is used. With the weight-controlled particle swarm-optimized (WCPSODA) being suggested, a combined technique for RP is described. The results were evaluated using conventional methods and MATLAB simulations, according to the study's results, the proposed systems performed effectively. The research gap observed in this paper is driver presence.

An unmanned driving robotic vehicle (UDRV) that has robust nonlinear control and adaptive steering that is dependent on driver behavior. To account for modeling mistakes and unidentified external disturbances, the approach utilizes a nonlinear disturbance observer (NDO) when combined with an adaptive robust backstepping controller. Double lane change studies demonstrate the stability of the control system [13], and comparative analysis results demonstrate the efficiency of the suggested approach in relation to alternative control strategies and human drivers. The research gap observed in this paper is charging issues.

For robotic vehicles that need to maintain a minimum positive forward speed, the motion control problem known as moving path following (MPF) is explained. The special orthogonal group SO (3) is used to formulate the attitude control issue, which is addressed using geometric concepts [14]. To eliminate conservative limits on the vehicle's initial position and manage the movement of a virtual point along the reference path, an MPF error model is developed. The MPF control laws attempts to direct the vehicle in the direction of the moving path and bring it to a virtual point. The controller can withstand external disturbances and imprecise tracking faults. The results of simulations show that the suggested MPF control laws works effectively. The research gap observed in this paper is charging issues.

3-DOF cable-driven serial manipulator (CDSM) and a moving platform make up the 4-DOF cable-driven auto-charging robot (CDACR). Six cables run through five disks linked to the stiff links of the CDSM activate the 3-DOF CDSM in this system. The flexible plug that operates as the CDACR's end-effector is capable of overcoming small elastic deformation [15]. Both the plugging-unplugging technique and the control algorithm were created to react to different parking scenarios with or without yaw error. In the area of automatic charging, this study introduces the cable-driven robot first. Additionally, it has been shown that utilizing CDACR to achieve auto-charging for electric vehicles is both possible and useful through simulated charging experiments.

A model predictive control technique that creates a performance index by combining the consensus objective with the output regulation objective, developing an existing auxiliary consensus control laws. There are convergence guarantees offered under which this coordinated output regulation challenge can be resolved. The efficiency of the suggested technique when applied to a cooperative path following the control problem of a network of three-dimensional nonholonomic robotic vehicles is demonstrated by numerical simulations [16].

A robotic device with wheel legged that uses force control to modify its stance over uneven roads. To compute the necessary leg forces, it makes use of a dynamic model with feedback and references to body position. The force tracking system has a funnel control technique with predetermined transient performance [17]. To ensure convergence of force tracking errors, a robust event-triggering condition is created. A physical prototype is used to test the control scheme, and several results from experiments confirm its efficiency and stability.

It focuses on data collection in clustered robotic networks that considers energy. Assigning tasks to other robots, a cluster head robot gathers sensor monitoring data. After that, an unmanned aerial vehicle (UAV) gathers data from cluster head (CH) robots at each cluster to which the data has been provided. Based on the robots' locations and battery life, the UAV selects which ones to visit. A nonvisited CH robot transmits data to other CH robots if it is present [18]. When analyzing cost optimization, the UAV's fixed battery capacity is taken into consideration. The algorithm is compared for different priority settings and numbers of CH robots.

A robotic penguin depth control system utilizing reinforcement learning and data-driven model predictive control (MPC). The framework uses a motion capture device, computational fluid dynamics, and a backpropagation neural network to simulate the underwater mode of a biological penguin. The closed-loop controller's performance is greatly enhanced by approximating the best policy using the RL technique. Through experiments and simulations, the suggested framework's validity is examined [19].

Investigate the flight mechanism of biological butterflies, the USTButterfly is a servo-driven biomimetic robotic butterfly. It can manage its tailless by using two servos to drive its left and right wings. The glasswing butterfly served as a model for the design of the butterfly's wings [20]. When compared to real butterflies in climbing flight, the wing-body contact observed by a multicamera motion capture system analyzes its flight characteristics. USTButterfly provides a different unmanned aerial vehicle paradigm and a new strategy flight specialization.

To train a robotic arm with 6 degrees of freedom in the target-reach problem, a hybrid version of the well-known deep deterministic policy gradient (DDPG) reinforcement learning technique is made available at: specifically, we introduce a deep neural network (DNN) for the critic model and a spiking neural network (SNN) for the actor model with the goal of determining a perfect set of actions for the robot. The SNN can be deployed in neuromorphic hardware for inference because the deep critic network is only used during training and then removed. A combination of RGB and laser scan data that are used for object detection and collision avoidance support the agent. We demonstrate the superiority of our method by comparing the hybrid-DDPG model with a traditional DDPG model [21].

To avoid collisions with obstacles while navigating a moving target person, a cognitive robotic system (CRS) is suggested. A speed planning module that uses a dynamic window method and a cognitive agent built on the Soar architecture made up the system. A differential drive wheel robot that includes a color depth camera and two ultrawideband sensors is used for developing the system. To evaluate performance, experiments are conducted with tasks like avoiding obstacles and turning at corners while following a human user along a corridor [22].

This study investigates and compares several model optimization methods, including the quantization, pruning, fine-tuning, and clustering, for applications involving autonomous driving. TensorRT optimization is also explored for advanced hardware devices. For comparison, offline measurements such as inference time and mean squared error are utilized. The behavior metrics assessment tool and the CARLA simulator are used to evaluate the optimized models. This speedup makes it possible for DL robot-control programs to run smoothly even on low-end computing hardware. The work can be easily repeated and extended because it is open-source [23].

The goal in this pursuit-evasion game is to use a differential drive robot to capture a Dubins Car in the least amount of time. While it tries to control the vehicle, the car is trying to avoid the robot. The time-optimal motion strategies of the players are calculated and analytical expressions are provided by the differential game theory [24]. There are four surfaces are revealed a transition surface (TS), one pursuer’s dispersal surface (PDS), two evader’s dispersal surfaces (EDS), and one. Examples of the players’ time-optimal motion techniques are displayed through numerical simulations.

Vehicles over uneven terrain that has different surfaces or inclinations can be moved by the use of drive control [25]. The robotic vehicle’s physical model was used to verify the control. When signals from inertial sensors are combined with stereoscopic camera technology, visual odometry eliminates the inaccuracy of odometric calculations based on wheel speed sensors. To ensure reusability and compatibility with other hardware platforms, the solution is built on the robotic operation system (ROS). The research gap observed in this paper is efficiency.

This is the way the remaining paper is arranged: The introduction and literature survey is included in section 1, section 2 presents the big data based data transfer model for design and analysis for robotic arm position for automatic electric vehicle, section 3 explains result analysis; section 4 concludes the paper.

## 2. METHOD

In this section, framework for design and analysis for robotic arm position for automatic electric vehicle is observed in Figure 1. The vehicle is connected with solar panel on the top, so that battery will store the power. For this vehicle 4 IR sensors are added on the two sides of the vehicle and front and back. Through that sensors vehicle can avoid the accidents. Hand glove will have 3 flux sensors. The 3 flux sensors are doors, lights and breaks will operate. Because of these flux sensors driver can operate without moving from that place. So, accidents are avoided and 100 percent driver presence is not needed. All these sensors are connected to Raspberry Pi.

The number of vehicles and transportation is growing quickly, which is causing pollution to increase everyday. The primary cause of pollution is the burning of fossil fuels. Since the environment is an essential component of the ecosystem, attention to the pollution that comes from vehicles is quite important. There is a large number of electric vehicles currently an the market and they do not produce any pollution. However, the issue is that there are less charging stations and less range, the intention is to maximize the range of electric vehicles. More application and a way to use green energy are made possible by the vehicle’s utilization of solar energy. The quantity of carbon dioxide that cars produce would be greatly decreased if such a vehicle became accepted, as would the need for oil. Along with running Linux, the Raspberry Pi is an extremely low-cost computer that also has a set of general-purpose input/output (GPIO) pins that let you interact with the internet of things (IoT) and control electronic components for physical computing. Python is the most popular programming language for the Raspberry Pi. It is the preferred language for creating electrical projects, machine learning (ML) methods, and internet-based applications. Python is a favorite among developers, students, and Pi users because of its easy-to-understand syntax. An electrical device known as an IR sensor emits light when it detects an object in its environment. In addition to detecting motion, an IR can measure an object's heat. Thermal radiation is typically produced by all objects in the infrared spectrum. They cannot see these types of radiations, but an infrared sensor can identify them.

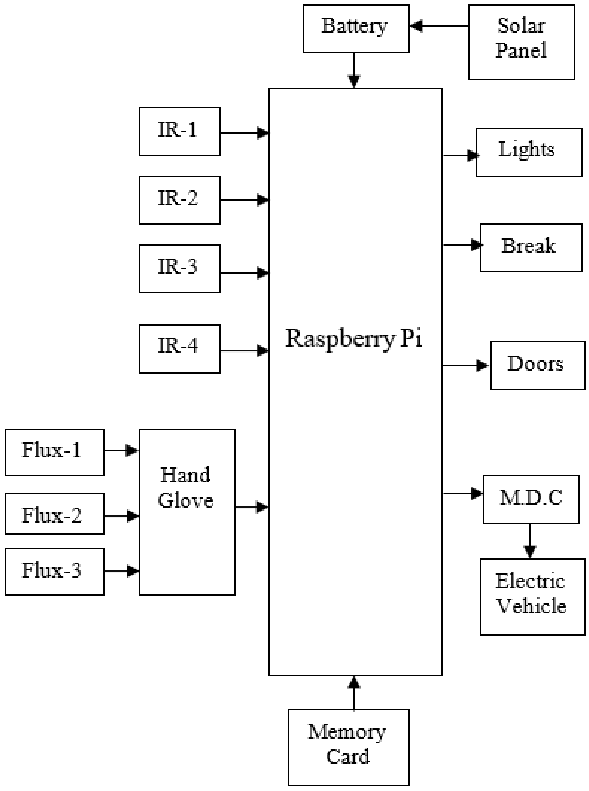


Figure 1. Framework for design and analysis for robotic arm position for automatic electric vehicle

All that's required for the emitter and detector are an IR light emitting diode (LED) and an IR photodiode, respectively. The same-wavelength infrared light that the infrared LED produces can be detected by the photodiode. The photodiode's resistances and output voltages will change in direct proportion to the amount of infrared light it receives. A standard infrared detection system consists of the following five fundamental components: an optical component, an infrared source, a transmission medium, infrared detectors or receivers, and signal processing. Used as infrared sources are infrared lasers and LEDs with a certain wavelength.

One non-destructive way to test pipelines for changes in magnetic field flow is to use a flux sensor device. Such inspection techniques are used in trenchless rehabilitation to find corrosion or corrosion-related damage in steel pipelines, like pitting. Trenchless inspection techniques reduce costs and save time by identifying areas of concern that may be addressed specifically. Typically, motor driver circuitry consists of an integrated circuit that can supply sufficient current to run the motor and, through power transistors combined in parallel, provide shaft control for accurate speed adjustment.

Many ways to control devices through external physical quantities have been established the continuous growth of technology and the widespread development of automated control systems. In order to increase manufacturing operations efficiency, quality, and safety, industrial robots are now commonly used in production systems. The use of robots in conjunction with production line operators is a recent development. When some tasks are either too difficult for a single robot to do or when the cooperation of several simple robots provides unique benefits, there is an interest in cooperative systems. Robots have been utilized for a range of purposes in mining, underwater navigation, exploration, and military environments. Mobile robots may need to meet a number of requirements regarding their design and specifications, depending on the application. Where as in traditional system accidents are happen because of uncontrolling of vehicles and sudden collision of vehicles. But in this system because of IR sensor and Flux sensors accidents are avoided. Even this system provides safety for the people, when compared with traditional methods.

## 3. RESULT ANALYSIS

In this section, performance analysis for design and analysis for robotic arm position for automatic electric vehicle is observed. In Table 1 performance comparison is observed between solar powered robotic electric vehicle and electric vehicle, comparison parameters are in terms of charging issues, accident ratio and driver presence.

Table 1. Performance analysis

| Parameters | Solar powered robotic electric vehicle | Electric vehicle |
|---|---|---|
| Charging issue | 51 | 91 |
| Accident ratio | 10 | 80 |
| Driver presence | 15 | 100 |

In Figure 2, X-axis demonstrated electric vehicles and Y-axis demonstrated charging issues. The charging issues comparison graph is observed between the electric vehicle and solar powered robotic electric vehicle. The solar powered robotic electric vehicle will generate the energy and stores in battery, so that charging issue will not be faced by users. Where as in traditional systems vehicle is to charge for long hours, in case of long distances travelling, charging may not sufficient and searching of charging stations are the issues faced by users. So, those issues are overcome by using this solar powered robotic electric vehicle.

Accident Ratio for Solar powered robotic electric vehicle and electric vehicle is compared in Figure 3. In Figure 3, X-axis demonstrated electric vehicle and Y-axis demonstrated accident ratio. As accident ratio in electric vehicle is high. Solar powered robotic electric vehicle has IR sensors, so that the vehicle can detect the object. Therefore, accidents are avoided. Though driver is very attentive, then also accidents are happened because of sudden collision of objects or objects from sideways. But, in this proposed system accidents can be avoided by using of sensors. This system provides safety for users.

For solar powered robotic electric vehicle driver presence is not needed 100% because it is having IR sensor to detect the objects from all sides and it is having flux controllers in hand-glove even driver is not able to handle steering. Therefore, driver presence can be low when compared with electric vehicle in Figure 4. Figure 4, X-axis demonstrated electric vehicle and Y-axis demonstrated driver presence. This system reduces the risk factors while driving when compared traditional system. As the charging issue is overcome by using solar to the vehicle, so vehicle will charge continuously. Accidents can be avoided because of sensors. Therefore, this system provides safety for users. This system gives better results in parameters like charging issues, accident ratio and driver presence.

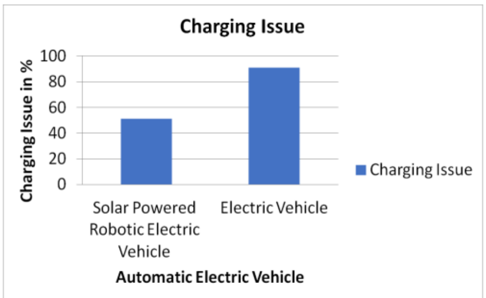


Figure 2. Charging issue comparison graph

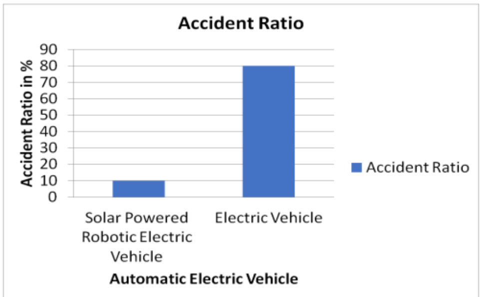


Figure 3. Accident ratio comparison graph

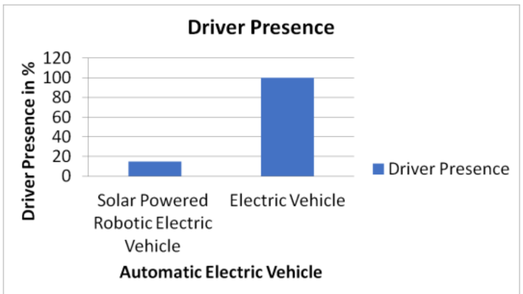


Figure 4. Driver presence comparison graph

## 4. CONCLUSION

Hence, the design and analysis for robotic arm position for automatic electric vehicle is concluded in this section. Normally, electric vehicles are used to reduce the fuel cost and pollution but charging issues are still facing. But in traditional system charging is done manually, depending on usage of vehicle. Because of sudden collision or object accidents are happen, so driver presence is required more and more. Even small mistake by driver also leads to a great damage to the user while driving in vehicle. Therefore, by using this solar powered robotic electric vehicle, the charging issues are overcome by solar panels which are placed on top of the vehicles. As this solar powered robotic electric vehicle detects the objects and avoids the accidents by using 4 IR sensors and it is having flux controllers in hand-glove even driver is in sleeping to close the doors, for brake and lights on/off. Therefore, driver presence can be reduced. This Raspberry Pi, python software with ML algorithm SVM is used in this system. When this solar powered robotic electric vehicle is compared with electric vehicle, solar powered robotic electric vehicle shows better results. Hence, this solar powered robotic electric vehicle achieves better results in terms of charging issue, accident ratio and driver presence. In future, further features are improved for more safety by using this system.


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| Name of Author | C | M | So | Va | Fo | I | R | D | O | E | Vi | Su | P | Fu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mukund Ramdas Kharde | ✓ | | ✓ | | ✓ | | | ✓ | | ✓ | | ✓ | ✓ | |
| Sayyad Abdul Kalam | | ✓ | | | | ✓ | | ✓ | | ✓ | | ✓ | | |
| Kalyani Teku | ✓ | | | ✓ | | | | | | ✓ | ✓ | | ✓ | ✓ |
| Thumu Srinivas Reddy | | ✓ | | ✓ | ✓ | | ✓ | | ✓ | | | ✓ | | |
| Gollapalli Veera Satya Srinivas | ✓ | | ✓ | | | ✓ | | ✓ | | | ✓ | | ✓ | ✓ |
| Pavani Kollamudi | | | | | | | | | | | | ✓ | | |
| Shaik Baba Fariddin | ✓ | ✓ | | ✓ | | | ✓ | | | ✓ | | | ✓ | |
| Gopinati Pranay Kumar | | ✓ | | | ✓ | | ✓ | | ✓ | | | ✓ | | ✓ |

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

## CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

## DATA AVAILABILITY

The authors confirm that the data supporting the findings of this study are available within the article.

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