Review of Intelligent Control Systems with Robotics

Ahmed K. Abbas[1] , Yousif Al Mashhadany[2], Mustafa Jameel Hameed[3], Sameer Algburi[4]
[1]Department of Construction and Projects, University Headquarter, University of Anbar, Ramadi, Iraq
[2]Department of Electrical Engineering, College of Engineering, University of Anbar, Iraq
[3]Electrical and Electronic Engineering Department, Collage of Engineering, Thi-qar University, Iraq
[4]Al-Kitab University, College of Engineering Technology, Iraq

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ABSTRACT

The interaction between humans and robots provides several important elements in improving the productivity of the tool in mechanical technology because the development of many complex tasks takes place through the application of multi-use robots technology that is self-adapted in these processes in various industrial or medical applications, which greatly contributed to the development of human life and achieving ways well-off Existing automated control frameworks have shaken up the construction business, making them highly adaptable and easy to use. This paper examines current and upcoming types of control frameworks and their implementation in mechanical technology, and the function of artificial intelligence in applying autonomy. In addition, he is expected to reveal insights into the various issues around control frameworks and the different approaches to fixing them. In addition, it proposes the basics of the application of autonomous control frameworks and various types of control frameworks in mechanical technology. Each type of control framework has its pros and cons which are discussed in this paper. Another type of robot control framework that upgrades the difficulty of the quest stage is man-made brainpower. Part of the speculations used in man-made reasoning, for example, artificial intelligence (AI) such as fuzzy logic, neural network, and genetic algorithm, are shown in this paper. Finally, a part of the joint effort between mechanical autonomy, personnel, and innovation is indicated. Coordinated human effort, for example, kinematic signal recognition used in games and versatile upper arm-based robots used in the clinical field for individuals with disabilities. Later on, it is only natural that the importance of different sensors is built up, thus expanding the knowledge and activity of the robot into a modern field. The data in this paper was collected based on many international references in publishing houses such as Springer, Elsevier, MDPI, IEEE, and others.

Corresponding Author:

Ahmed Khudhair Abbas,
Department of Construction and Projects,
University Of Anbar, Ramadi, Iraq
Email: ahmed89at@uoanbar.edu.iq

1. INTRODUCTION

Virtually AI, as well as robotics, are significant for every individual in our world. Artificial intelligence as an area of study and development has arisen as well as is developing in tandem with automated control systems, AI is one area of computer science and computation, then control automation [1], focused on making robots behave such as humans. John McCarthy [2] unveiled that concept in 1956. The first manufacturing and processing AI implementations date to the 1980s. During that same time, AI achieved several levels of stabilization and maturity. AI is the estate of the computer system that occurs in their reaction to information, which is the same way a person responds to data [3]. Throughout the monograph [4], AI strategy is defined as the science of agents obtaining performance for external environment perception actions and conducting logical functions.

With the appearance of the age of automation, communications technology, information technologies, robotics technologies, and artificial intelligence are moreover combined. During a long evolution in the electronics and electrical era, robots welcome a new generation of intelligence. An operation involves three parts is reflected on: Firstly, conventional industrial technology such as controllers and servo motors has been just changed to automated intelligence technology such as the processing of natural languages and deep learning; Secondly, robots are becoming more profoundly incorporated into society, attracting bringing both industrialized users, and commercial enterprise, and individual into attention; Thirdly, cooperation and interaction replace existing independent human-robot relations. Layering that control method assists to make the robot more powerful and more resilient [5].

In the modern world, robot controllers have advanced significantly in technical terms [6]. There is no question that the functions of intelligent robots are more critical than ever in society and the manufacturing process. From the devices process point of view, Intelligent robots could be classified into robots, (manufacturing, serving, specialist) robots [7]. Industrial robots are indeed a (multi-joint) handling or (multi-degree) of freedom which is usually used in the manufacturing field. It is an automatic controller, automatically moving and automatically powered machinery that can complete a variety of tasks. The industrial robot would also organize the path of movement and subsequently start to operate under a preset program, including soldering, painting, collecting, placement (packaging and filling) as well as the sensing as well as testing of the product.

Service robots, such as (reception, shopping, cooking, ing, and safety) robots, etc. could customize services based on application scenarios and achieve tasks such as advertising, consulting and guidance and security patrol, etc. In addition, specialized robots are used for particular applications [8]. It may help to complete tasks in difficult and hazardous conditions or tasks that are extremely accurate. The medical robot, for instance, offers advanced treatment and rehabilitation solutions to reduce surgery. The military robots, as well as robots for reconnaissance, robots for fields of battle, and minesweeper robots. In addition, several robots are used for scientific investigation as well as cutting-edge technologies fields, etc.

The human-robot collaboration has a vital part to play in increasing the mechanism's efficiency in robots [9]. Several complicated tasks are carried out in real-time by robots. Industrial robot systems had revolutionized the industry, which makes them quite flexible, easy to use, and Friendly to the customer.

2. ARTIFICIAL INTELLIGENCE

Artificial Intelligence has become a large subject of attention, which focuses on topics such as:

- Deliberate action, organization, intervention, and insight.
- Perceive, show, and understand situations that are available.
- Communicating with various robots and with humans.
- Incorporating these skills into scalable engineering technologies [10].

While robotics and AI have spread widely away, a growing curiosity in control science and application exists of the control the integration of traditional automated control techniques with AI techniques and AI implementations in the area of complicated control [11]. The combination has been proved to be extremely important because it allows independent motions to satisfy certain constraints in the working environment from beginning to end [12]. AI technologies and robotics was utilized for Robot Path Preparation. Because the majority of theoretical and applied studies in the field of AI controllers have increased like an avalanche in recent years, the review of the most significant achievements in this area is the subject of the research paper.

There are several intelligent techniques have been used with a new set of approaches to issues with various control systems. During the few past years, robot control was used in conventional techniques like PID. The issue with PID is that the technique is effective in a restricted area of the environment [13]. There are several techniques are available which allow for obtaining accuracy and certainty. Massive progress has been made in intelligent control systems will be included.

Fuzzy Logic (FL), Two kinds of FLS, such as type-1-fuzzy-logic-system (T1FLS), type-2-fuzzy-logic-system (T2FLS), Artificial Neural Network (ANN) as well as the Genetic Algorithm (GA), etc.

2.1. Fuzzy Logic Controllers

The traditional proportional integral derivative (PID) control has a reasonable output for the linear model and has been commonly used for the industry because of its simple design and reliability in various operating conditions. Nevertheless, it is difficult to reliably change the PID controller's parameters, since most industrial facilities are very complicated or have other problems, like non-linearity and time delay [14]. Because of the difficulty in certain industrial facilities, as well as the weakness of PID controllers. Unprecedented attention was redirected to Fuzzy Logic Controller (FLC) implementation. Fuzzy controllers are more flexible than PID controllers because they have more parameters (types and membership function parameters in the fuzzification and defuzzification modules). That's because it utilizes professional expertise, as well as the linguistic rules that define its control operation. Furthermore, the FLC really doesn't need control of the accurate mathematical control system as well as therefore can deal with nonlinearities properly [15-17].

Generally, the same mathematical models really aren't usable or are really difficult to devise, for actual physical structures or devices. The issue above is one of the most fundamental challenges facing developers when designing functional controller systems. Therefore, the main reason researchers are heedful of fuzzy is that they may use them to describe in a mathematically narrow sense the vague thinking of the human being. Several industrial processes in fact are non-linear and possess a certain degree of uncertainty [18, 19]. During the last century, several other modern controllers, like non-linear, adaptive, and optimal control, have been utilized [20]. While these control techniques demonstrate great efficiency, it is also complicated and hard to implement [21]. The FL principle had first been introduced in 1965 by Zadeh [22] as well as later extended throughout all technology development areas. The fundamental principle for fuzzy logic, rather than simply the Boolean logic, is the method to handle computation with degrees of real. Fuzzy control has been the most widely utilized among many implementations of fuzzy logic. From the theoretical viewpoint, it is possible to identify a non-linear controller and model, known as a "universal approximation," utilizing a fuzzy rule base of logic [23]. A numerical sample, human expert data, and concrete inputs/outputs data; are the outlets that contribute to providing the most suitable system information for each device.

The Fuzzy Controller is typically composed of four elements. Firstly, the base of rules that carry the information over how greatest to control the framework. Secondly, the inference process chooses the applicable existing control rules at the same time and then selects the most suitable input for a facility. Thirdly, the fuzzification module only adjusts the definition inputs and compares them with the rule of the rule system. Forth, the defuzzification device transforms the results of the inference process into the inputs to a field. Figure 1 shows the designs of the closed-loop Fuzzy logic control diagram.

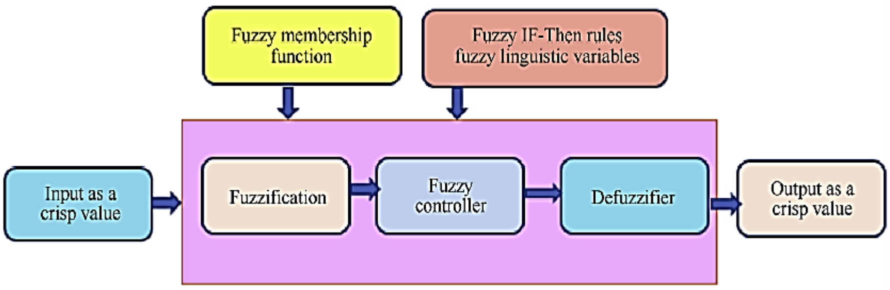


Figure 1. Fuzzy logic control architecture.

The application of the principle of FLS has improved the machine's capacity to solve unpredictable problems [24, 25]. The fundamental characteristic of fuzzy logic enables various forms of uncertainty to be handled [25]. Such characteristics comprise the simplicity at which expert information is integrated into the control rule, less dependent on the design, flexible which can also be utilized conveniently to implement linguistic rules [26]. The FLC, which relies on fuzzy logic, proposes a mechanism for changing linguistic control techniques to the programmed control mechanism with a perspective of expert information [27].

The FLC is relatively cheap, clear to understand, sophisticated, and easy to implement by manufacturing [28]. In reality, fuzzy regulation provides a systematic way to reflect the heuristic awareness of the human being, develop it, and apply it [29]. It can be implemented and achieved by Non-specialists in control systems [30]. Another advantage of fuzzy controllers with enough flexibility to carefully change their parameters for the required non-linear control behavior. Fuzzy logic cannot respond to extremely scientific issues, but fuzzy logic is a suitable candidate for issues that are connected to the control [31]. FLC is relatively cheaper in terms of functionality than some other traditional controllers. Capacity to cover a wide variety of operating conditions. FLC reliability and high performance are more robust than traditional systems.

Franssila and Koivo [32] have utilized the transputer array to manage the industrial robot (Puma 560) as one of the first applications of fuzzy logic to operate the adaptable manipulators. Sun et al. [33] suggested a control rule consisting of a standard fuzzy controller as well as a control concept in order to guarantee the reliability of closed-loop systems. Zavlangas et al. [34] has been showed a fuzzy system (Sugeno) that is dependent on navigation for an Omni-directional robotic system. Castellano et al. [35] have developed an advanced fuzzy rule production method that enables obstacle avoidance. To navigate efficaciously. The navigating method is introduced using the FL to prevent navigational issues like continuous loop-making [36] in a static and dynamic system set.

Surdhar and White [37] stated that the investigation was conducted with proprietary optical tip displacement feedback information on the fuzzy logic controlled, nonlinear, double-axis handler with a monocular flexible connection. They proved that it is possible to speed up the achievement of the fuzzy controller by putting all of the various roles of a controller, Inference, defuzzification, and outcome processing on different functions running simultaneously and using singleton outcome.

The approach was developed for versatile single-link manipulation on the centralized fuzzy logical controller [38]. To monitor a flexible dual-link manipulator, Mougdal [39] built a versatile adaptive controller. The variables of elastic systems for sensing-free motion devices were defined by Khalil et al. [40]. The dispersed fuzzy logic controller was implemented in the flexible link manipulator by Shi and Trabia [41]. Two-speed variables of higher significance were grouped into their controller as income for the speed controller, while two lower-value configuration parameters were used as income for the displacement logic controller. [42, 43] by introducing the Fuzzy Logic on a data-driven strategy. The method to navigate the robotic system in an unknown cluttered, embroiled was proposed by Hoy et al. [44].In order to increase the robot's ability to move, the stereovision system for FL was presented by [45, 46] Navigation coding structure is displayed in (Figure 2).

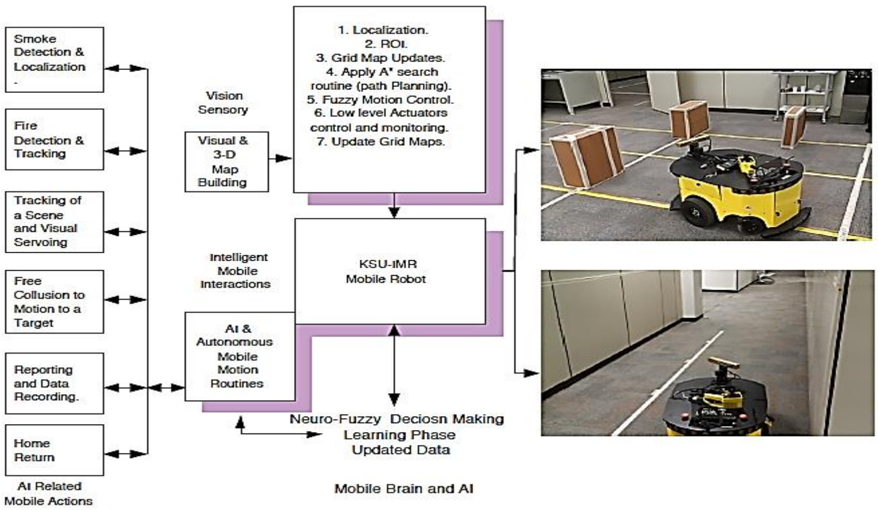


Figure 2. Shows Navigation coding & exponential structure [46].

The fuzzy strategy has been implemented in the 2D environment by [47] to navigate a humanoid robot (Figure 3). Represents the fuzzy logic controller flow chart. In a 3-dimensional system navigating is among the challenging things that are tackled utilizing the fuzzy logic of aerial robotics path planning, and underwater robots [48, 49]. The FL technique was utilized for the tracking as well as control of missiles and drones.

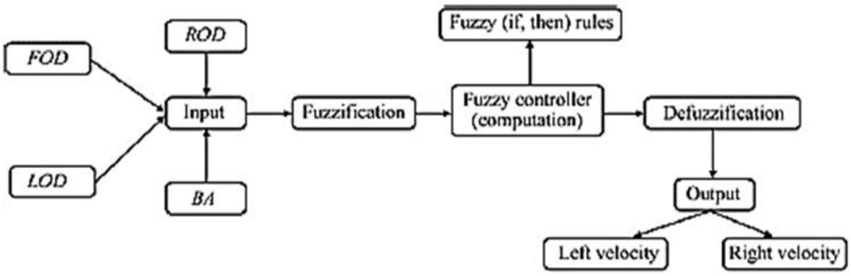


Figure 3. Flow chat for fuzzy analysis. [47].

The fuzzy controller enables a robot to mimic biological behavior. By incorporating multiple ultrasonic sensors into a robot, the suggested structure was implemented to gather the data from an environment. The bionic action of a custom-constructed robot was tested using three real-world examples, which showed its viability. The tests showed that the suggested fuzzy logic worked satisfactorily. The control allowed the robot could display intelligent human behavior under complicated conditions [50].

As known that the great performances of conventional controllers cannot be accomplished if high non-linearity or uncertainty characterized the mechanisms to be regulated. Moreover, FLC requires a lot of information to be used, High Human experiences requires and the rules need to be modified within a period. Two kinds of (FLS) are available, i.e. the type-1-fuzzy (T1FLS) and type-2-fuzzy (T2FLS).

2.1.1. Type 1-Fuzzy Logic System

Fuzzy logic systems (FLSs) are reliable methods utilized in independent robot navigation and for the representation of behaviors to overcome and restrict these uncertainties [51-53]. FLS is centered on the type-1 fuzzy membership feature as well as was used for a variety of challenges, in particular in controlling systems [54]. The modeling method relies under different conditions on the operator's behavior [53, 55]. In several industrial applications, the Type-1 Fuzzy Logic Control (T1 FLC) was utilized. Its key benefits are the ability to implement understandable human information in the form of language rules, as well as to face confusion, inaccuracy, and uncertainty. However, the resultant efficiency of the control system could be adversely influenced by complex uncertainty, inherent in several real-world applications [56]. The T1-FLC can't explicitly answer these vector requirements utilizing directly fuzzy memberships. Most of this uncertainty can be addressed by the general manner of fuzzy reasoning and fuzzy utilized type-1 fuzzy logic that appear to be unclear through scale [0, 1]. Considering that the exact value of uncertainty is hard to determine, it is much more rational to work with the T1FLS method.

The following were listed as different sources of uncertainty:
- Uncertainty regarding the right output results.
- Noisy input-related uncertainty.
- Uncertainty regarding the data utilized to fine-tune control system variables.

Such uncertainties could result in a major retrogradation of the T1FLC performance. This deterioration is largely attributed to the very functions of a T1-fuzzy membership (MF).

A (T1FLC) is typically divided into 4 main parts, input fuzzification, fuzzy inference, fuzzy rule base as well as defuzzification of the outcomes [57]. This kind of controller retains an implied form of a fuzzy rule basis filled with fuzzy linguistic rules. The T1FLS comprises fuzzification and inference blocks; the outputs have only a defuzzification block as seen in Figure 4.

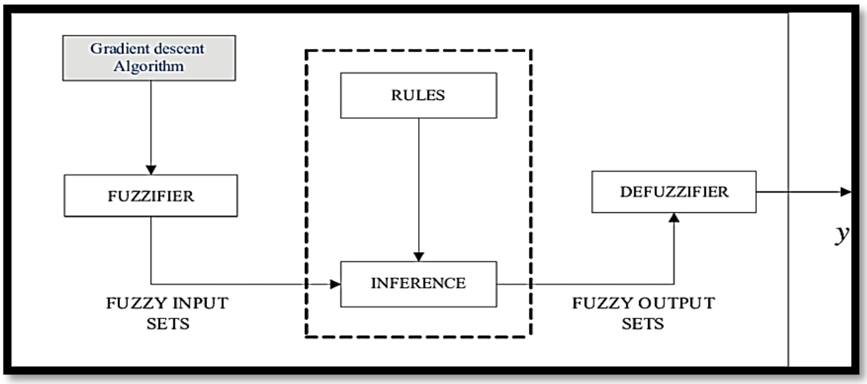


Figure 4. Type 1 Fuzzy logic system

Nurul and Sharifah et al. [58], Type-1-Fuzzy-Logic-Controllers (FLC) were used with good results in various applications in the real world. Cherroun, M. Nadour, et al [59], Fuzzy-based controllers were being utilized to address different kinds of engineering issues, Particularly for Robots and Controls. Robot navigating is perhaps the most common activity of inaccuracy, uncertainty, and utilization of fuzzy logical structures has been deliberated. Type-1-fuzzy-system is predicated on a two-dimensional Fuzzy membership function. The ambiguity caused by this function could not be fixed in several implementations.

In situations where a high degree of uncertainty exists, some scholars argued. For situations where the degree of ambiguity is high, the type-1-fuzzy-set (T1FS) has restricted handling capacity, because it has a simple number of membership degrees [60-62] for each input. Moreover, Mendel notes that the Fuzzy Logic Systems Type-1 cannot deal directly with the complexities of the rule. Further, the traditional Type-1-FLC fuzzy sets could not cope adequately with high degrees of ambiguity. Yet there are certain drawbacks in coping with uncertainty in this kind of control system.

2.1.2. Type 2-Fuzzy Logic System

Fuzzy logic controllers are generally built up with Type-1-fuzzy-sets [63]. It is common knowledge that whenever the mechanisms to be managed are marked by greater non-linearity or uncertainty, improved performances with conventional control devices are not possible; the precise value of the question is impossible to assess even whether we have a greater level of uncertainty in the issue. Lately, a new type of fuzzy logic controller, that is called "Type-2 FLCs" [64], has been shown to help deal with all the machine non-linearity and uncertainties. Many documents show several significant changes in the accuracy of T2FLS in comparison to its type-1 equivalent [62, 65-68]. It is argued that T2FLS be favored over T1FLS in the event of ambiguity [69].

This kind has been used for its reliability and for its ability to manage nonlinearities of the system effectively. So the T2FLS removes T1FLS [18, 61, 70] limits. Fuzzy Type 2 logic structures can also be used to tackle the greater level of uncertainty and complexity [71]. Therefore, the volume of ambiguity in the method could be minimized because this principle has improved the capacity to manage linguistic inconsistencies by modeling information ambiguity and unreliability [72, 63]. A significant interest of scientists in type-2-fuzzy [60]. For certain actual cases, the noise or constantly shifting environment could be seen as getting a greater degree of complexity as well as we could suppose the type-2-fuzzy-logic is doing a great way to handle it. As shown in (Figure 5), the T2FLS includes fuzzified and inference blocks. The outcome processing block also includes form type-reducer and fuzzified block.

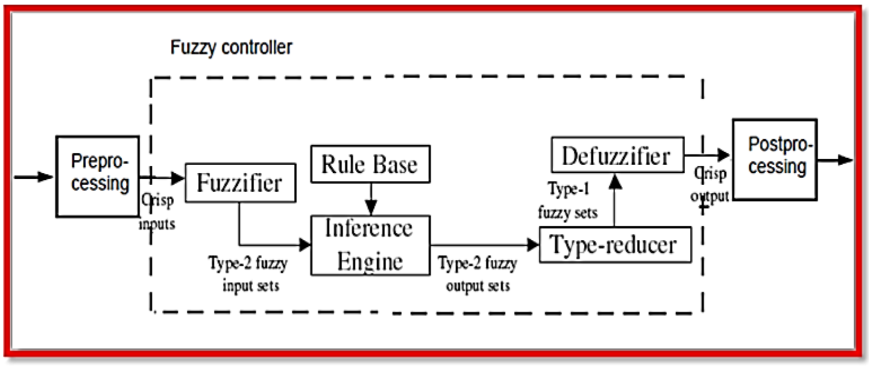


Figure 5. Fuzzy logic system type-2.

In this article, there are two mechanisms of type-1 (FLCT1) and type-2 (FLCT2) that are presented as fuzzy logical controls which are to regulate the robot arm system tip location [73]. They compared the actual performance of a robot, FLCT2 settlement time is better than FLCT1 [74]. Type-1 and Type-2 FLC results were shown to resolve the incertitude in the rule as well as (MFs) and Type-2-FLC are found to be above their conventional Type-1 FLC counterparts. The researchers Nurul and Sharifah have used fuzzy-logic-type-2 was shown to utilize to manage high inertness rates properly better than conventional FLC type-1[52]. Moreover, in this analysis by Naik the FLC type-2 proves that less overshoot over and quick rise times lead to satisfactory results compared to FLC type-1 [74],

As such, type-2 FLCs are deemed to be capable of overcoming the constraints of Type-1 FLCs and producing a new generation of fuzzy controllers with efficiency improvements for several applications that demand a high degree of uncertainty. This allows it to better deal with these challenges and therefore to achieve better outcomes [59]. In this search, the results collected from T2FLS showed that the efficiency is better, good performed, and much more reliable compared to T1FLS. But in the secondary membership function (MF), the process suffers from uniform uncertainty. Further overcoming this constraint by our interpolating reasoning methods based on triangular types-2 fuzzy possibly offer a new possibility for the fuzzy logic system. Until now, due to the general type-2 FLS computational complexity.

2.2. Artificial Neural Networks

An artificial neural network is a circuit, computational algorithm, or based mathematical models of the widely linked group of neurons comprising biological neurons. Throughout the 1940s, researchers interested in imitating the human brain's processes developed basic biology neuron software and device neurons and behavior [75]. In the 1950s to 1960s, a group of scientists created the first artificial neural network [23], which consisted of combined biological and surgical representations generated by McCulloch Pitts as well as other scientists. NNs have also been utilized in various areas of engineering, such as robotics, digital signal, transport, automotive and medical, etc.

Neural networks have several benefits for learning capabilities, and implementation fields like pattern analysis, data, and graphics analysis, as well as in smart management of difficult and non-linear devices like robotics in particular. The architecture of robot controllers receives a lot of attention; neural network is indeed an innovative means of controlling robot motion [76]. Flexible manipulators control utilizing neural networks resolves the problems and difficulty of these robotics because of structural flexibilities in joints resulting from the influence of a manipulator's endpoint [77, 78].

Controller training could be performed without any of the device specifications being known. The difficulties in this form of the manipulator are due to non-linearity, coupling effects, non-minimum characteristics and the differences of parameters, Control methods that neglect these uncertainties, and non-linearization. Normally, an appropriate closed-loop output is not passable. The powerful learning capacities of NN allow a high degree of precise input/output representation to approximation of any permanent function. [66]. These teaching skills enable NN to build controls without using accurate mathematical [79]. (NN) has proved effective to recognized, analyzing, measuring, and controlling a variety of trend issues.

The neural network's fundamental structure consists of three main neuron units: input units, hidden units as well as outcome units as seen in (Figure 6). For feed-forward networks, the signal stream is just from the (input to output) systems in the feed-forward path. Accordingly, information processing could also stretch on many units of modules, however, there are no feedback relations.

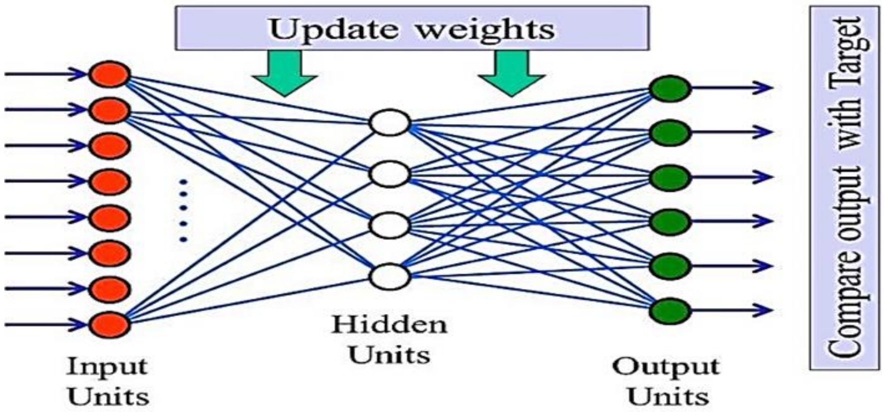


Figure 6. A typical neural network.

Every unit shall be related to weights (produced randomly). The data are being fed forward for every income neuron for all other hidden neurons by means of certain weights. Therefore, the data operations are used for every hidden neuron with the transfer function (linear or sigmoid). All the produced values must then be summed for every hidden neuron and data must then be transmitted by linking weights to the outcome neuron. The data should then be processed again through the outcome neuron transfer function method to obtain final values. Biases are taken into account; Bias is used to remove the dominant strategies only at hidden units or even the outcome unit. The entire feeding cycle from income to outcome is called feed-forward.

The last value was found in the outcome units as compared to the objective value. It then determines the differential in errors between both the observed as well as the expected value. A back-propagation mechanism could be utilized to (backpropagate) errors until a minimal error among both observed as well as expected values have been configured. Throughout the case of backpropagation Partial derivatives are determined in terms of related weights. The updated weights of the chain rule [80] have been utilized. The updating continues till the stop conditions have been met (a Thousand instances are achieved or the lowest error discrepancy). Numerous strategies for learning, such as the Scaled Conjugate, Levenberg Marquardt as well as other strategies, etc. learning rate speeds up a training procedure and moves the approach towards concurrence. The neural network goal is to minimize (MSE, and RMSE) errors.

The authors studied the use of neuronal networks to regulate adaptive manipulator drive functions. A modular relation manipulator was implemented with an adaptive outcome-feed-back system approach depending on an artificial neural network. In that analysis, the neural network input data were taken into account by the income–outcome signal delays and the neural network had been built to estimate the associated system uncertainty [81]. Abe. A [82] produced a new route mapping system in a point-to-point movement for a flexible Cartesian-robot manipulator. To produce an accurate computational model, He used the recognition method to find the variables of the dynamic motion formula. After this, the ideal base location was created by a neural network. Ultimately, the learning algorithm was utilized to cultivate the particle swarm by choosing the sum of the manipulator displacements as a topical function. He then proved that perhaps the manipulator's latent vibrations could be removed by reducing the manipulator's movement.

Janglova [83] has implemented the framework of NN in a partly unknown area of wheeled robot navigation. They utilized dual NN-based systems of collision-free trajectories. A first neural system uses sensory data to locate the space available, the next NN discovers a secure route by avoiding the closest obstacle. Qiao et al. [84] proposed an automated research technique for avoiding human direction during navigation operations. Depending on the nature of the situation and the function for the work, in order to execute a navigation function, the NN manages the addition and removal of new hidden layers throughout learning without any human input. NN has been applied by in Li et al. [85] for Fast-simultaneous Localization, mapping (fast SLAM). To prevent the aggregation of errors caused by incorrect odometry with a nonlinear SLAM feature. Using the NN with Quick SLAM improves the way the robotic navigates without collisions. (Figure 7) shows the DLR cognition dataset as well as the Performance of NN.

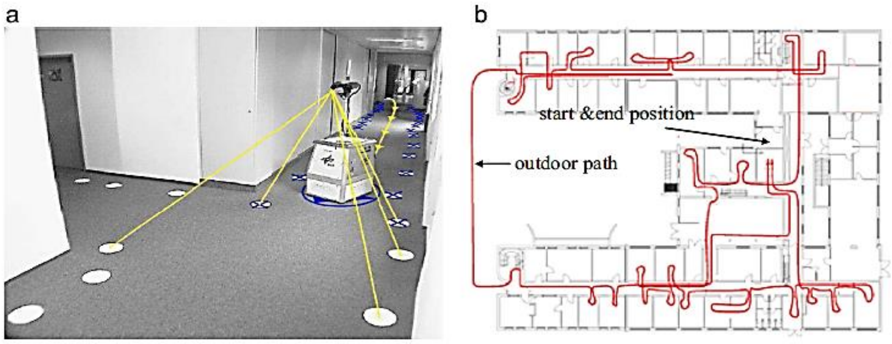


Figure 7. (a) DLR robot with a visual system, (b) Robot path of the DLR cognition [85].

This studied present that the neural networks, including feed-forward and feedback amplification, have a greater effect on the applications to human issues and it has good performance [86]. Consequently, feedback and feedback propagation ANN approaches are designed for a study focused on criteria including precision, data processing, Velocity, latency, distance, usability, and convergence. Moreover, NN has a less restricted approach, flexible to perturbation, and is capable of interpolating behaviors [87].

This article demonstrates an implementation of Artificial Neural Networks (ANN), which analyzes enormous amounts of time series data gathered by sensors on a virtual robot. The neural network method utilizes a learning algorithm for back-propagation to identify various situations that the robot experiences utilizing sensors-collected data. A network of two units of forward-back-propagation feeding was developed, trained, and effectively assessed. The experimental results indicate that time-series identification utilizing neural networks achieves successful performance. They reached a 100 percent accuracy rate, for a limited data set which is 900-time series analysis sets obtained from 15 various simulations [88].

This study deals with the development of an intelligent robot system. The algorithm was suggested to train the artificial neural network. The route provides excellent movement from the robot's current location to the specified location taking into consideration the direction. There are two neural networks in the control system suggested. The first one is for the location as well as the size of an impediment to be specified, and the second one is for trajectory continual to arrive for the tithe system is trained depending on the information collected by modeling the motion equations of a wheels-driven robot that guarantee its movement throughout the Euler elastic trajectory. The outcomes of the experimental methods demonstrate that the designed control algorithm is successful in moving the robot to the specific location and orientation by the suggested control system [89].

During this research, the principle of a neural network system which is utilized to identify and control the robot arms through 2-links is generated by two secondary formulas that alternate simultaneously during its running. The neural network was trained to understand the complex behavior of robot arms. The outcomes of simulations on a model-based basis of a neural network for the identity and regulation of the robot's arm movement provide many close outcomes [90].

The study shows by S. Petersburg [91]. Tracked robot by using neural network system. The control embraces a black-line follow an algorithm that utilizes 2-infrared reflecting detectors for the detection of black lines. With the objective of learning the neural network, the findings of a robot with such a fuzzy controller have been utilized. A tracked robot system that relies on Robo-PICA information was created to manage the neural system; after that recently developed controller was compared with such a proposed integrated fuzzy system. Two systems have been designed by (Matlab /Simulink) in Real-Time as presented in (Figure 8). The minimum number of member functions as well as the least necessary number of neurons in every unit was calculated in accordance with the fuzzy and neural network systems. Based on the progress of outcomes, the neural network is preferable than the fuzzy system in the velocity and precision.

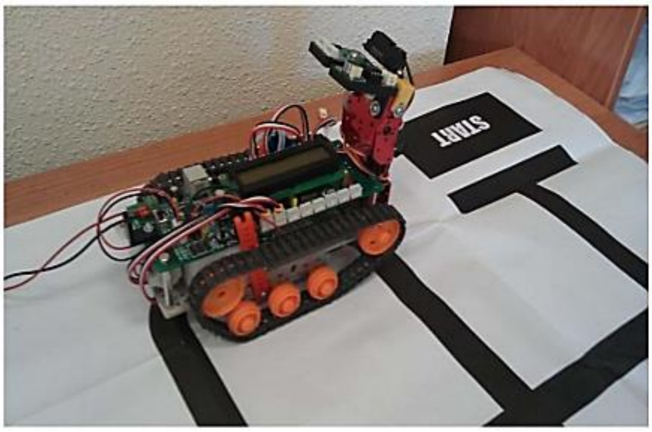


Figure 8. The tracked robot real time [91]

The operation of NN with sonar to move robot navigating was submitted by Pal [92]. This article has been implemented in real-time by utilizing ultrasonic sensors [93]. Syed et al. [94] have adjusted the NN specific to enable GAPCNN to achieve rapid convergence of portable automaton-moving variables in such a static and dynamic system to enhance NN performances as seen in (Figure 9). In reference [95] are presenting an NN-based self-learning method for the robots in (Figure 10). The modeling approach is utilized as a robot navigation tool in an unidentified NN environment and has been proved by [96].

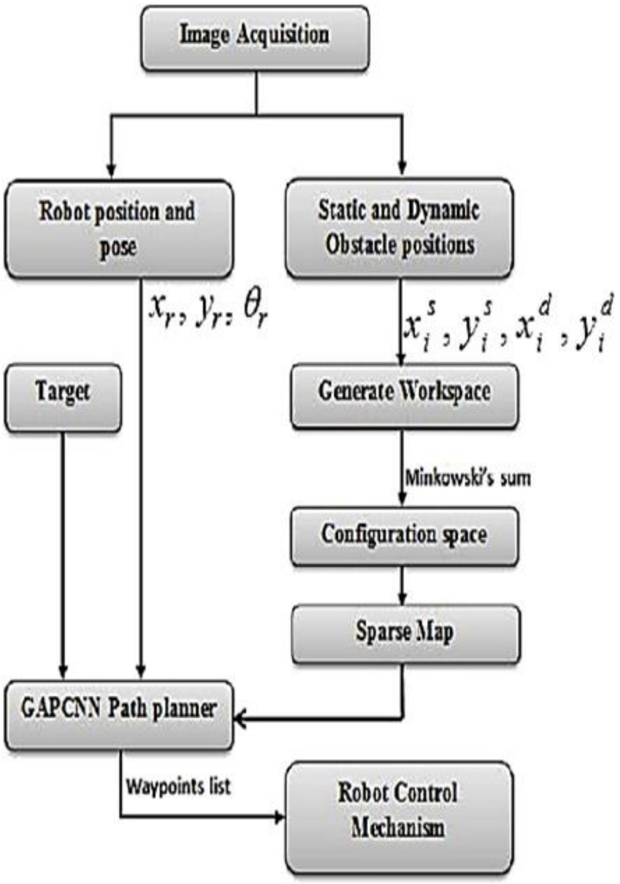


Figure 9. Overview of the complete system [94]

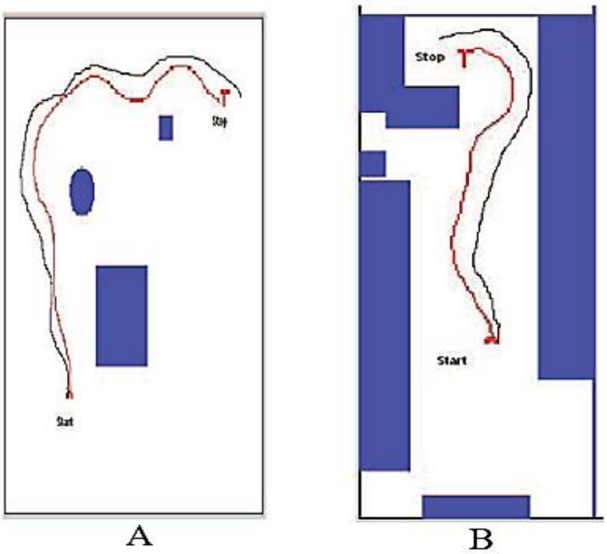


Figure 10. (A) Robot's path for complex configuration (B) Robot's path avoiding obstacles in real laboratory [95]

NN is utilized in a two-dimensional environment in the trajectory tracking of a humanoid robot [97] as well as the industrial robot [98], underwater-robot and military robots [99, 100], in a three-dimensional environment. Hence the NN was used by Bishop [101] to model a nonlinear function of inputs from different sensors to optimal performance. Avci et al. [102] proposed another NN technique for an intelligent device from the high-resolution echo signal of the target range. Abe A [103] presented a new approach for trajectory design in the point-to-point movement for versatile Cartesian robotic manipulators. The optimal foundation location is generated by an artificial neural network. The results revealed that the manipulator's remaining vibrations could be minimized by reducing the manipulator displaced. Through evaluating simulated and experimental outcomes, the efficiency and validation of the constructs approach are shown in (Figure11).

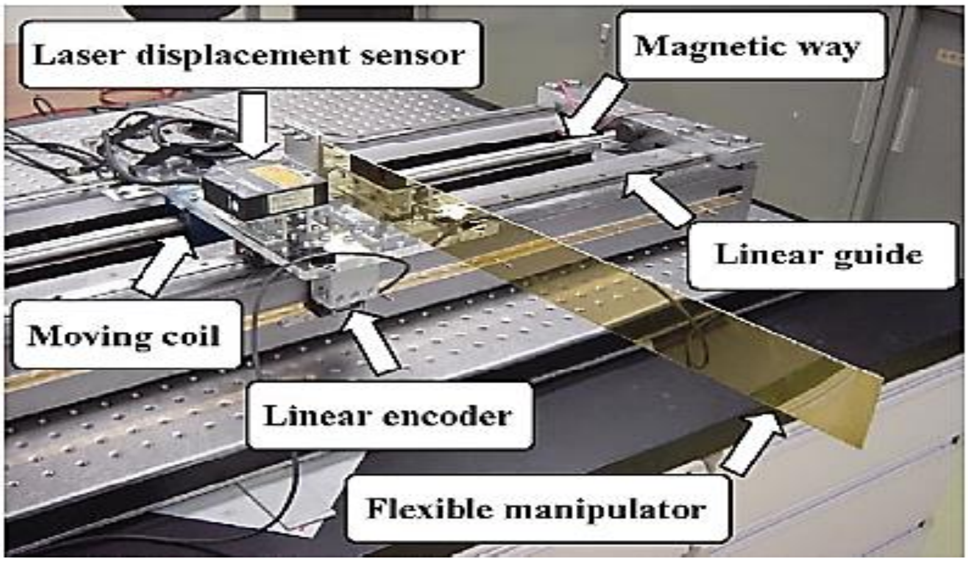


Figure 11. Shows the experimental setup [103].

The biggest downside has been the intensive training time required, exercise costs could be very high, as well as the large proportion of neural network points [104]. the monitoring function of the robot in this research is provided by the neural network control system. The illustration simulation outcomes prove that while using the neural network approach alone the detection result is not strong [105].

2.3. Genetic Algorithms (GA)

A genetic algorithm (GA) is a computer system that imitates biological as a heuristic search strategy algorithm that functions on the natural selection (Darwin) as well as genetic modification (Mendel) features which is discovered by Bremermann [67] in 1958. Then John Holland suggest the fundamental basis of GAs in 1975 [106, 107]. Darwin has reported that perhaps the stronger people are most probable to be the winner in a competitive environment [108]. GA mixes the fitting artificial survival with a naturally abstracted genetic algorithm to form an amazingly effective search method developed for a range of search issues. Every string is assessed for assigning the fitness value (having checked objectives and constraint conditions). Every string is assessed for assigning the fitness value (having checked objectives and constraint conditions). Then, the situation of termination in the algorithm is validated. If either the revocation requirement was not satisfied, the (convergence, reproduction, as well as mutation functions) of the organism must be performed. The three tasks are performed to build a new community.

The iterative process continues throughout the population to its last generation or the intended outcome has been achieved. The population-based and the global search strategies are genetic algorithms. In general, GAs do not really need details on analytic gradients; however, with changes, these data can be used if available. Genetic learning systems depend on the structural reforms generated by an algorithm covering various levels of complexity [109], from parameters enhancement (easiest case) to rule-based learning (highest complexity) [110].

This kind of technique of artificial intelligence was commonly utilized when designing different controllers offline. GAs are commonly used as feature optimizers and have been used in several issues with automation. Genetic algorithms in several issues have been shown to be capable of discovering the best sustainable solution. GAs function with several different kinds of optimal solutions instead of just one – or partial solution – solution and therefore vary from some of the conventional searching algorithms [28]. The findings of genetic algorithms are thus preferable to conventional algorithms

Genetic algorithms work in a basic cycle of Processes as shown in (Figure 12). Every process creates a new generation with potential answers to either a specific issue. During the initial process, the specific community (population of parents), Definition with possible members of the answer is generated for implementation of the quest process. Then, it selected couples of parents to keep continue the operation. The operation for cross-over and mutations is invited to obtain children. This same operation is renewed by selecting the kids in becoming new parents till the development is halted. This strategy is changed to suit the issue's current requirements.

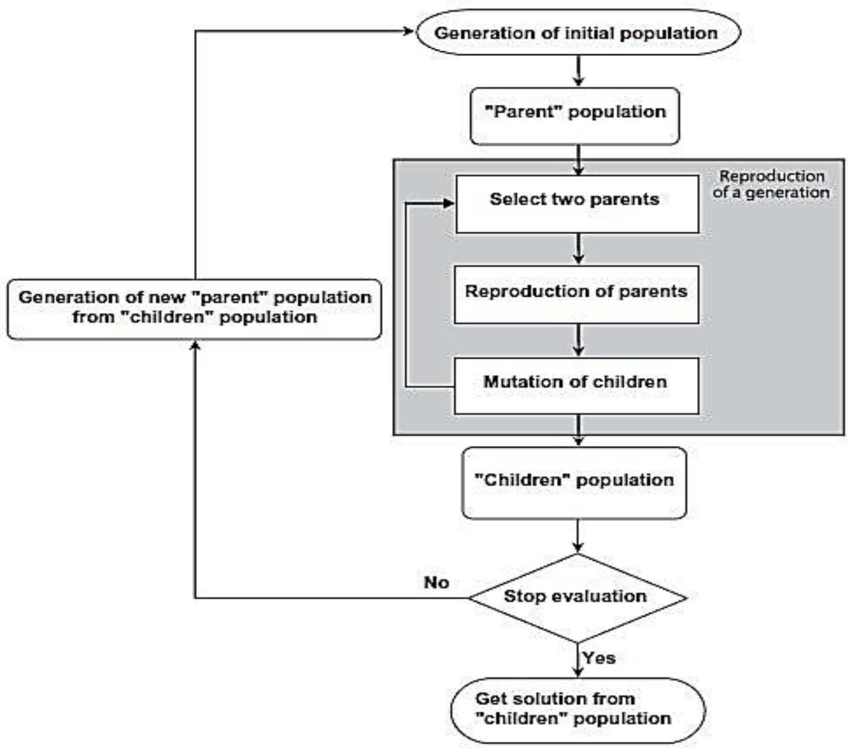
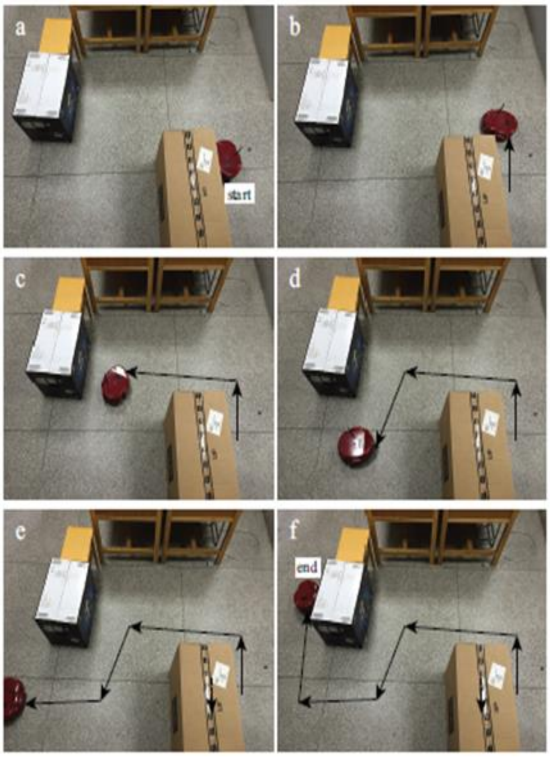


Figure 12. Shows the flowchart for Genetic Algorithms.

GA is a powerful search technique that needs a little environmental knowledge about effective scanning. Xiao et al. [111] are using this approach in order to achieve navigating goals like trajectory length, as well as avoiding obstructions. The path-planning techniques for multi-mobile robots in complex places were approached by the use of GA [112, 113]. In this research, they established a time-efficient coordinate technique to prevent collisions in a static environment of many robotics. Related to multiple-robot navigation, a multi-targets technique for a static environment is proven. [114]. A multi-mobile robot framework navigation in a dynamic situation is resolved by [115]. The researcher Proposed an updated GA path planner via the application of a robotic navigating co-evaluation system for the population [116]. By adjusting the GA, enhanced results were obtained for the avoidance of obstacles as well as optimal trajectories for multiple robot systems. In order to optimize trajectories, Jianjun et al. [117] present a different adjusted model of GA. in their process, the length of the chromosomes is changed to achieve the optimal outcome (Figure 13).

```
//////// Pseudo code of the proposed algorithm ////////
Initialization ( );
%Initialize the parameters and the population;
Do {
    Cal_fitness ( );
    %Calculate the fitness for feasible and infeasible paths.
    % Perform the conventional genetic operators;
    Selection ( );
    Crossover ( );
    Mutation ( );
    %Perform the new added operators;
    Simpification ( );
    Revision ( );
    Substitution ( );
} while stopping condition is reached;
Return the best individual .
```

(A)



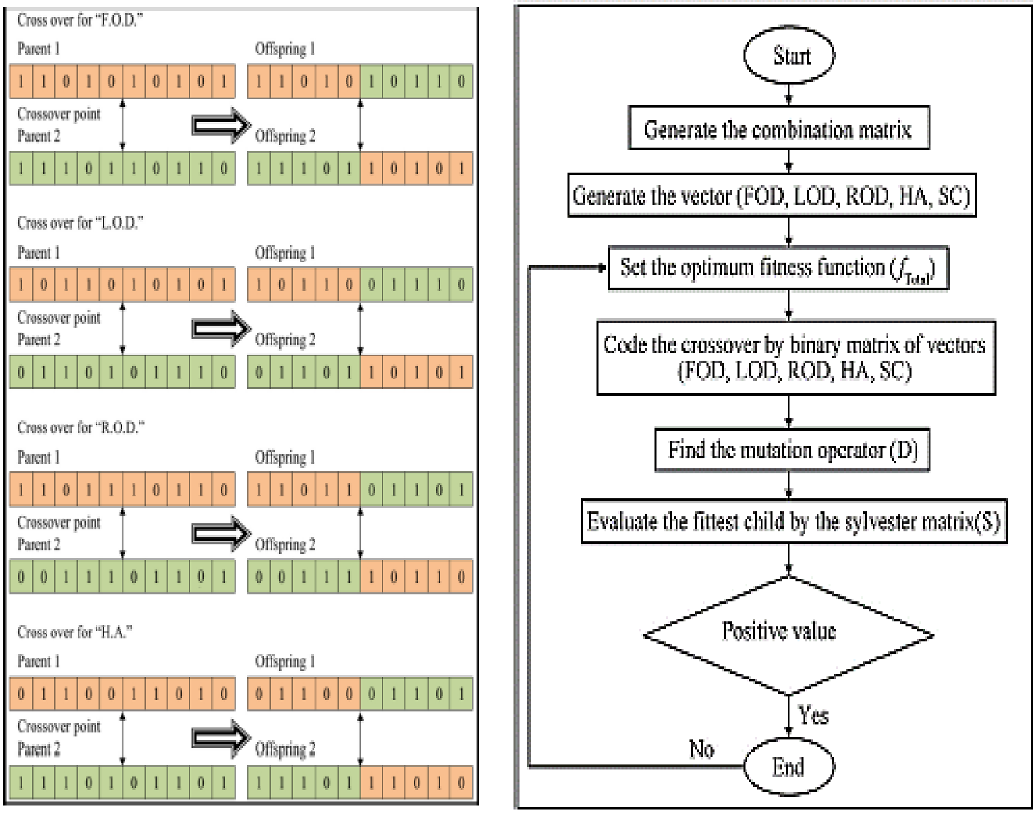
(B)

Figure 13. (A) the pseudo-code of the proposed algorithm. (B)The experimental robot path planning in a static environment [117].

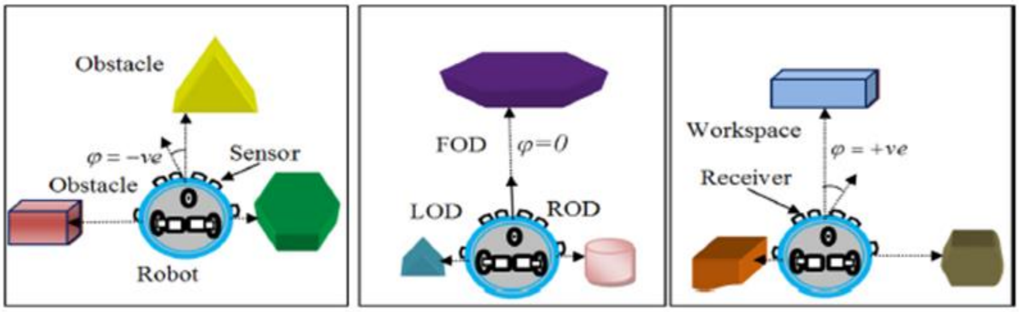
The genetic algorithm optimization method was employed by Ge et al. [118] to discover the optimal benefit of a versatile control manipulator. They had looked in the studies at the system's fixed tip load and produced a number of improvements that utilize the genetic algorithm for its design. They suggested genetic modification of a Lyapunov-based controller in which the Lyapunov structure guaranteed reliability, and genetic algorithm adjustment improved the controller efficiency. Jain et al. [119] implemented a robust flexible manipulator neural network system trained with genetic learning. The genetic algorithms used by Cui and Xiao [120], evaluate the optimal type of weight-constraints single-line flexible robotic arms.

The genetic algorithms utilized by Nguyen and Morris [121] enhance the efficiency of a fuzzy control system to manipulate a robot's relation and joint flexibility. In addition, they conducted computational measurements and tests to make a substantial reduction in the residual vibration. [122] A PD-type closed-loop logic controller for the manipulator was built in this research. A genetic algorithm is had been utilized with creative tuning methods, to maximize the control parameters collected.

The study shown by Patle et al. [123] presented a matrix of a binary code dependent on GA (MGA) for a (single-multi) robot system in a complicated environment. The robot could even readily track the moveable obstacle as well as moving objects, in a short amount of time to achieve a target (Figure 14). C. Lamini, S. Benhlima, [124]. The GA is used quite in this research project to find a clear and viable route for the path optimization process. Among both two locations while preventing obstacles and improving certain requirements like distance (path longitudinal), security (path should be as far off from barriers as probable), etc. A new suitability feature is also proposed, taking into consideration distance, protection, and energy. It is used for many different environments to the veracity the feasibility of the suggested technique. The simulated outcome shows that GA with enhanced crossovers as well as fitness is an aid in finding optimum settling. A GAs fitness feature is used to optimize the robot's energy consumption, by reducing the number of turns to reach its target. In addition to solving the path planning issues, it has been applied to several of environments with various sizes and compared to current GA methods. The outcome evinces that the GA method that has been used here detects the optimal path.



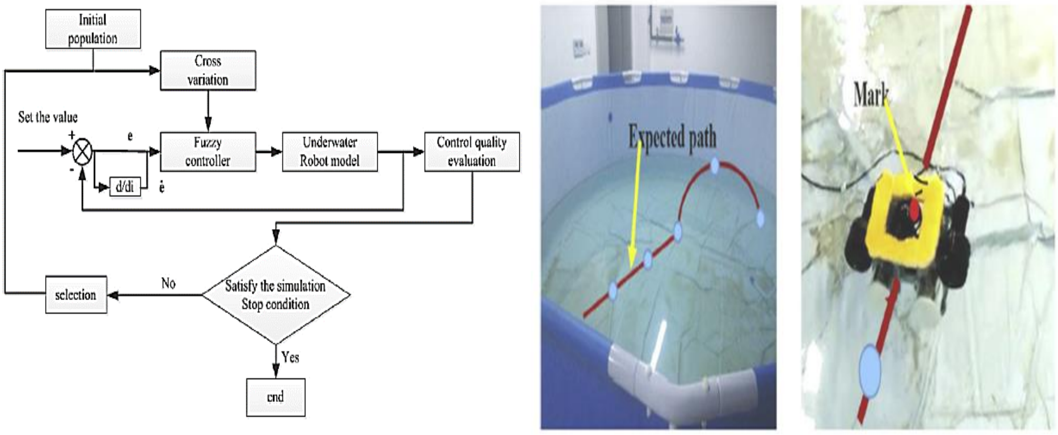
(1) Flow chart (2) Crossover mechanism



(3) Output in terms of heading angle

Figure 14. MGA (1) Flow chart (2) Crossover mechanism (3) Output in terms of heading angle [123]

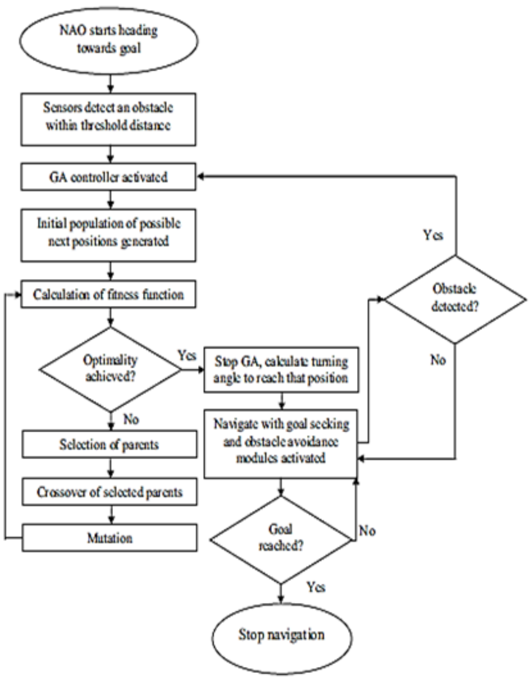
This article presents an improved control structure instead for collaborative robotics consisting of two manipulators capable of collecting as well as manipulating objects with defined geometry. Centered on the passive decomposition method, the dynamic of the co-operative is decomposed in into form as well as locked frameworks, taking into account the complexity of robot dynamics. Two higher-order-sliding-mode controller has been designed for this as well as are optimized for an optimization issue with genetic algorithms. Finally, the comparative simulation findings show, that the suggested control system operation well, as assumed. Fits better than the traditional sliding feature controls [125]. That GA technique is environmentally responds (known and unknown), Therefore the under-water robot [126] (Figure. 15). As well as aerial-robot [127, 128] have been implemented as a 3-D path planning issue, then humanoid-robot 2-D path planning [129]. .To tackle the moving objective issue. (Figure 16) shows the flowchart as well as shows the pseudo code.



(A) (B)

Figure 15. (A) Flow chart of the simulation (B) The path tracking control experiment [126]

This article discusses the collaborative robot's neural network control scheme depends on genetic algorithms. The robot is the basis of the study in this article. The objective of Aiming at its high coupling, the issue of robotic movement control proposed neural network is thoroughly focused with a view to its powerful conjunction, non-linear and multi-variable features. The base genetic algorithm as well as the enhanced genetic algorithm, known as messy, thus improve the neural network model, so that the robot's movement management issue can be clearly represented. Findings from this study indicate: not only was the tracking influence stronger, however, but the number of hidden network layer nodes also decreased by 5 layers from 12 to 7 during enhancement using a messy genetic algorithm [105].



The NAO starts navigating with its initial direction towards the goal position
When the sensors detect an obstacle in its way:
GA controller is activated
    Initial population of next positions generated according to the given rule base
    Fitness values of all the solutions are calculated
    Optimality is checked with the current fitness values
    If (Optimality is achieved)
        GA is stopped and turning angle for the next position is calculated
        NAO navigates with the three reactive behavior modules activated
        If (Goal is reached)
            Stop navigation
        Else if (Obstacle detected)
            Activate the GA controller to find the next best position
        Else
            Keep navigating till an obstacle or goal is reached
    Else
        Select parents according their fitness bias
        Perform crossover and mutation to produce next generation
        Go back to the fitness value generation step and loop till optimality is achieved

(A) (B)

Figure 16. Shows the Flowchart of the working of GA controller. (B) Pseudo code for the suggested GA controller [129].

3. CONCLUSION

This comprehensive review on intelligent control systems with robots in the old style and new strategies provided us with several points of focus as a key to this investigation as follows: Interactive methodologies work much better and more accurately than traditional techniques because they have the ability to achieve high performance in managing vulnerabilities in the ground, Intuitive techniques are most preferred to be used progressively to solve robot path problems. Much exploration work is not distributed depending on a strong field contrast to a steady state. In unique circumstances, there are fewer activities associated with the robot riding a moving target issue contrasting with a motion impediment problem. To date, most works only depict an examination of reproduction; Screenshot in continuous application takes much less. Road-related business in many wise robot systems does not contrast much with versatile robot systems. There are fewer chips on half-breed accounts than on independent accounts.

This is essential for the robot elite, to reduce the cost of the robot, and to automate new applications. With more sensors and higher robot security, intuitive robot programming and modification may be critical for the manufacture of small-scale items. These developments require specialists and component designers to have a deep understanding of application issues, which can usually be obtained if the real problems are concentrated in the assembly situation. Robot control is an innovation that will also greatly influence future robotic elements and mechanization frameworks if it is created with full information on new applications, industry divisions, mechanical autonomy elements, mechanical autonomy research, enabling innovation and programmed control.

The most important characteristic of smart robots is their high adaptability to solve problems presented in various industrial or medical applications or astronomy applications that depend very much on accuracy in carrying out works that reach nanometers in physical quantities, so we recommend through this review on Adopting artificial intelligence technology and increasing work on it in the field of robotics and its applications, because it will thus return to achieving many opportunities for progress and development in daily life applications.

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BIOGRAPHY OF AUTHORS

Ahmed Khudhair Abbas received his bachelor's degree in the Department of Electrical Power Techniques Engineering from the Al-Mamon University College in Baghdad, (2012). Where he also obtained his Master of Science (M.Sc.) degree in 2015 in school of Electrical system engineering (Electrical Power Engineering) from University Malaysia Perlis (UniMAP) in Malaysia. In 2016, he became an assistant lecturer in Anbar University and in 2021 became a lecturer. He is presently working in a University Headquarter, Construction and Projects Department in Anbar University, Iraq. He works since 2016, a lecturer in the Department of Electrical Engineering / Engineering College / University of Anbar. He has many publishing that included, seven Journals paper most of them (Scopus, international journal and local journal), and three conferences paper

Prof. Dr. Yousif Ismail Mohammed Al Mashhadany is a lecturer in Electrical Engineering Department – College of Engineering (Control Engineering). Senior member IEEE, He received the B.Sc. (1995), M.Sc. (1999), and Ph.D (2010) in Department of Electrical and Electronic Engineering from the Rashid School of Engineering and Science / University of Technology in Baghdad/Iraq. He completes postdoctoral fellow research in electrical engineering - control department at the University of Malaya in Malaysia (UMPEDAC) in 2012. He works since 2004, a lecturer in the Department of Electrical Engineering / Engineering College / University of Anbar. He has 9 in H-index with Scopus, 14 H-index with Google scholar, and 5 H-index in Publons with 204 reviews. Chief-in-Editor of Anbar Journal of Engineering Science.

Mustafa Jameel Hameed received his bachelor's degree in the Department of Electrical Power Techniques Engineering from the Al-Furat Al-Awsat Technical University Iraq, (2011). Where he also obtained his Master of Science (M.Sc.) degree in 2015 in school of Electrical system engineering (Electrical Power Engineering) from the South State Technical University in Russia. He works since 2016, a lecturer in the Department of Electrical and Electronic Engineering / Engineering College / University of Thi-Qar. He has many publishing that included, five Journals paper most of them (Scopus, international journal and local journal), and one conferences paper.

Prof Dr **Sameer Algburi** was born in Kirkuk in 1959 PhD in electrical engineering Visiting professor at the Center for Middle Eastern Studies, Lund University, Sweden Founder and President of the Swedish Iraqi Studies Network, and Vice President of the International Friendship Organization in the Kingdom of Sweden Founder and Chairman of the Board of Trustees of the Knowledge Enrichment Academy in the International Friendship Organization Professor at Al Kitab University.