

# A Study on the Usage of Robot Navigation to Determine Robot's Own Position in its Frame of Reference and then to Plan a Path towards Some Goal Location

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## Abstract

In this study, the issues and opportunities can be achieved with the help of a robotic navigation system. The determination of a robotic navigational system is able to ensure the proper development of different understandings which are achieved with the help of different problems as these can solve different issues. Navigational robots are used in different fields and provide great growth in these fields which are effective and promotional developments are understood. Drones are used for different navigational improvements such as mapping which provide accuracy in the system as these are beneficial for gaining growth in goal achievement through different AI-based software systems. Secondary qualitative research is done for the completion of the research which is able to provide proper knowledge in this research in the field of robot navigation. Nowadays navigation can be easily accessible with the help of GPS systems as people are able to get the location of any place from anywhere on the internet. These facilities are ensuring proper development in the business process of companies as different businesses achieve their profitability with the help of a robotic navigational system that has gained progressive development in the research. The understanding of the robot's own location is able to develop the quality of the robot's ability which are helping to ensure planning toward the goal location. Real-time navigation is creating different ways for aiming towards navigational path planning which are helping to achieve material handling, patrolling, disaster relief, and rescue operations.

## Keywords

Artificial potential field, autonomous navigation, Dijkstra, extended Kalman filter, Global Navigation Satellite System, Global Positioning System, hybridization techniques, LIDAR, local navigation system, near fields communication, Robotic navigation, Vector field histograms.

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## INTRODUCTION

Navigation is a process of directing any craft through science and technologies to evaluate the total distance of travel. The term navigation can effectively find out its desired location without any collision or issues. Individuals who travel by water and air, mainly prefer to use Navigation technology to record their own location. In this way, hazards within the travel can be encountered by observing direction and distance. In order to avoid any type of dangerous situation during travel, navigation systems have been utilising Robots in their system. Digitalization and technological advancement have upgraded the working ability of Robots which can further determine the position and goal location. The framework for the robot navigation model can reshape the metric map to describe the location. In recent years, labour burden can be considered highly expensive, therefore it is required to lower the expenses after utilisation of technologies.

Robots or machines can think and perform just like human beings and they have abilities more than humans. The study will further shed light on the planning of paths after utilising robots in the navigation system. Apart from that, path planning is not an easy task for planners, and the study will further highlight those obstacles faced by path planners.

Therefore, testing should be conducted after considering different types of robots such as "air vehicles", "motion robots", "wall climbing" and underwater robots. In the pathfinding system, Robots are required to move from the initial position to the goal location. In the initial phase, multiple scientists have paid attention to the 2D path planning technologies, however, in the later phase those scientists have shown interest in path planning with the help of mobile robots in 2D environments. In the era of technology and robotics mobile navigation is one of the identical issues, that needs to be addressed as soon as possible. For decades, most scientists have been working on solving ideas of path planning to determine a collision-free path to travel from one location to another. The knowledge regarding robotic navigation can further include some offline and online algorithms. During the formation of these robots, some sensors have been attached separately. Therefore, those robots can generate mapping with the help of those previously attached sensors.

## LITERATURE REVIEW

### Types of Robot Navigation method

The study is mainly focusing on different techniques and roots for the robot navigation system. One of the fundamental purposes of this study is to conduct the navigation process

within a cluttered environment. The hybridization techniques of nondeterministic and deterministic algorithms can be taken as a revolutionary step for solving path related issues in the Navigation system [1]. In that case, navigation can be further divided into two parts such as local navigation and global navigation.

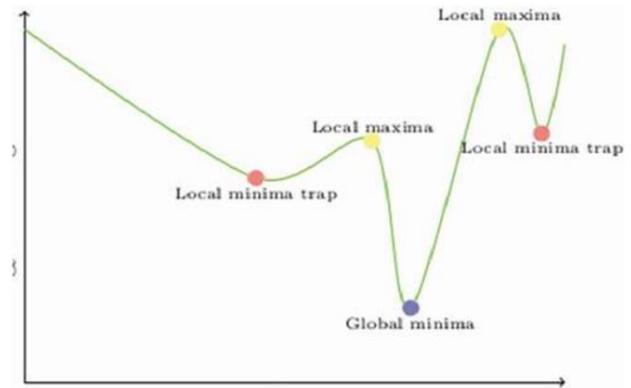
Local navigation is developed with the help of GPS (Global Positioning System) and gained proper growth in understanding the issues of navigations [7]. This is beneficial for understanding the overall development by knowing the issues of navigations created in different navigational systems and achieving proper growth with the help of robotic navigation by knowing the position of robots.



**Figure 1: GPS system**  
(Source: 7)

Global Navigation Satellite System (GNSS) is referred to as a constellation of satellites providing signals from space which are transmitting positioning and different timing data to GNSS receivers [10]. GNSS provides global coverage by determining locations which are beneficial for gaining an effective communicational system. GPS is the most accurate & dependable form of navigation available and it can replace almost every other form of navigation. A GPS acts as both a transmitter and receiver by using geostationary satellites hundreds of miles above the Earth's surface.

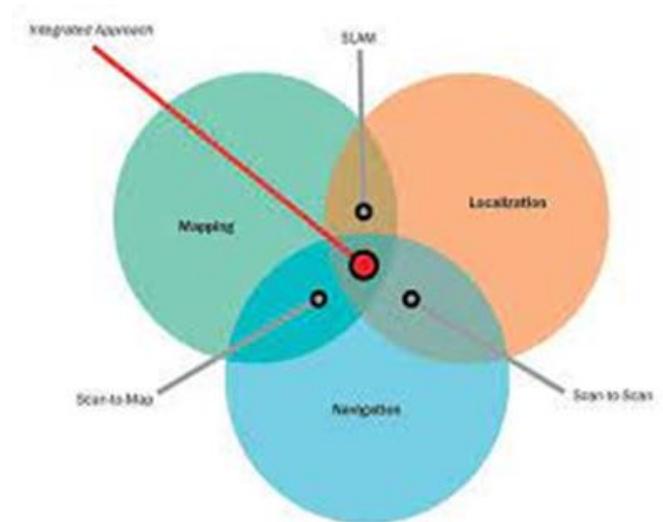
**APF:** One of the innovative navigation technologies is APF and it mainly stands for “Artificial potential field”. The main concept of APF is to attract robot technologies with artificial potential fields after utilising a specific type of force. As a result, robots are generally attracted toward the goals. There are mainly two types of potential forces that can be observed such as “repulsive force” and “attractive force” [2]. In the field of APF robots generally travel from low-potential areas to high-potential areas. In this context, the creation of an attractive field occurs just for reaching the goal location. Therefore, the utilisation of the potential fields can calculate the position of robots.



**Figure 2: APF navigation process**  
(Source: 2)

### Dijkstra

It is mainly related to searching for a graph for evaluating a path for robots to reach their goals. The search process with the help of graphs can be considered as one of the simplest methods which consumes less time [6]. The particular path is highly efficient as it can solve complicated issues regarding computation methods. The connection between robots and paths can be established through nodes. The algorithm of Dijkstra can be denoted as a searching process for graphs in case of problem-solving in the navigation process. The technology can be used in finding a path for a single destination or location.



**Figure 3: Robot Navigation**  
(Source: 6)

**LIDAR:** In the case of the establishment of a local navigation system, LIDAR can be used as a sensor to impose control over those Robots. LIDAR software has the capability to work independently and it is more effective in navigation rather than GPS. Apart from that, the modern method also compiled a camera and inertial navigation system with LIDAR to enhance its capabilities in mapping [3]. For instance, attaching a camera with LIDAR, may provide a better position opportunity. This kind of technology

can be further used for mapping within a local landmark. On the other hand, Vector field histograms can be considered as another specific type of tool that can act mainly based on VFF.

### **Concept of Navigation Technique**

The study is further going to discuss the importance of mobile robot automation techniques for navigation. The automation in robotics can be recognized by the board's cameras which are located on the forward and backward portions of the robot. There are mainly two methods that can be found in AGV which can be further calculated based on the capacity of carrying load such as "single load unit" and "multiple load units" [4]. These vehicles are responsible for traveling from the initial part to the targeted destinations. In the case of AGV, the guidance can be used for the determination of the dynamic path. This kind of guidance can include some systems inside the vehicles such as magnetic tapes, wires, RFID, and radio frequency. There, the static path system also incorporates "bidirectional" and "unidirectional" categories [5]. However, a unidirectional system can be considered as one of the beneficial approaches as it can help vehicles to move in any direction. Sometimes, vehicles can behave as an autonomous functional system in the case of a dynamic path system. Avoiding different dangerous situations like collisions and unsafe conditions like temperature, exposure to weather, and radiation can be gained with the help of a robotic navigational system. Complex equations for both environmental mapping and hard computation are achieved with robotic navigational systems which are able to ensure better growth in society as a robotic navigational system is beneficial for providing a large area under the range of accurate navigation. They are the mobile robotic system, the manipulation robotic system, and the data acquisition and control robotic system are the robotic systems which are creating different effects in navigation. Mobile robotic navigation is helping to provide a difference by creating industry, transportation, and rescue robots which is able to determine to solve the path.

An autonomous robot has various applications such as transportation, defense, space, industry, and defense. In this context, robots can also able to perform several kinds of tasks such as disaster relief, material handling, rescue operation, patrolling, and other kinds of work. Accordingly, the autonomous robot can easily able free travel in a dynamic and static environment. Safe and smooth navigation helps to a cluttered environment from the beginning position to the goal position by following the path. On the other hand, it has the capability to create the path as well. In robot navigation techniques path planning plays an essential role to communicate and reach the aim as well [16]. The robotic navigation process is divided into two types such as local and global navigation. The global navigation process is based on the knowledge environment and this is also called path planning in offline mode. The local navigation process is known as an online mode based on orientation and position. It has the capability to control motion by using several kinds of

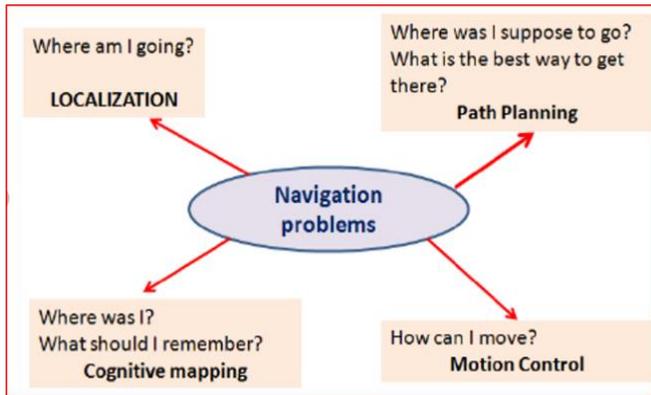
sensors. In this context, ultrasonic sensor, infrared sensor, vision sensor, and laser plays a major role in the autocorrection process. This process also includes various kinds of software and other technical processes.

### **Improvement in Robotic navigation**

Autonomous navigation has a particular waypoint that can traditionally be accomplished with a stack layer of the planning of the layer path of global planning. In that can, the local motion planning module can able to generate obstacle-free and feasible trajectories. In that case, the modules can able to modified meet the specific task constraints and that is based on the user preference as well. In that case, the current procedure of modification requires substantial efforts in expert robotics with an outstanding deal. In this context, the global planning and machine learning module have a major connection with the updated system. In order to improve the robot navigation system, scientists need to do thorough research on this topic [17]. From various research, it has been seen that nowadays there are several kinds of updated sensor that can improve the process of navigation and also helps to detect issues. In the modern era, scientists are using various kinds of cameras, and a chip that helps to develop the working process of robots. Robotic navigation helps to provide better opportunities to business organizations and also governments as well. This process also helps in the rescue process and monitoring process. In the modern era, private business organizations, and other sophisticated government organizations use robotics automation processes and also help to provide better service. The GPS and other systems, help to provide information about the outcoming difficulties [18]. In one word it can be portrayed that this system can able to create a prediction of future circumstances.

### **Problems with robot navigation**

Robotic navigation sometimes can create major issues as it can automatically change the location and route of the destination for a person. These issues can be creating a bad impact on the communicational medium, logistical mediums, and others. The robotic navigational system can be controlled with the help of mobiles and is able to develop growth [8]. In the system, the navigational issues can create losses for the companies and also develop a different issue in the business growth. A hacked household robot can physically harm the people in the house which is developing some serious issues. The sensors of different robotic navigational systems can tamper which is not able to provide more data. The satellites are also not enabled to provide locations due to connectivity issues which are creating different problems in navigation.



**Figure 4:** Robot Navigational issues  
(Source: 7)

In autonomous navigation, generally there are eight kinds of major factors that can make an impact on robotics and its working process. Robot shape, mobility, agility, planning space, obstacles, localization, speed, and the number of agents are the major difficulties in the autonomous navigation process. On the other hand, localization, path planning, cognitive mapping, and motion controls play a significant role in the robot's navigation. In that case, it can be stated that localization is the method that is able to determine the actual location of the robot based on the environment as well. This is one of the basic fundamental competencies that is the primary requirement of robot navigation. Robot localization is one of the packages of fuse information of the sensors. Sometimes it uses (EKF) extended Kalman filter and UKF or unscented Kalman filter [18]. It can be disrupted sometimes by environmental hazards and issues.

Path planning is one of the essential processes of autonomous navigation and is involved with the determination of the way robots can move from the beginning location to the target location in a specific environment. Some path planning faces various kinds of issues due to coding generation, encryption, and technological difficulties. At that time robot navigation are not able to work properly and make an impact on the working process. On the other hand, it is also connected with the domains, autonomous driving, and other working sector.

In this context, it can be said that cognitive mapping is interrelated with the localization process and after detecting the error in localization, make the effects on the cognitive mapping. By using of NFC or near fields communication, LIFI, visible light communication, electric beacons, and Bluetooth can able to create issues and it can be also responsible for the hampered environment as well [19]. Accordingly, motion control is the technique and system that helps to move the parts in a systematic manner. In this context, the motion control process can be considered as a major issue. Basically, it includes some controllers, gearboxes, motor, and other kinds of sensors. Raising difficulties on those factors is able to make an impact on robotics navigation.

## METHODOLOGY

The entire research study completely follows the rule of methodology which consists of different parts such as research approach, research philosophy, research design, and much more. To complete the entire research on navigational robots' researchers are using the secondary qualitative method which is essential. The growth of research is easily achieved with different journals, articles, and books that are able to understand the development in the field [13]. On the other hand, significant parts of research are ensured with data collection and data analysis. This study has followed a specific design to get an accurate structure for gaining development about the issues of robotic navigation. The understanding of robotic navigation and its limitations are easily solved with the help of different objectives which are essential to produce a better opportunity in the field of robotic navigational systems. An inductive approach is chosen for the study and it has the capability to provide an accurate, and general conclusion for the study; it also makes an effective impact on the study. The gathering of proper real-world data is helping to ensure growth in the research process which is providing a solution to the major issue in the system. This study has selected this approach to provide the work's actual value. The understanding of GPS systems is developed with different growth in the research which is able to provide a better observation in research growth, helping to ensure properly observing the positions in the world. This also provided an opportunity in different new sectors which are gaining job creation and Precision Motion Control with the help of robotic navigational systems. A new environment provides a better opportunity and development as it can ensure growth and assurance for creating a positive development in the research process.

## DISCUSSION

Dead reckoning navigation, Celestial navigation, inertial navigation, and electronic navigation are the different navigational approaches which have gained visible growth in the field of navigation. Compass, GPS, radar, and sextant are helping to develop basic navigational growth in the world [12]. These navigational systems have become accurate and provide specific growth in the world. Appraisal, Planning, Execution, and Monitoring are helping to provide essential growth in the navigational system. Magnetic Compasses were used by humans before the development of robotic navigational processes, these are helping to produce a growth. The navigational growth is able to achieve proper development in the process of finding the proper locations with the help of different navigational equipment. GPS navigation systems are used for storing different map information for determining the optimal route selection on the basis of the shortest path algorithm. CIMON is the first robot which is used for navigational purposes. The navigational robots are providing better growth in the research work and different developmental gains and a positive approach in the research promotions. The vast use of

AI is helping to ensure the proper understanding of different research developments which are essential for ensuring development in the process of understanding the issues such as navigational problems [11]. The drones are used for completing Navigation is necessary in ensuring the growth website is accessible and usable. Drones are able to ensure the better provision of navigational systems is gaining growth in the systems.

The drones are used for developing a proper navigation process which are helping to promote growth in the identification of different navigational growth in the system. Different mobile phone applications are nowadays used which, with the help of advanced AI are able to identify different locations accurately which are ensuring the proper growth in the system. Navigational issues can be easily solved by the mode of transportation which is providing a growth in the navigation, routes are easily solved with different navigational maps which ensure the map location. Real-time data are helping to solve the navigational problems which are essential for gaining a positive development in the navigational approach [15]. Distance is easily solved by the issues of different navigational problems that have gained proper understanding of distance. The direction is provided with navigational drones helping to achieve a proper understanding of different issues which are developed with the navigational robots. The duration between two places is estimated with the help of robotic navigational systems to easily identify the issues of any place any obstacles or other routes are also provided by the navigational robots which have successfully ensured the proper development process of understanding the routes in this process. Destination with the pre-installed software is easily achieved by the growth in the system which ensures proper achievement in the system using the AI-based navigational robot [9]. Dangers are identified easily with the help of different navigational drones which are helping to solve the issues of drones and also eliminate the obstacles that are helpful for achieving a proper development in the navigational issues. With the help of advanced navigational systems, the companies are able to ensure the growth in the business of logistics and delivery [14]. The proper navigations are useful tools for these businesses which have gained the ability to progress in a competitive business market that are also ensuring profitability of the market as companies are able to achieve growth in the market with a proper progress in the system. Mapping and proper surveillance are easily achieved with the help of mapping systems which are gained growth in the system as different issues such as any conflict maintenance, providing security and others are easily maintained with help of a robotic navigational system as it developed a benefit in the business.

The way planning is helping to ensure proper growth in systems as it is beneficial for finding a goal. The goals of navigational achievement are providing a benefit which are developed that are gained development in the research. Non-servo robots include manipulators, robotic appendages,

effectors that function as the arms and hands of the robot as proper benefits are automatically moving one place to another. Robot repeatability is the ability of the robot to position the tool-tip in the same place again and again that are developed in the system. Computational problem to find a sequence of valid configurations that moves the object from the source to destination in planning and navigation. Voronoi diagram (VD), Cell decomposition (CD), probability roadmap (PRM) and visibility graph (VG) are among the earliest, most established and most popular methods in path planning. Navigation Systems are helping to develop the robotic systems as these are ensuring the growth in the robot. Land navigation, marine navigation, aeronautical navigation, and space navigation are gained with the help of robotic navigational systems which are providing a better opportunity at the human level as it is beneficial for progressing growth.

### CONCLUSION

From this research it can be concluded that the entire robotic navigational system has provided different development and benefits in society. This navigational system is helpful for gaining a proper understanding of different issues which are creating some problems in the development of navigational issues in the world. The navigational problems are easily solved by determining the position of a ship, plane or any other vehicle, and helping to guide it into a proper destination. A secondary qualitative research approach is taken for completing the research work which is able to provide a visible growth in the research as different aspects of the robotic navigational system are gained with the help of different navigational robots that are gained a progressive achievement in the field of different sectors.

The navigational systems nowadays become a useful and essential material that are able to achieve a different growth in the process of daily life. The achievement is effective and provides proper knowledge that ensures the growth of the physical life of humans in modern times. The different navigational areas of the world and also space can be achieved with help of a robotic navigational system as it is majorly a progressive growth in the knowledge gaining and understanding of different issues and development surroundings. This study has shed light on the several kinds of robot navigation type and techniques. It has been observed that hybridization techniques of nondeterministic and deterministic algorithms can be taken as a revolutionary step for solving path related issues in the Navigation system. In robotic navigation system there are various kinds of system such as GPS system, APF navigation process, Dijkstra, LIDAR and many more. This article also has elaborated the concept of navigation techniques and basically there are two method such as AGV.

There, the static path system also incorporates "bidirectional" and "unidirectional" categories. Avoiding different dangerous situations like collisions and unsafe

conditions like temperature, exposure to weather, and radiation can be gained with the help of a robotic navigational system. autonomous robot has various applications such as transportation, defense, space, industry, and defense. This study has also highlight the improvements in the robotic navigation that is based on the path way planning. On the other hand, from this study, it has been know that there are various kinds of issues in robot navigation and it may hamper the environmental changes and some times it can catch the changes automatically. From the above analysis it can be stated that usage of robot navigation can make the effective impact on the modern world

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