International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 08 Issue 12 December 2025
DOI: 10.47191/ijcsrr/V8-i12-34, Impact Factor: 8.048
IJCSRR @ 2025
www.ijcsrr.org

MRW: Manasik Robotic Wheelchair for Tawaf and Sa'i in the Holy Mosque in Makkah in Saudi Arabia

Abdullah A Sheikh
Computer Science Department College of Computers and Information Technology, Taif University, Taif, Kingdom of Saudi Arabia

ABSTRACT: As the number of elderly and disabled visitors to Al Masjid Al Haram increases, an efficient and easy transportation solution becomes essential. However, existing methods have limitations, such as relying heavily on the visitor's driving skills, traditional wheelchairs needing human intervention and significant physical effort, and language barriers between all visitors. Therefore, a new and innovative transportation solution is needed to overcome these challenges. This project focuses on the need to innovate new solutions, develop and train driving skills, reduce physical effort, enable independent mobility, overcome language barriers, and ensure a stress-free transportation experience for visitors to the Holy Mosque. This project uses a line-following robot equipped with a color sensor and a distance sensor to navigate a predefined path. The color sensor enables the robot to follow a black line and uses red markers to count labs and navigating between Tawaf and Sa'i. The distance sensor allows the robot to stop automatically when an obstacle is detected within 10 cm and resume movement once the path is clear. A proportional control method is applied to ensure reliable line following. The robot begins its journey in the Mataf area to perform Tawaf, and upon completing seven laps, it transitions to the Masa' area to perform Sa'i. The system was tested in an environment simulating Al Masjid Al Haram pathways, focusing on navigation accuracy, obstacle detection. A functional prototype was successfully developed, demonstrating effective line-following and obstacle detection. The robot accurately followed the designated path, responded to red line markers, and detected obstacles, ensuring smooth and safe navigation. The system was tested in an environment simulating the pathways of Al Masjid Al Haram, showing high reliability in guiding the robot through the specified routes. The Manasik Robotic Wheelchair provides an innovative solution for mobility challenges in the Holy Mosque. It significantly improves accessibility and convenience for visitors, making religious journeys more inclusive and stress-free. Further refinements and real-world testing are recommended to enhance its effectiveness and ensure widespread implementation.

KEYWORDS: Robotics, Wheelchair, Hajj Services.

INTRODUCTION

The holy mosque in Makkah, commonly known as Al-Masjid Al-Haram, is one of the holiest sites in Islam, attracting millions of visitors from around the world every year [1]. These visitors include pilgrims (Hujjaj), Umrah performers (Mu'tamireen), and regular worshipers.

In recent years, the number of visitors to the mosque has increased, creating challenges. In 1440 AH (2019), the range of visitors to the mosque reached approximately 6.7 million, then increased to approximately eight million in 1441 AH (2020). However, in 1442 AH (2021), the COVID-19 pandemic caused rules that reduced the range of site visitors to only 300,000, as strict protocols were imposed. Since then, the number of visitors has accelerated once more, attaining 9 million in 1444 AH (2023) and 10 million in 1445 AH (2024) [2][3].

While visitor numbers continue to increase, the large size of the mosque and the high density of visitors, specifically during the most crowded seasons such as Ramadan and Hajj, make it difficult to ensure smooth and efficient movement for all. This becomes an even bigger problem for the elderly and people with disabilities, who can struggle to navigate the large and congested spaces of the mosque. One of the existing solutions is electric-powered carts for the elderly and disabled, though they come at an expensive cost to visitors. Therefore, the primary task is to find a solution that ensures safe and smooth movement for all visitors. The growing number of visitors requires new and practical systems to provide comfort and accessibility for those who need it most [4].

To solve these challenges, the Saudi General Authority has already begun to implement innovative mobility solutions. In 1445 AH, during the Ramadan season, 101 large electric vehicles controlled by visitors were deployed to carry 6 to 10 people and help people with disabilities navigate the area of the mosque. In addition, more than 2,700 small electric vehicles were made available for individual use, providing the necessary mobility. This effort has proven to be useful but still faces restrictions due to the increasing number of visitors, challenges in managing congestion during peak times, and their high costs for visitors [5].

Although these solutions have improved mobility to some extent in the mosque, dependence on manual control is very difficult, and potential congestion still requires more innovative, intelligent, and automated systems that enhance mobility for all visitors. The idea of robots has been around since the last time, and many early machines were developed to perform specific mechanical functions. However, the modern concept of a robot appeared in the 1900s. The word "robot" (from Rossum's Universal Robots) was coined in 1920 by Czech playwright Karel Čapek. His plays introduced the idea of robots as artificial, human-like workers [6].

In the 1950s and 1960s, robotics began to grow from the scope of imagination to practical technology. The first industrial robot, "Animet," was developed in 1956 by George Davol and Josser Angel Berger and was introduced in 1961 at a General Motors facility. "Animet" revolutionized the production industry with automation in welding and assembly. This success marked the beginning of the industrial robot era, where robots were used to replace humans in dangerous or repetitive work, improving efficiency and safety [7].

Robotic technology has seen rapid progress in recent years. In the 1970s, robots began to be used for more complex tasks, and in the 1980s and 1990s, robots started to incorporate artificial intelligence (AI), based on data from sensors and cameras, allowing them to make decisions. In the late 1900s and the 21st century, robots became part of various industries, including health services, space exploration, and even home environments (robot vacuums, delivery robots, and other robots). Today, robots have entered almost every field, from industrial robots working in factories to health services, entertainment, and supportive robots in homes. The integration of AI and machine learning allows robots to push boundaries, enabling them to be more autonomous and competent in complex interactions with their environment [8].

A robot is a machine able to perform complex functions automatically or semi-automatically. Robots are usually equipped with sensors, actuators, and control systems that allow them to interact with and respond to the environment in real time [9]. The main components of a robot include:

- Sensors: Devices that enable a robot to detect and process information from the surroundings, such as distance sensors, cameras, or temperature sensors [9].
- Motors: Mechanical components that allow robots to transmit or perform physical functions, such as engines, wheels, or robotic arms [9].
- Controllers: Computer systems that process sensor data and make decisions about how the robot should behave. The controller is typically operated by software that executes algorithms to make the robot intelligent and able to respond to its environment [9].
- Software/Programming: A set of instructions that control the behaviour of a robot, allowing it to function and adapt to the environment [9].

Robots can be classified into two main types:

- Industrial Robots: These robots are mainly used in production and industrial applications. They are often used for tasks such as welding, painting, assembling, and packaging in factories [10].
- Service Robots: These robots assist people with everyday tasks. Examples include robotic vacuum cleaners, medical robots that assist with surgery, and robots that provide mobility assistance, such as those used in the Holy Mosque [10].

The use of robots in the holy mosque is still very important, but it has increased significantly over the recent years. Given the challenges of managing many visitors, especially during peak seasons, the introduction of intelligent automated solutions can enhance the experience for visitors. Robots can help elderly and disabled visitors navigate the vast spaces in the mosque while reducing congestion and improving safety.

RELATED WORK

This section discusses the related work of using robotics and wheelchairs or the most technologies used to help people to ease services or in transportation in the holly mosque. In addition, it presents the most common technologies that are used in Saudi Arabia.

In recent years, smart inventions have become highly useful for the mobility of the elderly and people with disabilities, as well as in other areas. For example, a smart wheelchair with a navigation system was developed to facilitate the movement of its user through congested environments.

In turn, robotic exoskeletons provide basic assistance in standing and walking. And there are high-quality delivery robots and robots in factories, there are also household robots that perform household chores. There are some other ideas and inventions [13].

The history of robotics includes several years of research and the creation of robots, or the creation of an integrated intelligent system based on artificial intelligence able to perform several tasks in various industries such as healthcare and manufacturing. There are advances in the fields of Engineering, Computing, and artificial intelligence that are the main factors that continue to significantly affect our lives now and, in the future, [14].

Robotics as we know it today in the 20th century through the emergence of industrial robots. In 1921, the Czech Karel Kopek first used the name "robot" in his science fiction play, imagining machines that could do human work. Research into robot technology grew rapidly in the 1960s and 1970s, with artificial intelligence becoming the key in some developments.

The robot Shaki, created by the Stanford Research Institute in 1969, is the first intelligent robot that can think and decide. And robots have become working with advanced artificial intelligence, thereby creating robots that can work independently and interact with their environment. The use of robots in hazardous environments, their flexibility, and accuracy have been significantly increased. In the 21st century, robotics is becoming more and more popular with advanced artificial intelligence and machine learning, which has enabled robots to perform more and more advanced tasks [15].

Robotics depend on several key technologies, including motion control, which enables robots to move exactly through systems such as Motors; vision, which allows robots to perceive and interpret their environment using cameras and sensors; artificial intelligence, which provides robots with the ability to make decisions, learn from experience and adapt to new tasks; sensing, which ensures that robots can interact with their environment exactly through sensors such as radar and sensors for the absence of accidents [36] [37]. These technologies have been combined to create robots that can perform complex tasks [16].

A. Similar Invention:

There are many approaches that innovated similar idea to help people in the holly mosque to do Tawaf and Sa'i as the following:

1. Tanaqol Electric Vehicles [17]:

Overview: Tanaqol electric vehicles are designed specifically to assist Visitors during Hajj and Umrah, providing a comfortable and air-conditioned mode of transportation, and simplifying mobility in crowded areas see Figure 1.

Features:

- Comfortable seats for multiple passengers in varying sizes.
- Equipped with air conditioning to tackle extreme summer temperatures in Makkah.
- Battery-powered and eco-friendly.
- Operates within designated lanes to reduce crowding and congestion.

Figure 1. Tanaqol Electric Vehicles [18]

2. ALBA Robotic Scooter [19]:

Overview**:** ALBA is a self-driving robotic scooter designed to transform mobility for people with disabilities, providing a seamless and independent experience see Figure 2.

Features:

- Self-driving with no need for human intervention but can switch to manual control with a joystick.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 08 Issue 12 December 2025
DOI: 10.47191/ijcsrr/V8-i12-34, Impact Factor: 8.048
IJCSRR @ 2025
www.ijcsrr.org

- Equipped with AI, sensors, and computer vision for obstacle avoidance.
- Comfortable seating and a control panel to adjust speed.

Figure 2. ALBA Robotic Scooter [20]

3. Zamzam Water Dispensing Robot [21]:

Overview: The Zamzam water robot is a self-driving robot designed to distribute Zamzam water efficiently to visitors, introduced during the COVID-19 pandemic to reduce physical contact see Figure 3.

Features:

- Navigate through crowded areas to provide contactless water distribution.
- Equipped with sensors and a user-friendly interface.
- Ensures water quality and maintains hygiene standards.

Figure 3. Zamzam Water Dispensing Robot [22]

4. Amazon Scout [23]:

Overview: Amazon Scout is a self-driving robot used by Amazon, and designed to deliver packages directly to customers' doorsteps see Figure 4.

Features:

- Auto navigation with advanced sensors for safe and efficient delivery.
- Compact design for easy navigation through various environments.
- Provides user notifications for package updates.
- Operates at walking speed and weather-resistant for year-round use.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 08 Issue 12 December 2025
DOI: 10.47191/ijcsrr/V8-i12-34, Impact Factor: 8.048
IJCSRR @ 2025
www.ijcsrr.org

Figure 4. Amazon Scout Autonomous Delivery Robot [24]

5. SEER Robotics [25]:

Overview: SEER Robotics is used in industry and it focuses on robots that move car engine components weighing less than 2 tons within warehouses see Figure 5.

Features:

- Self-driving navigation with real-time data analytics for efficiency.
- Transfers engine components with high speed and accuracy.
- Modular, collaborative designs for flexible task execution and integration with IoT technologies.

Figure 5. SEER Robotics in Warehouse Automation [26]

6. Philips Homerun Robot [27]:

Overview: Philips Homerun is a robot designed to simplify house cleaning through advanced navigation and mapping technologies see Figure 6.

Features:

- Moves efficiently around spaces, avoiding obstacles for thorough coverage.
- Powerful suction for capturing fine dust and larger debris.
- Multiple cleaning modes, including spot cleaning and scheduled sessions.

Figure 6. Philips Homerun Robot [28]

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 08 Issue 12 December 2025
DOI: 10.47191/ijcsrr/V8-i12-34, Impact Factor: 8.048
IJCSRR @ 2025
www.ijcsrr.org

7. Aman wheelchair [29]:

Overview: An electric wheelchair with a built-in controller that is controlled by the visitor see Figure 7. Features:

- Safety Includes automatic brakes for visitor protection.
- Comfortable Seating Designed for comfort during long time sitting.
- Simplicity of design and ease of control Easy to use and control for visitors

Figure 7. Aman wheelchair [30]

Most of these technologies designed for different purpose and drivable or programmed to do a specific task. However, the Manasik Robotic Wheelchair (MRW) designed to transport people around the holy mosque on specific colored line.

B. Manasik Robotic Wheelchair (MRW):

1) *Overview*:

The MRW is a robot in the form of a wheelchair to serve visitors, the elderly, and people with disabilities, following colorful paths or specific paths inside the Holy Mosque.

2) Features:

- Self-Driving Navigation: Follows predefined colorful or specific paths with obstacle avoidance.
- Battery Life and Charging: Long battery life with automatic recharging.
- Wheelchair Design: Comfortable, adjustable seat, armrests, and footrests for users with movement issues.
- Real-Time Location Tracking: Provides directions to key areas inside the holy mosque.

3) The Design:

The basic prototype is a robot designed for testing and analysing the movement on the track see Figure 8. It works as same as the complete design with all features and functionality.

Figure 8. Manasik Robotic Wheelchair (MRW) Prototype.

4) The MRW Components:

The MRW consists of two main components Software and Hardware. These two components are combined together to ensure that the MRW is working with best performance.

A. Software Components:

Software is essential for the MRW to ensure every part operate safely and efficiently. Software includes several functions that is required to operate the MRW such as line following, lab counting, obstacle detection, motor control.

 *Corresponding Author: Abdullah A Sheikh

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 08 Issue 12 December 2025
DOI: 10.47191/ijcsrr/V8-i12-34, Impact Factor: 8.048
IJCSRR @ 2025
www.ijcsrr.org

- Line Following:

To develop all functions that are required using the color sensor to detect a specific color (lane color) to follow and to correct the path if any distractions occur.

- Lab Counting:

The MRW uses an automated lap counting mechanism based on color sensor. A short red line is strategically placed on the black lane to serve as a lap marker. Every time the wheelchair crosses this line, the lab counter will increase by one.

- Obstacle Detection:

To use data from the distance sensor to identify obstacles that might be facing the MRW, then to pass this information to the motor control system to analyse it and to take any actions required.

- Motor Control:

The Motor control uses the provided data from line following functions and obstacle detection functions to make any actions needed such as turning around obstacles or stopping if required.

B. Hardware Components:

Hardware parts are required to manage the MRW and to facilitate its motions safely and to navigate directions avoids congestion during Tawaf and Sa'i. Hardware components includes color and distance sensors, motors, and programmable hub.

- Color Sensor:

To detect and identify the lane color, this sensor can identify up to 8 colors by assigning the main path color with a unique color number see Figure. 9.

Figure 9. Color and Light Sensor [31].

- Distance Sensor:

To measures distances between the MRW and any other objects might cause interruptions. This sensor sends high frequency sound waves that bounce off any object in the MRW range [31] see Figure. 10.

Figure 10. Distance Sensor [31].

- Motors:

These motors will receive all data from other sensors color and distance to control the MRW movement and to adjust speed see Figure. 11.

Figure 11. The MRW Motors [31].

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 08 Issue 12 December 2025
DOI: 10.47191/ijcsrr/V8-i12-34, Impact Factor: 8.048
IJCSRR @ 2025
www.ijcsrr.org

- Programmable Hub:

This is the control centre analyses all inputs from all sensors and send instructions to motors with appropriate actions during Tawaf and Sa'i see Figure. 12.

Figure 12. Programmable Hub [31]

C. Comparison between MRW and others:

To compare the MRW with other works, there are some aspects need to be considered as the following:

- Fully performs Umrah: means entering to holy mosque, performing Tawaf around the Kaaba, walking between Safa and Marwah in Mas'a.
- Special path: A special path for the robot, designed with smooth surfaces and clear markings. It ensures safe and easy movement through congested areas, allowing the visitor to perform Umrah comfortably.
- Self-driving: allows to independently navigate the designated paths, without manual control. It uses sensors and AI to detect obstacles and adjust its movement, ensuring a smooth and safe experience for the visitors.
- Customizable for User Needs: the customizable for visitors needs feature allows the robot to adjust settings like speed, seating position, this ensures comfort and accessibility for each visitor during their Umrah.
- Autonomous Navigation: enables to independently move along the designated paths. It uses sensors and AI to detect obstacles, map surroundings, and adjust its route for a smooth and safe experience.

Table 1. shows the comparisons between MRW and other works considering these aspects. Also, it shows that the MRW can fully perform Tawaf and Sa'i following special path without any human interactions with navigation system that works from the start and to the ends.

Table 1. MRW Compared to Other Works

Features	MRW	Aman	Tanaqol	ALBA	Zamzam	Amazon	SEER	Philips
Fully Perform Umrah	✓	✓	X	X	X	X	X	X
Special path	X		X	X		X	X	X
Self-driving	X		X	✓	✓	✓	✓	
Customizable for User Needs	✓	✓	X	✓	X	✓	✓	X
Autonomous Navigation	X		X	✓	✓	✓	✓	X

D. Objectives of MRW:

The main objective of the MRW is to improve mobility and accessibility for elderly visitors and people with disabilities during their visits to the Holy Mosque in Makkah. The MRW will address challenges related to movement and navigation within the congested

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 08 Issue 12 December 2025
DOI: 10.47191/ijcsrr/V8-i12-34, Impact Factor: 8.048
IJCSRR @ 2025
www.ijcsrr.org

environment of the mosque, particularly during high-traffic times like Hajj and Umrah. These objectives are as follows:

1. Enhance Mobility Through Intelligent Hardware Components:

The project aims to develop a robotic wheelchair using essential hardware elements, including sensors, motors, and a programmable hub, to facilitate easy and independent movement. This system will offer easy navigation assistance to the elderly and People with disabilities within the Holy Mosque.

2. Smart Navigation with Pathfinding and Lane-Following Techniques:

The wheelchair will use a path-finding algorithm and color-detection sensors to follow designated routes. These techniques will ensure efficient and accurate navigation through congestion areas, minimizing delays and enabling smooth movement, even in high-density environments.

3. Ensure Safety with Obstacle Detection and Motor Control:

Equipped with advanced obstacle detection technology, including distance sensors and a motor control system, the robotic chair will provide safe navigation by detecting obstacles visitors. The system will adjust speed and direction as needed to avoid collisions in congested areas.

4. Enhance Visitor's Experience with Stress-Free Mobility:

Through seamless integration of hardware (sensors) and software (algorithms), the Manasik Robotic Wheelchair (MRW) will reduce the physical strain and stress associated with navigating the Holy Mosque. This allows users to concentrate on their religious obligations, ensuring a comfortable and fulfilling visitor experience.

5. Scalability and Adaptability to Varying Conditions:

The Manasik Robotic Wheelchair (MRW) will be designed to adapt to changes in the mosque’s layout, fluctuating congestion densities, and diverse environmental conditions. It will also support future technological enhancements, ensuring that the system remains effective and relevant as the number of visitors continues to grow.

METHODOLOGY

This section introduces the methodology for the Manasik Robotic Wheelchair (MRW) prototype, and covering hardware and software components. Then it discusses the key challenges with possible solutions, testing environments, limitations, and future enhancements.

A. Key Challenge and Solutions

Several challenges are facing developing wheelchair robots to do Tawaf and Sa’i as follows:

- Collision detection:

Ensuring that the MRW effectively detects obstacles is a significant challenge. While the MRW follows a predefined lane, unexpected obstacles or random objects blocking its path can disrupt its movement. The MRW must be capable of identifying such obstacles without colliding with them.

To overcome collision detection challenges, MRW will have an integrated distance sensor that will measure how far it is from the surrounding objects and it will also have an emergency stop mechanism that will halt the motors when necessary.

- Reliable Lane Following:

Ensuring that the MRW accurately follows its designated lane is essential for smooth navigation. minor deviations caused by small stones on the path can add up and cause the wheelchair to drift away from its path, this will make the wheelchair color sensor unable to detect the colored lane.

To maintain reliable lane following, the MRW will use a P Controller (Proportional controller) in combination with a color sensor. This controller, control mechanism that continuously adjusts the wheelchair’s movement based on deviations from the lane. It works by calculating the error (difference between the desired and actual position) and making precise corrections (turn wheels right and left as needed) to keep the MRW on track.

- Lap Counting:

In the context of Umrah rituals, the pilgrim is required to complete seven rounds during the Tawaf and Sai. For a robotic wheelchair assisting individuals with disabilities, it is essential that the system not only navigates accurately but also counts each completed lap reliably. Mistakes in lap counting could invalidate the ritual or cause confusion for the user.

The MRW uses an automated lap counting mechanism based on color sensor. A short red line is strategically placed on the black lane to serve as a lab marker. Then every time the MRW crosses this line, the lab counter will increase by one.

- Off-Path Prevention:

To achieve a stable and accurate path following from the start of Tawaf or Sa'i. This challenge can be solved by using the PID controller and filtering data from the line sensor and camera.

- Recovery:

To make the MRW accurately detecting deviation and performing a precise recovery turn to the main rout in case of any distracting or lane changing.

To do this, there is a built in 360-degree rotating camera to detect the main path, and to help the MRW to return to its original rout. Also, there is a live location rout could be added to help the MRW to navigate to the correct path.

- Alert of Fails:

This challenge is about notifying supervisors or responsible offices if there any failures that preventing the MRW from completing the tasks.

There will be failure code will be implemented by wireless communication to alerts and provides a remote diagnostic and control tool for the supervisors to reboot the MRW.

- Distraction of Lighting Reflection:

Distraction od lighting reflection that could affecting color sensor or any high reflections on shiny floors or objects could cause issues to the color sensor to misinterpret line color.

Calibration of sensor to detect a range of values and include matte coating or filtering to limit glare during detection.

- Obstacle with similar Lane Color:

Objects that placed on or near the path with similar lane color could cause confusions to the MRW then it might stop or changing to wrong direction.

To avoid that, using a combining method including color and distance sensors working together to distinguish flat lane marking from any raised objects.

TESTING AND RESULTS

To ensure that the MRW works and functioned properly a prototype has been developed and designed to simulate the actual MRW and the Tawaf and Sa'i environment.

A. Prototype and Testing Environment

To simulate the Tawaf and Sa'i environment a map with big picture of the holly mosque printed with high quality details see Figure 13. Also, a small prototype with similar design of the MRW used to perform Tawaf and Sa'i see Figure. 8.

This simulated design includes all features that are existed in the MRW. The simulated environment includes the following:

- Simulated Tawaf and Sa'i path with a black line that color sensor can detect then the MRW can follow it.
- Simulated obstacles to be positioned randomly on the map.
- The simulated environment used for safety testing to conform that the MRW can stop instantly to avoid any collisions or to cause any damages. Also, it tests The MRW motor speed and other features like breaking and changing direction as needed depends on the navigation situation.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 08 Issue 12 December 2025
DOI: 10.47191/ijcsrr/V8-i12-34, Impact Factor: 8.048
IJCSRR @ 2025
www.ijcsrr.org

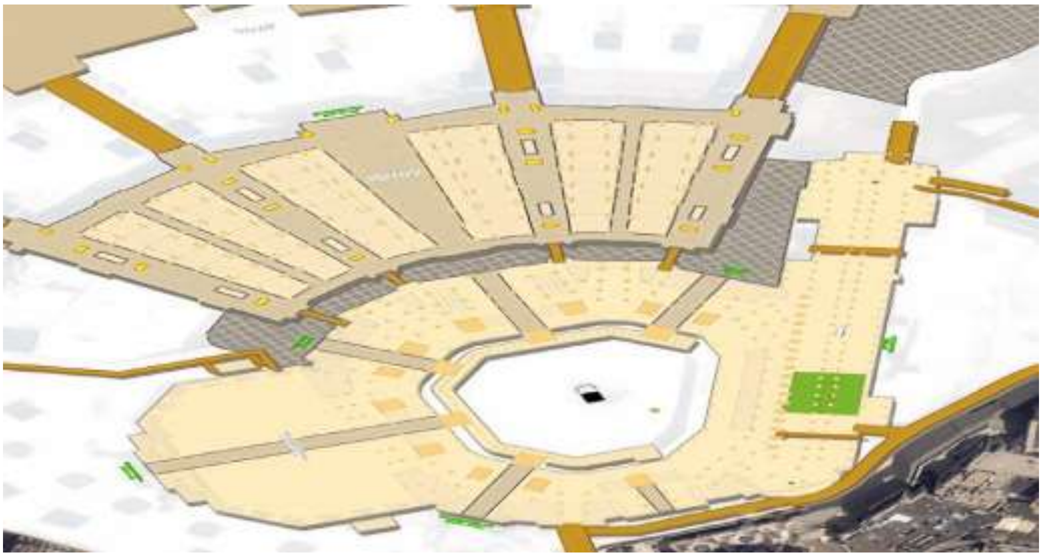

Figure 13. Testing Environment MAP

B. Prototype vs MRW

This section discusses and compares the prototype versus the MRW final product features and costs with any possible limitations. Table 2. shows comparisons between the prototype and the MRW final product in many aspects such as cost, purpose, design, user interface and technology used to program and how operate both in the environment.

Table 2. The Prototype vs The MRW comparison

Aspect	**Prototype (MRW)**	**Final Product**
Cost	2570 SAR	3750SAR
Purpose	Tested in a similar environment to illustrate the idea.	Apply it in the real environment and its use in the Holy Mosque.
Manufacturing quality	Medium - Simple and experimental materials	High quality materials
Accuracy & Performance	Limited - For testing only	Precise and efficient – suitable for real tasks
Components Used	General – LEGO, breadboards, basic sensors	Specialized – often custom-designed parts
Battery Life	Short - usually 30 minutes to an hour	Long - 8 to 16 hours on a single charge, with a quick 15- minute charge.
Sensors	Simple sensors, including a color sensor and a distance sensor.	It has the same sensors and also a camera to help the robot return to its path. These sensors are more advanced, very accurate, and more complex.
Durability	Does not continuous use or hard environments.	Designed to long-term operation and various environmental conditions.
Safety	Basic – limited safety mechanisms.	Advanced – Includes collision avoidance systems, automatic braking when wrong
User Interface and OS	controlled by basic programming only	ROS [38] or more advanced operating system. It may have a touch screen or its own app.
AI	Limited – depend on simple programming and functions	Advanced – AI may be used for navigation and decision making.

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 08 Issue 12 December 2025
DOI: 10.47191/ijcsrr/V8-i12-34, Impact Factor: 8.048
IJCSRR @ 2025
www.ijcsrr.org

C. Discussing Results

The comparisons in Table 2. between the prototype and the MRW final product in some aspect shows differences and explaining similarities of doing Tawaf and Sa'i as the following:

- Cost: The prototype of the MRW was developed at a cost of 2,570 SAR, focusing on affordability for initial testing. In contrast, the final product is estimated to cost around 3,750 SAR, reflecting the investment in high-quality materials, advanced components, and real-world application standards.
- Purpose: The prototype was built to test the concept in a controlled, similar environment to simulate the Holy Mosque and validate the idea. The final product, however, is designed for direct use in the real environment of the Two Holy Mosques, serving actual users in live conditions.
- Quality: The prototype used medium-quality, simple, and experimental materials suitable for early testing. The final product will be made with high-quality, durable materials to ensure safety, reliability, and long-term performance.
- Accuracy & Performance: The prototype offers good accuracy and performance in the simulation environment that prepared for testing movement and basic functions such as collision detection, avoid obstacles, and correcting path . The final product is expected to be more precise and efficient, fully capable of performing the Umrah rituals and with more reliably.
- Components Used: The prototype was built using general, easily accessible components like LEGO parts, breadboards, and basic sensors. The final version will feature custom-designed, specialized components optimized for the robot's tasks and durability.
- Battery Life: The prototype is powered by a high-capacity 2,100 mAh lithium-ion battery, which provides a short battery life of 30 minutes to an hour. The final product will have a battery life of 8 to 16 hours, with the ability to recharge quickly, taking as little as 15 minutes for partial charging.
- Sensors: The prototype uses simple sensors, such as a color sensor and distance sensor, to perform basic navigation. The final product will include more advanced sensors, enhanced accuracy, and a camera system to ensure the robot can precisely follow its path and safely return if it deviates.
- Durability: The prototype is not designed to handle continuous use or harsh conditions and is primarily for demonstration. The final product will be highly durable, built for long-term operation in crowded, challenging environments.
- Safety: The prototype has basic safety features with minimal protection against errors. The final version will include advanced safety systems, such as collision avoidance, automatic braking, and emergency stop functions to protect both passenger and nearby people.
- User Interface and OS: The prototype is controlled solely through basic programming. The final product is expected to have a user-friendly interface, possibly including a touchscreen or a dedicated mobile app, making it accessible for all users, including the elderly.
- AI: The prototype relies on simple, basic pre-programmed functions. The final product will integrate advanced AI capabilities for smart navigation, decision-making, and real-time adjustments, significantly improving its autonomy and reliability.
- Reduce Risks and Accidents: Testing the prototype and the MRW has shown that the design and features of both can reduce risks of crashing people or objects around during movement to do Tawaf and Sa'i, Also, both can avoid collisions and accidents due to sensors and camera that have been used.
- Independency and reducing physical efforts: Both the prototype and the MRW work independently and there is no need from any individual to assist to push or moving with people.

CONCLUSION

This paper has described the Manasik Robotic Wheelchair(MRW). It has presented an overview of the MRW and its features. In addition, it presented the MRW design and main components. Also, it showed how the MRW will work to do Tawaf and Sa'i and what are the key challenges that are facing the MRW. Then it shows the benefits of using robotic wheelchairs in the Holy Mosque.

Then it explained the testing environment using a prototype and it explained what are the differences between the prototype and the MRW the final product. Then it compared the results of testing the prototype in the testing environment with the MRW in the real environment in the Holy mosque in Makkah in Saudi Arabia.

Finally, the MRW could facilitate and provide good experience for people who need assistant or having issues to do Tawaf and Sa'i by themselves. Also, the MRW could reduce the number of accidents that can be result in from crashing or tiredness of moving around the Holy Mosque.

ACKNOWLEDGMENT

The researcher would like to acknowledge the Deanship of Scientific Research, Taif University for funding and supporting this work.

REFERENCES

1. King Abdullah Center. (2024). King Abdullah bin Abdulaziz International Center for Interreligious Dialogue. November 2, 2024, from https://kaiciid.org.
2. Saudi Ministry of Hajj and Umrah Reports on Visitor Statistics from https://www.haj.gov.sa Access on 9 November 2024 from https://www.amazon.com/Essays-AI-Automation-Technology-Future/dp/1974513505
3. Saudi Press Agency – Makkah News on Smart Solutions https://www.spa.gov.sa
4. Report on Mobility Solutions for Al-Masjid Al-Haram, Saudi Press, 2024 from https://www.spa.gov.sa.
5. Smart Mobility Solutions in Religious Sites, Research on Accessibility, 2024 from https://www.mdpi.com/journal/smartcities/special_issues/5TCNT897RR.
6. Capek, Karel. R.U.R. (Rossum's Universal Robots), 1920 from https://www.gutenberg.org/files/59112/59112-h/59112-h.html
7. Devol, George, and Joseph Engelberger. 2014, Unimate: The First Industrial Robot, IEEE Robotics and Automation Society, from https://www.automate.org/robotics/engelberger/joseph-engelberger-unimate.
8. The History and Development of Robotics, Robotics Today Journal, (2021) https://scientists.uz/uploads/202402/C-1.pdf.
9. Definition and Key Components of a Robot, Robotics International, 2020 from https://builtin.com/robotics.
10. The Role of Service Robots in Modern Society, Robotics Review Journal, (2022) from https://www.emerald.com/insight/content/doi/10.1108/jstp-04-2019-0088/full/html.
11. IEEE Xplore Digital Library: A Review on Robotic Technologies for Elderly and Disabled People 8 November 2024 from https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9945963
12. Robot path in the Holy Mosque Photo form https://makkahnewspaper.com/article
13. Nature and Science Robotics: The Role of Robotic Exoskeletons in Rehabilitative and Assistive Technology 9 November 2024 from https://www.science.org/journal/scirobotics
14. The History of Robotics: From Ancient Times to the Present 9 November 2024 from https://spectrum.ieee.org/tech-talk/robotics/industrial-robots/history-of-robotics
15. The Industrial Robot Revolution: Past, Present, and Future 9 November 2024 from https://www.researchgate.net
16. Artificial Intelligence for Robotics: Build intelligent robots that perform human tasks using AI techniques
17. Saudi Press Agency. (2024). SPA. Retrieved October 17, 2024, from https://www.spa.gov.sa.
18. Tanaqol Electric Vehicles Photo. November 2, 2024, from https://www.spa.gov.sa/2211041?lang=ar&newsid=221104
19. ALBA Robot SRL. (2021). ALBA Robot. Retrieved October 15, 2024, from https://www.albarobot.com.
20. ALBA Robotic Scooter Photo. November 2, 2024, from https://www.spa.gov.sa/2211041?lang=ar&newsid=2211041.
21. ArabNews. (2024). Smart Robot To Distribute Water. Retrieved October 17, 2024, from https://www.arabnews.jp/en/saudi- arabia/article_63203/.
22. Zamzam Water Dispensing Robot Photo. November 2, 2024, from https://www.italdesign.it/projects_brand/alba-robot.
23. Amazon. (2024). Meet Scout. Retrieved October 17, 2024, from https://www.aboutamazon.com/news/transportation/meet-scout.
24. Amazon Scout Photo. November 2, 2024, from https://www.aboutamazon.com/news/transportation/meet-scout.
25. LinkedIn. (2024). Application of Mobile Robots in the Automotive Industry. Retrieved October 17, 2024, from https://www.linkedin.com/pulse/look-application-mobile-robotsautomotive-industryfrom-xiaomi-n8ekc.
26. SEER Robotics. (2024). SEER Robotics Helps 3PL Industry Upgrade Warehouse Automation. Retrieved October 17, 2024, from https://www.seer-group.com/.

27. Philips Homerun Robot . November 2, 2024, from https://www.techadvisor.com/article/2112681/philips-homerun-7000-aqua- review.html.
28. Philips Homerun Robot Photo. November 2, 2024, from https://www.techadvisor.com/article/2112681/philips-homerun-7000- aqua-review.html.
29. Aman wheelchair (2024) from https://www.aman-wheelchair.com/
30. Aman wheelchair Photo (2024) from https://www.aman-wheelchair.com/
31. Maurer, A. (2022). Design Innovative Robots with LEGO SPIKE Prime: Seven Creative STEM Robotic Designs to Challenge Your Mind. Packt Publishing.
32. Trumptech. (2024). SPIKE™ Prime Technic™ Colour Sensor.Retrieved October 17, 2024, from https://let.trumptech.com/en/product/18.
33. Jeulin. (2022). SPIKE Prime DistanceSensor 45604 LEGO. Retrieved October 17, 2024, from https://jeulin.com/jeulin_en/184320.html.
34. Amazon. (2024). LEGO Technic Large Hub for Spike Prime. Retrieved October 17, 2024, from https://www.amazon.sa/-/en/LEGO-Technic-LargeSpikePrime/dp/B07QN7ZKQT?language=en_AE.
35. YouTube. (2024). Explore the LEGO Education SPIKE Prime Motors. Retrieved October 17, 2024, from https://www.youtube.com/watch?v=AOiUIz9ethU.
36. Wheelchair-Related Accidents: Relationship with Wheelchair-Using Behavior in Active Community Wheelchair Users. November 2, 2024, from https://www.sciencedirect.com/science/article/abs/pii/S0003999311000505
37. Public Authority. (2024). A Destination for More Than 10 Million Visitors Since the Beginning of 2024. November 2, 2024, from https://gph.gov.sa.
38. Koubâa, A. ed., 2017. Robot Operating System (ROS) (Vol. 1, pp. 112-156). Cham, Switzerland: Springer.

Cite this Article Sheikh, A.A. (2025). MRW: Manasik Robotic Wheelchair for Tawaf and Sa'i in the Holy Mosque in Makkah in Saudi Arabia. International Journal of Current Science Research and Review, 8(12), pp. 6229-6242. DOI: https://doi.org/10.47191/ijcsrr/V8-i12-34