

Final Project 1

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Faculty of Management
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How can computer network and wireless communication technologies be utilized to design a smart guiding stick that helps visually impaired individuals navigate their surroundings safely and independently?

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Graduation Project – 1

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1. Chapter 1: Introduction

1.1. Research Background

The goal of this project is to develop the guide stick and make it more effective and developed, as this project was developed with the (Arduino) technology to help them move around and give the blind more independence.

As for the process of skipping and avoiding obstacles by ultrasonic sensors, the blind person is alerted by the siren alarm in case of an obstacle, and the blind person can send his location via text message if he wants help from one of his relatives using the Global Mobile Communications System (GSM), and we have added the feature of locating the current location of the blind person through (GPS).

In light of the rapid advancement in networking and communication technologies, it has become possible to harness computer network systems to develop intelligent solutions that serve various segments of society, including individuals with visual impairments. The "Guiding Stick" project aims to design a smart system that utilizes computer network technologies and wireless communication to provide a safe and effective assistive tool for the visually impaired during their daily mobility.

The project integrates electronic components such as sensors and wireless communication modules (e.g., Wi-Fi or Bluetooth) into a smart stick capable of detecting obstacles and alerting the user through audio or vibration signals. The stick can also be connected to a smartphone application or a small processing unit (such as a Raspberry Pi or Arduino) to exchange data and enhance the user experience.

1.2. Research Problem

1.2.1. Theoretical Gaps

Visually impaired individuals face daily challenges while navigating public and private environments due to the lack of effective technological tools that combine intelligent sensing with real-time network communication. Although traditional aids such as white canes or guide dogs exist, they lack the ability to dynamically interact with the surrounding environment or provide instant feedback about obstacles and hazards.

With the rapid advancement of computer network systems and wireless communication technologies, there is a growing need to develop smart solutions that leverage these capabilities to offer safer and more efficient assistive tools. This research problem is framed by the following central question:

"How can computer network and wireless communication technologies be utilized to design a smart guiding stick that helps visually impaired individuals navigate their surroundings safely and independently?"

From this main question, several sub-questions emerge:

- What are the appropriate technical components for designing a smart stick based on wireless networks?
- How can the guiding stick interact with the environment and deliver real-time alerts to the user?
- What are the suitable communication mechanisms between the smart stick and other devices (e.g., smartphones or cloud servers)?
- How can reliability and responsiveness be ensured across different environments?
- This study aims to address these issues by designing a prototype of a guiding stick that relies on computer network technologies and evaluating its effectiveness in improving the quality of life for individuals with visual impairments.
- Getting stuck in the way or not having the right signification.
- When the stick falls , it cannot be easily found on its own.

1.2.2. Practical Gaps

At the applied level, the research problem centers on the technical and functional challenges involved in designing and implementing a smart stick that relies on computer network technologies

to effectively support individuals with visual impairments. While sensing and wireless communication technologies are available, integrating them into a cohesive system that performs reliably across diverse environments and responds promptly to user input presents an engineering and technical challenge that requires thorough investigation.

The core applied question is:

"To what extent is it feasible to develop and implement a smart guiding stick based on computer network technologies that ensure real-time responsiveness and high reliability in obstacle detection and user guidance?"

This applied problem includes several key considerations:

- Selecting appropriate sensors capable of accurately detecting obstacles in various environments.
- Choosing wireless communication protocols that ensure fast data transmission between the stick and connected devices.
- Designing an effective alert interface (audio or vibration) that interacts with the user in a clear and safe manner.
- Testing the system in real-world settings (indoor and outdoor) to evaluate performance and responsiveness.
- Ensuring low power consumption to support daily use without frequent recharging.
- The applied study aims to build a prototype of the guiding stick, conduct field testing, and analyze the results to determine its effectiveness in enhancing user independence and mobility.

Therefore, the main research problem can be stated as:

"The absence of an integrated smart system based on computer networks that guides visually impaired individuals during mobility and ensures reliable, real-time obstacle detection and interaction."

1.3. Research Significance

The "Guiding Stick" project holds notable theoretical significance by highlighting the potential of computer network technologies in serving individuals with special needs, particularly those with visual impairments. At the theoretical level, this study enriches scientific understanding of how networking and wireless communication components can be integrated with smart sensing systems to create interactive, real-world solutions.

1.3.1. At the theoretical level

- Expanding theoretical concepts related to the integration of computer networks with embedded systems in humanitarian applications.
- Analyzing the role of computer networks in enabling real-time interaction between smart devices and users.
- Exploring theoretical models for designing assistive systems based on wireless communication and evaluating their responsiveness and reliability.
- Advancing academic research in the field of assistive technologies from a computer networking perspective, linking technical innovation with societal needs.
- Providing a theoretical framework that can serve as a foundation for future projects aimed at supporting individuals with disabilities through network-based technologies.
- This study contributes to building a knowledge base that bridges theory and practice, opening new avenues for researchers to develop innovative solutions that enhance quality of life through network-driven systems.

1.3.2. At the practical level

The applied significance of the "Guiding Stick" project lies in developing a practical model that utilizes computer network technologies to support individuals with visual impairments by designing a smart tool that enables safe and independent mobility. The value of this study is reflected in transforming theoretical concepts into real-world solutions that can be implemented and tested across various environments.

Key aspects of the applied importance include:

- Designing and implementing a prototype of a smart stick that integrates sensing and wireless communication technologies, offering a hands-on experience of system integration.
- Testing the system's effectiveness in obstacle detection and delivering real-time alerts to users, enhancing mobility quality.
- Evaluating network performance in terms of response speed and reliability of communication between the stick and connected devices (e.g., smartphones).
- Improving usability by developing suitable alert interfaces (audio or vibration) tailored to user needs.
- Promoting innovation in assistive technologies by presenting an adaptable model for different environments (indoor and outdoor).
- This applied study contributes to building a feasible technical solution and opens the door for future projects that rely on computer networks to develop assistive tools with tangible social and humanitarian impact.

1.4. Research Questions

First: Research Questions at the Theoretical Level

- How can computer network technologies be utilized to develop assistive tools for individuals with visual impairments?
- What theoretical features should a smart system possess to ensure real-time interaction with the surrounding environment?
- To what extent can wireless networks support continuous and secure communication between the smart stick and connected devices?
- What are the appropriate theoretical models for designing a sensing system based on network technologies for obstacle detection?

Second: Research questions at the applied level

- How effective are the selected sensors in accurately detecting obstacles in both indoor and outdoor environments?
- What are the most suitable wireless communication protocols to ensure fast response and reliable connectivity between the smart stick and connected devices?
- How can an alert interface (audio or vibration) be designed to interact with the user in a safe and intuitive way?
- To what extent can the prototype operate effectively under varying environmental conditions (e.g., lighting, humidity, crowd density)?

The main question of the research problem

"How can computer network and wireless communication technologies be utilized to design and implement a smart guiding stick that helps visually impaired individuals navigate safely and independently by detecting obstacles and interacting with the surrounding environment in real time?"

1.5. Research Objectives

First: General Objectives

1. Design and implement an effective bug tracking application that helps development teams manage bugs and improve product quality.
2. Integrate software development lifecycles by linking bugs to analysis, design, implementation, and testing.
3. Enhancing cooperation between work teams through a unified platform for documenting and following up on bugs.

Second: Theoretical Objectives

1. Studying theoretical models to track bugs and linking them to the components of the software system.
2. Analyze the impact of having a bug tracking system on software quality and stability.
3. Build a traceability matrix that connects bugs to requirements and test cases.
4. Testing software engineering hypotheses related to defect management and performance optimization.

Third: Applied Objectives

1. Develop an easy and efficient user interface to record and follow up on bugs.
2. Providing a mechanism for classifying bugs according to priority and severity.
3. Integrate the app with development tools like Git and Jenkins to facilitate automatic tracking.
4. Generate analytical reports that help in making technical and managerial decisions.
5. Reduce bug processing time and improve response speed in technical support teams.

1.6. Research Hypotheses

1.6.1. Theoretical Hypotheses:

1. There is a positive relationship between the use of computer network technologies and the effectiveness of assistive systems for visually impaired individuals.
2. Integrating wireless communication protocols contributes to improving the response speed and real-time interaction of the smart stick.
3. Combining sensors with network systems enhances the system's ability to accurately detect obstacles in various environments.

1.6.2. Applied Hypotheses:

4. Using audio or vibration alert interfaces improves the user experience and increases safety during mobility.
5. The smart stick prototype delivers reliable performance in both indoor and outdoor environments in terms of obstacle detection and real-time responsiveness.
6. Connecting the smart stick to a smartphone application enhances usability and provides additional information to the user.
7. Low power consumption positively affects the continuity of smart stick usage without frequent recharging.

1.7. Research Model

The model followed by the project "Guiding Stick" shows the conceptual design of the smart stick intended to support people with visual impairments.

You can open the card above to preview the form, as it contains:

- Sensors are built into the front of the stick to detect obstacles.
- Wireless communication module near the handle to communicate with the smartphone.
- Audio and vibration alert system inside the handle.
- Internal components such as microcontroller and battery.
- Technical design is suitable for academic presentation.



1.8. Research Methodology

1.8.1. Research Approach

The study adopts an experimental applied approach, where a smart stick prototype is designed and implemented, followed by field testing in real-world environments.

1.8.1.1. Research Tools

- Smart stick prototype
- Sensors (e.g., ultrasonic sensors)
- Wireless communication modules (e.g., Bluetooth/Wi-Fi)
- Smartphone application connected to the stick
- Performance measurement tools (e.g., user satisfaction surveys, data analysis software)

1.8.1.2. Study Population

The study targets a selected sample of visually impaired individuals, with whom the prototype is tested in both indoor and outdoor settings to assess its effectiveness.

1.8.1.3. Study Procedures

- Design and build the smart stick prototype
- Program the system and integrate it with a mobile application
- Test the prototype in various environments (hallways, streets, enclosed spaces)
- Collect performance data (response speed, detection accuracy, user feedback)
- Analyze results using descriptive statistical tools

1.8.1.4. Data Analysis Methods

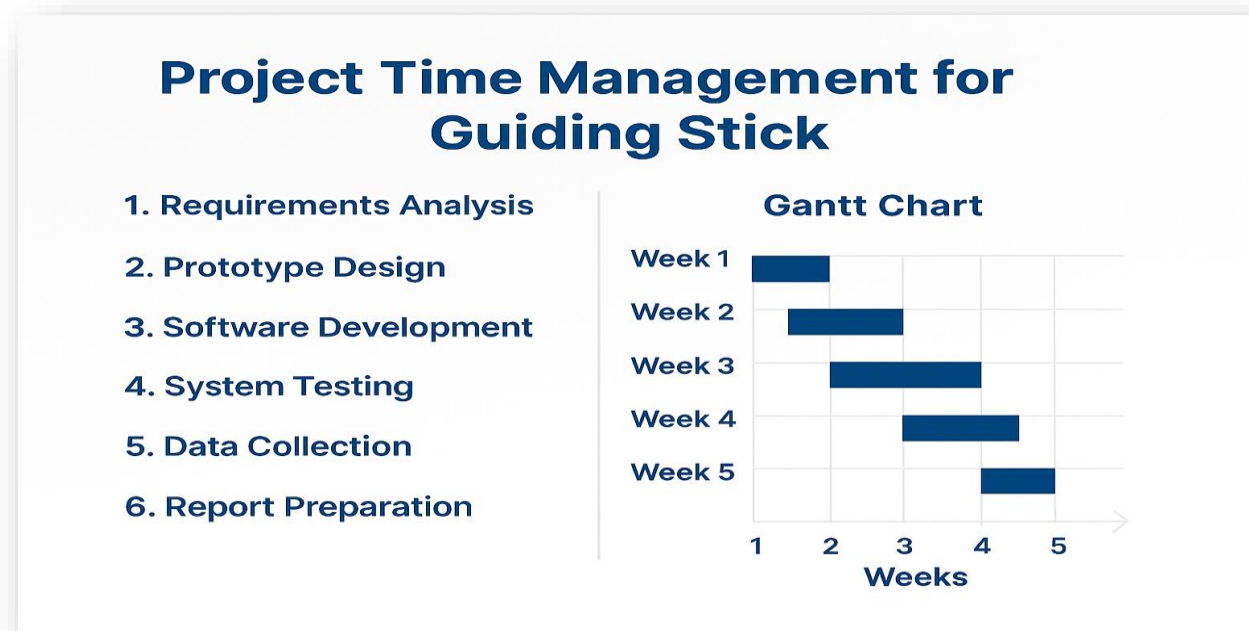
- Descriptive analysis to measure performance averages
- User feedback analysis to evaluate usability
- Comparative evaluation against predefined project objectives.

1.8.2. Review of project management elements

1.8.2.1. Scope Management for the Guiding Stick Project

Scope Management for the Guiding Stick Project	. Project Deliverables	Key Activities Within Scope	Out-of-Scope Activities	Scope Control
The project aims to design and implement a smart guiding stick that assists visually impaired individuals in navigating safely by integrating computer network technologies, sensors, and wireless communication into a unified system that provides real-time alerts.	A smart stick prototype equipped with sensors and a communication module	Analyzing the needs of visually impaired users	Developing a full navigation system based on 3D mapping	Periodic review of project requirements
	A mobile application connected to the stick	Selecting appropriate technical components (hardware and software)	Supporting multiple languages in the mobile app during the initial phase	Documenting and approving any scope changes by the project team
	An audio and vibration alert system	Designing the smart stick prototype	Integrating with government or external institutional systems	Using scope management tools such as WBS and change logs
	Design and programming documentation	Developing software and integrating network connectivity		
	A performance evaluation report based on field testing	Testing the prototype in indoor and outdoor environments		
		Collecting and analyzing performance data		

1.8.2.2. Guiding Stick Project Time Management



1.8.2.3. Cost management of the project

Item	Description	Estimated Cost (SAR)
1. Sensors	Ultrasonic sensors for obstacle detection	600
2. Wireless Communication Unit	Bluetooth or Wi-Fi module	350
3. Microcontroller	Arduino or Raspberry Pi	250
4. Battery and Power Supply	Rechargeable battery and charger	200
5. Stick Body Design	Lightweight and ergonomic cane structure	150
6. Alert System	Small speaker and vibration motor	300
7. Mobile App Development	Programming and interface design	1,500
8. Testing and Evaluation Tools	Indoor/outdoor testing setup and user surveys	400
9. Documentation and Reporting	Project documentation and final report preparation	200
10. Contingency Reserve (10%)	For unexpected costs	44

Total Estimated Cost: 4,395 SAR

1.8.2.4. Quality Management Specification Table – Guiding Stick Project

Item	Required Quality Standard	Measurement Method	Verification Tool	Acceptable Quality Threshold
1. Sensor Accuracy	Obstacle detection accuracy not less than 95%	Field testing in varied settings	Field test results	$\geq 95\%$
2. Response Speed	Alert issued in less than one second	Time measurement tools	Performance tracking app	≤ 1 second
3. Communication Reliability	Stable wireless connection across environments	Wireless connectivity testing	Connection logs	$\geq 98\%$ connection stability
4. Alert Clarity	Audio/vibration alerts clearly distinguishable by user	User satisfaction survey	Survey results	$\geq 90\%$ user satisfaction
5. Power Consumption	Continuous operation for at least 8 hours	Battery usage testing	Power consumption log	≥ 8 hours
6. Usability	Ease of use of the stick and mobile app	User experience evaluation	Interviews and surveys	$\geq 85\%$ positive feedback

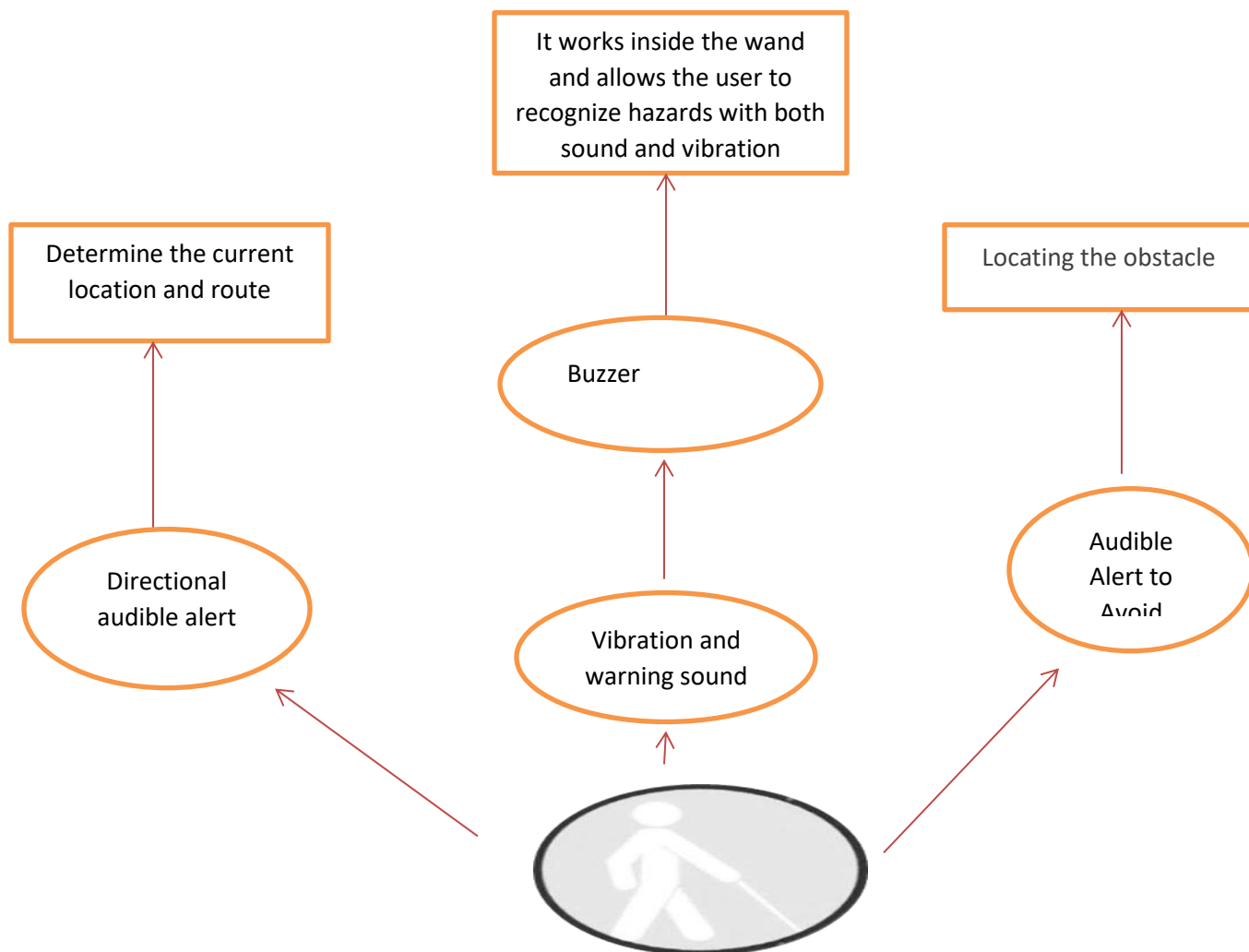
1.8.2.5. Guiding Stick System Requirements:

Vibration and Warning Sound Feature (GPS) device works inside the stick and allows the person to recognize the dangers, as it works automatically when the person starts using it, that is, as soon as he touches it and when he leaves it, it stops working automatically. A smart stick with ultra-precise technologies for the blind to enable them to recognize people's faces, stumbling, and the device uses our technology, as it alerts the user through vibration and transmitting sound signals, in addition to containing the stick on the positioning system to help him to move.

1.8.2.6. System Design

Sequence diagram: This diagram illustrates the method of ultrasonic obstacle detection (GPS) of the guide stick through vibration and works to identify the hazards by vibration, determine the location of the obstacle, determine the current location and the required path without stumbling and without the need for others and the blind person is self-reliant.

These lines represent the work of the (GPS) of this object activation, as we will now see in the Sequence diagram to put forward the way of signification in the right way and not to stumble by vibration...



1.8.3. Human Resource Management – Guiding Stick Project

1.8.3.1. Team Structure

Role	Key Responsibilities
Project Manager	Overall supervision, schedule and budget management, decision-making
Embedded Systems Engineer	Design of the smart stick's electronic system, programming the controller
Application Developer	Development of the mobile app, user interface, and network integration
Network Specialist	Configuration of wireless communication protocols and ensuring stability
Quality Specialist	Performance testing, quality reporting, and compliance monitoring
User Representative	Providing feedback and participating in field testing

1.8.3.2. Team Management Plan

- **Clearly define roles and responsibilities** from the beginning of the project
- **Hold regular meetings** (weekly) to monitor progress and address issues
- **Motivate the team** by setting measurable goals and recognizing achievements
- **Assign tasks** based on expertise to ensure efficiency and quality

1.8.3.3. Training and Development Strategy

- Train the team on sensor integration and embedded programming
- Conduct workshops on designing user interfaces for visually impaired users
- Hold academic review sessions to ensure compliance with research standards

1.8.4. Communication Plan – Guiding Stick Project

1.8.4.1. Communication Objectives

- Ensure clarity of vision among all stakeholders
- Strengthening coordination between the team and supporting entities
- Document project progress at each phase
- Build trust with donors and beneficiaries

Target Group	Type of Information Shared	Communication Method	Frequency	Target Group
Project Team	Tasks, progress updates, challenges	Weekly meetings, email	Weekly	Project Team
Donors and Sponsors	Progress reports, performance indicators, budget	Formal reports, presentations	Monthly	Donors and Sponsors
Beneficiary Organizations (e.g., blind associations)	User needs, feedback, field experience	Interviews, surveys, workshops	Phase-based	Beneficiary Organizations (e.g., blind associations)

1.8.4.2. Recommended Communication Channels

- **Project management platforms** such as Trello or Microsoft Teams for task tracking
- **Official email** for formal correspondence with donors and academic partners
- **Regular meetings** (in-person or via Zoom) to review performance
- **Progress reports** outlining achievements, challenges, and next steps
- **Field workshops** with users to gather feedback and improve the prototype

1.8.5. Risk Management – Guiding Stick Project

No.	Risk Type	Description of Potential Risk	Risk Level	Response Plan	Responsible Party
1	Technical	Sensor failure to detect obstacles accurately	High	Pre-testing sensors and preparing backup options	Embedded Systems Engineer
2	Software	App malfunction or device incompatibility	Medium	Test app on multiple devices and update regularly	Application Developer
3	Connectivity	Wireless disconnection between stick and mobile app	High	Use reliable protocols and signal redundancy	Network Specialist
4	Financial	Budget overrun beyond planned limits	Medium	Allocate 10% contingency and monitor spending	Project Manager
5	Schedule	Delays in task execution or prototype delivery	High	Use Gantt chart and conduct weekly follow-ups	Project Manager
6	Quality	Low user satisfaction with stick performance	Medium	Collect feedback and improve the prototype	Quality Specialist

1.8.6. Procurement Management – Guiding Stick Project

1.8.6.1. Procurement Objectives

- Ensure timely availability of technical components with appropriate quality
- Select qualified suppliers based on project standards
- Control costs and monitor contracts to ensure compliance

1.8.6.2. Contract Management Plan

- Prepare clear contracts specifying scope, cost, and timeline
- Review contracts by the project manager before signing
- Monitor contract execution and document any changes or delays

1.8.6.3. Procurement Monitoring

- Use a procurement log to document all purchases
- Compare prices across suppliers to ensure cost-efficiency
- Evaluate product and service quality upon delivery

Item	Type	Key Specifications	Suggested Supplier	Procurement Method
Ultrasonic Sensors	Product	Detection range ≥ 4 meters, high accuracy	Local electronics store or online	Direct purchase
Microcontroller (e.g., Arduino)	Product	Wireless support, programmable	Authorized embedded systems distributor	Direct purchase
Bluetooth/Wi-Fi Module	Product	Compatible with microcontroller	Electronics store	Direct purchase
Rechargeable Battery + Charger	Product	Operating time ≥ 8 hours	Electronics store	Direct purchase
Mobile App Development Services	Service	User-friendly interface, Android support	Freelance developer or software company	Development contract
Field Testing Services	Service	Prototype testing in indoor and outdoor settings	Research entity or volunteers	Collaboration agreement
Printing and Documentation Services	Service	User manual printing, project reports	Academic printing center	Service request

1.8.7. Project Design – Information Gathering Phase

Project Name: Guiding Stick

Objective: To develop a smart cane that assists visually impaired individuals in safe navigation using sensing and alert technologies.

1.8.7.1. Information Sources

Source	Extracted Information Type	Collection Method
Interviews with blind users	Mobility needs, daily challenges	Personal and field interviews
Previous studies	Similar technologies, strengths and limitations	Literature review
Technical experts	Suitable hardware specifications, technical risks	Advisory meetings
Rehabilitation centers	Safety requirements, user recommendations	Surveys and field observations
Preliminary testing	Sensor behavior, alert effectiveness	Lab and field experiment

1.8.7.2. Project requirements

"Application"



1.8.7.3. Hardware Specifications:

Ultrasonic sensors

are sensors that send out ultrasonic waves and bounce back these waves in the event of an obstacle, and Calculate the time it takes for these waves to bounce. Based on this time, the distance from the sensitivity to the obstacle is calculated.



GPS-2

It is a device that receives signals GPS from satellites and locating the electronic device in which it was placed



image 2

The Whistle:

It is an electronic component that makes a sound when a suitable voltage is applied to its ends, and it has several types, including those that operate at a voltage of 5 volts or more. This type makes a sound when a voltage is applied to it, and when the voltage is removed, the sound stops. And there is another type of it that works by frequencies when we give it a voltage in frequency

A certain makes a certain sound and it has a positive terminal and a negative terminal and we connect the positive terminal with the microcontroller and connect the negative end with the ground

Resistors: We use resistors worth 100 k Ω to adjust the input voltage value of the microcontroller.
Resistors-5



.Connecting wires : These are wires that are used to connect and qualify components together

Jumper-6



Software Specification-2

It is a device that receives GPS signals from satellites and locates the GPS electronic device.

SMS Button

It is a button to send a text message to give a signal in the form of example numbers and is copied in Google Map to locate the blind.(28,366858,87,545093)

Arduino - Arduino Board

It is a small computer that can interact and control the environment around it better than a desktop computer, but technically it is an open-source software platform consisting of an electronic controller and an integrated development environment for writing software Leddy



External Battery:

A stored electrical power source that contains one or more chemical cells.



Buck converter: Its usefulness reduces the voltage and provides you with a suitable voltage



SIM card

It is a unit of identification of the subscriber and technically it is an integrated electronic circuit made of silicon whose purpose is to provide a distinctive number or identity for the subscribers of cellular network services, and for communication between members of the community through communication or message.



1.8.7.4. Software Specifications

Language: Arduino C

It is a set of instructions or commands given to the observer, the observer can be a computer or any other device based on a microcontroller or processor.

The purpose of these instructions is to direct the observer to carry out a series of actions (outputs) based on some information (inputs).

It is a language used to program the microcontroller in the Arduino board, and it is a language that is delineated Arduino C.

1.8.8. Project Development – Guiding Stick

1.8.8.1. Team Assignment

The project team is formed based on required specializations:

Role	Suggested Member / Entity	Key Responsibilities
Project Manager		Overall supervision, managing time, cost, and quality
Embedded Systems Engineer	Technical Member	Designing the smart cane's electronic system
Application Developer	Software Member	Developing the mobile app linked to the cane
Quality Specialist	QA Member	Performance testing and quality assurance
User Representative	External Entity (Blind Association)	Providing feedback and participating in field testing
Documentation Officer	Administrative Member	Preparing reports and official documentation

1.8.8.2. **Develop the Project Plan**

The plan includes the following components:

Element	Core Content
Project Scope	Design and implementation of a smart cane with sensory alerts
Timeline	Gantt chart showing phases over a 12-week period
Budget	Estimated cost of components and services in SAR
Quality Management	Specification table and performance standards
Risk Management	Risk types and response strategies
Communication Management	Plan for team, stakeholder, and donor communication
Human Resource Management	Role and responsibility distribution
Procurement Management	Required products/services and sourcing metho

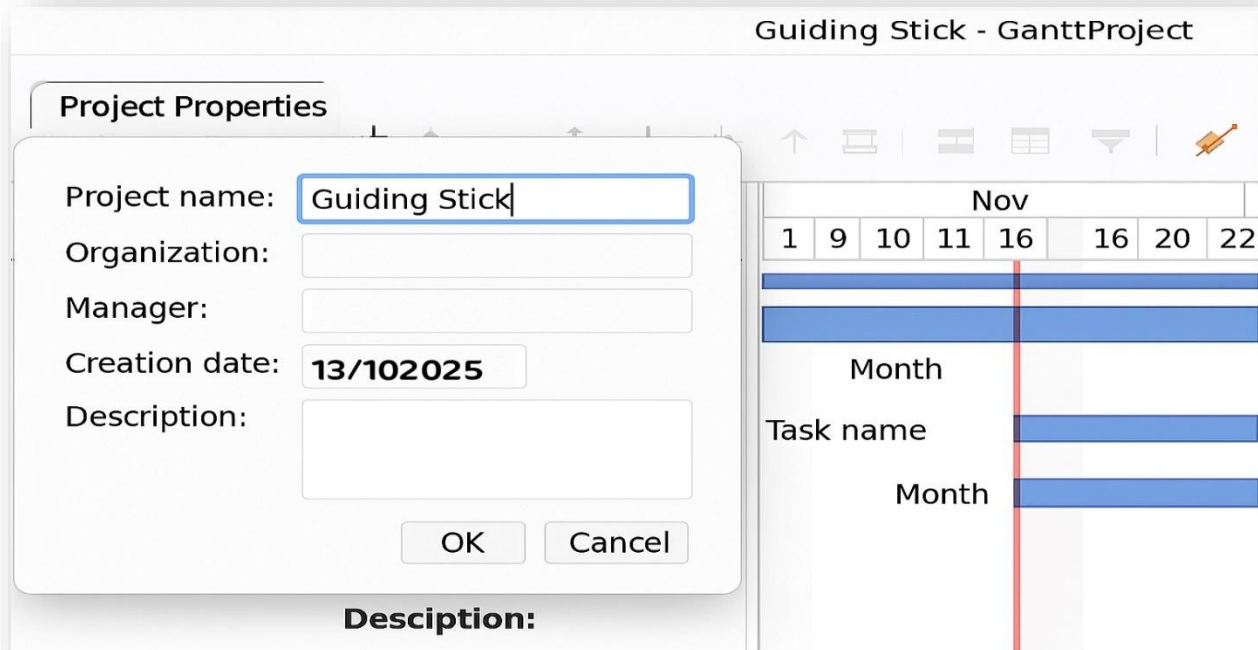
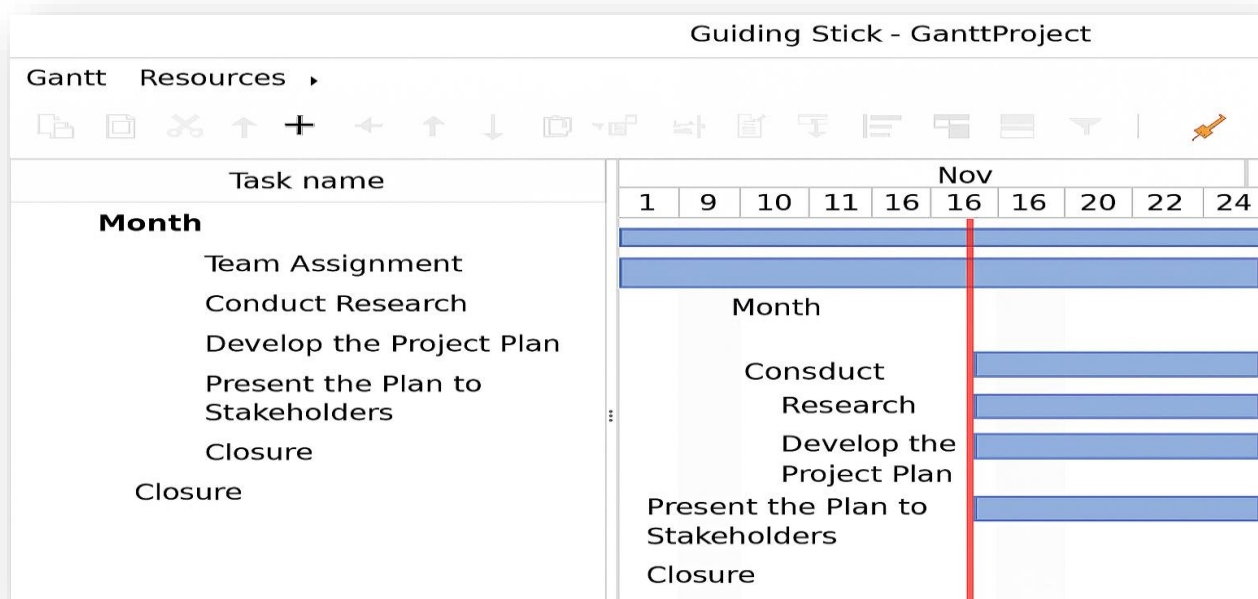
1.8.8.3. **Present the Plan to Stakeholders**

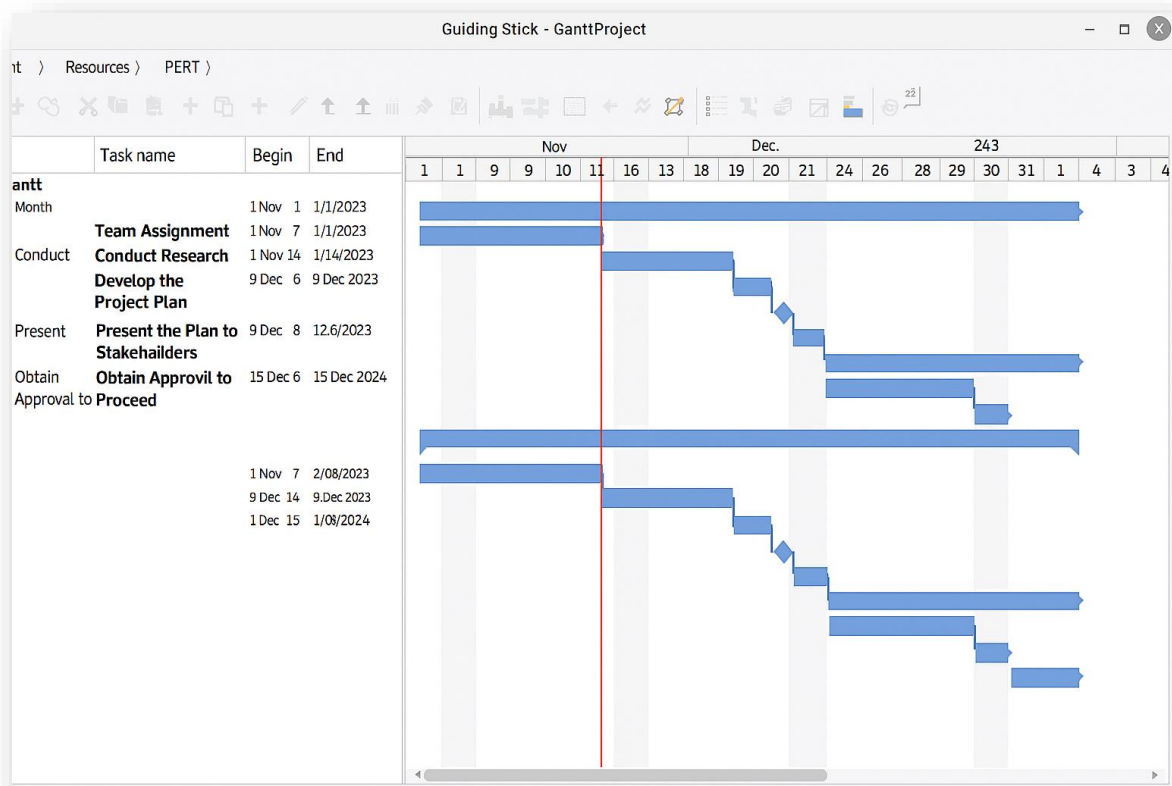
- Deliver a formal presentation covering objectives, timeline, budget, and expected outcomes
- Share project documents with donors, academic institutions, and blind associations
- Collect feedback and recommendations to refine the plan before execution

1.8.8.4. **Obtain Approval to Proceed**

- Sign cooperation and support agreements
- Get plan approval from academic or funding entities
- Launch project implementation according to the approved timeline

Implementing the Guiding Stick project using the Gantt Project program

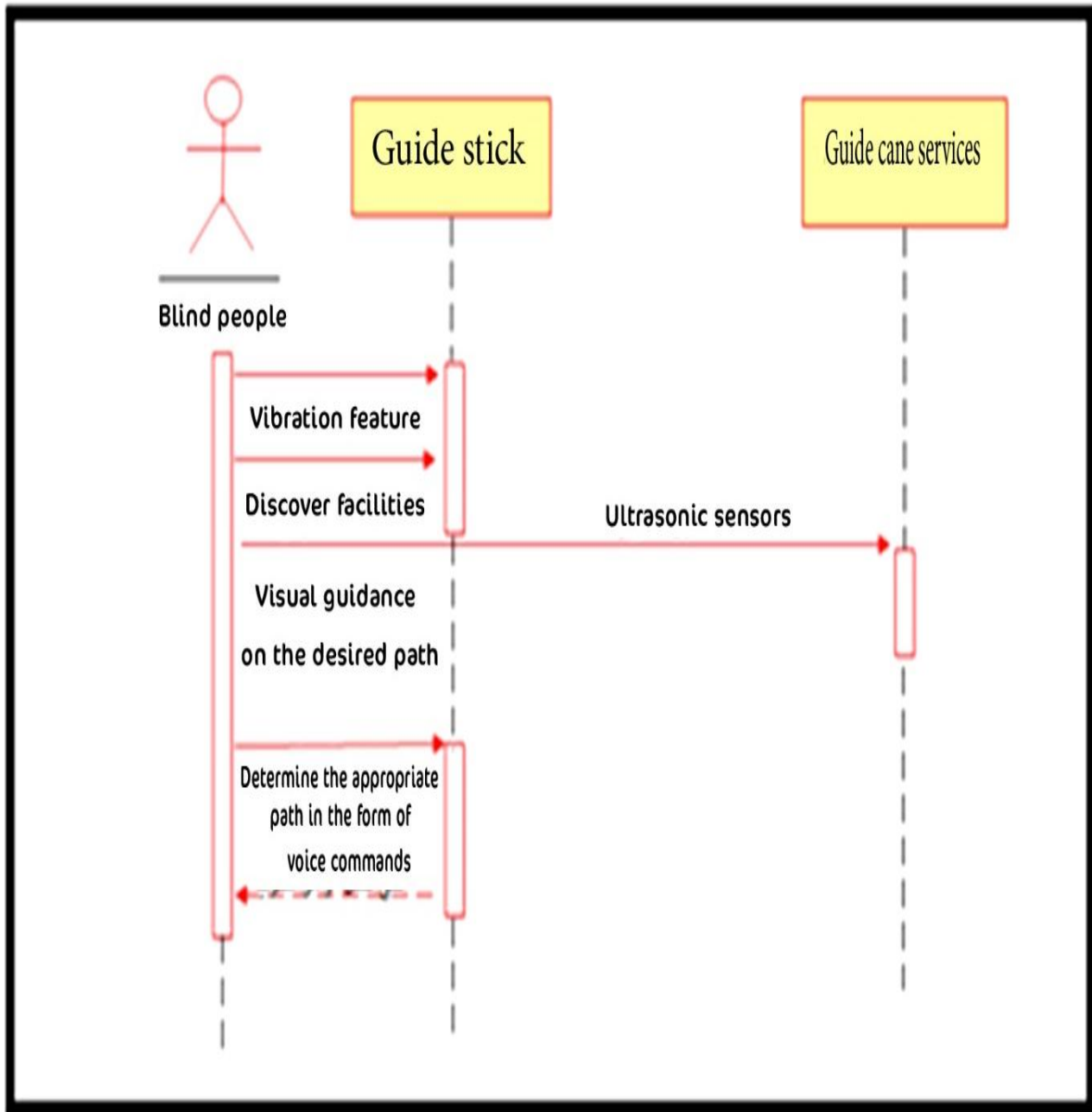




1.8.9. Resources and Cost – Guiding Stick Project (in SAR)

Resource	Unit	Cost per Hour (SAR)	Total Cost (SAR)
Ahmed (Project Manager)	Hour	100.00	5,000.00
Embedded Systems Engineer	Hour	150.00	12,000.00
Software Developer	Hour	200.00	10,000.00
Blind Association (User Rep)	Hour	100.00	2,000.00
Administrative Support	Hour	150.00	3,000.00
Total Budget			32,000.00 SAR

1.9. The Suggested Project Structure



1.9.1. Results and Outlook

For the sake of the group that has been deprived of the blessing of sight and God has not deprived them of the blessing of insight, we have decided with a cooperative work to develop a smart stick (the guiding stick) to guide them with several alerts, to help the blind to move safely, and we have worked with the aim of helping and benefiting from advanced technology, and our goal with this project is for the blind to be self-reliant and not need another person, so that the blind can have a normal life free of need. The straight road, i.e. obstacles and turns in the public place, there is a device that emits a sound to hear that there is a wrong turn or road here, and it is called, as we worked on it, (ultrasound sensor), and it measures distances, and in case the blind person is lost and does not know the signification, or return or go in any direction, there is a prominent button to use easily, and when the blind person presses it, he will receive a text message, the other party whose phone number has been linked with the guide stick for the blind when he receives the message for help, he will receive a text message. The numbers of the current location of the blind person appear, so we resort to helping him and do not make him feel alone, but attract him with a sense of security and not being afraid of anything.

The presence of feelings of love and strong relationships in the community makes us more solidarity and participation in various situations to be one hand and support each other, when cooperation increases, the need in society decreases because all individuals help each other and therefore there will be no one without help, and we have learned and faced responsibility but we have solved all the problems, we have overcome the consequences, and thank God, we worked on this work with full will, not only because it is not a job, but to help that group in the society that has been deprived of the blessing of the Sight, whoever you help today you will see tomorrow.

We hope that in the future we will work on our project by reducing the devices and hiding the wires to be more beautiful.

2. Chapter 2: Literature Review

2.1. Introduction

The Smart Parking Project

In light of the rapid advancement of modern technologies and the growing reliance on intelligent systems to enhance quality of life, there has emerged a pressing need for innovative solutions to manage public and private parking more efficiently. The Smart Parking Project addresses this need by developing an integrated digital system that leverages Internet of Things (IoT) technologies, Artificial Intelligence (AI), and smart sensors to provide users with a seamless and secure parking experience—from locating a spot to booking and payment.

The project focuses on solving common challenges associated with traditional parking systems, such as congestion, wasted time, and difficulty in finding available spaces. It offers smart solutions that include:

- Automatic detection of available parking spots using ground sensors or cameras.
- A mobile application that allows users to view and reserve available spots in advance.
- A secure and user-friendly electronic payment system.
- An administrative dashboard for monitoring performance and analyzing data to optimize operations.

This project represents a step toward digital transformation in urban infrastructure and contributes to achieving Saudi Arabia's Vision 2030 by promoting smart city concepts and improving the quality of services provided to citizens and residents

2.2. The independent variable

In the Smart Parking Project, the independent variable refers to the factor that is intentionally changed or controlled to observe its effect on the outcomes of the system.

The Independent Variable:

The type of technology used in managing smart parking systems Examples include:

- Ground sensors vs. smart cameras.
- Mobile applications vs. automated payment systems.
- Artificial intelligence techniques vs. traditional systems.

Why is this considered an independent variable?

Because changing the type of technology or system directly affects:

- The speed of locating available parking spots.
- The accuracy of detecting availability.
- User satisfaction and ease of use.
- Operational efficiency and traffic reduction.

2.3. The dependent variable

The dependent variable is the factor that is measured or observed in an experiment or study, and it is influenced by changes in the independent variable.

In the Smart Parking Project, the dependent variable can be one or more of the following indicators:

Examples of Dependent Variables:

Time spent searching for an available parking spot → Measures how effective the system is in reducing the time drivers spend locating a spot.

Parking occupancy rate → Reflects how efficiently parking spaces are distributed and utilized.

User satisfaction → Measured through surveys or app ratings, indicating the overall user experience with the system.

Number of violations or incorrect parking cases → A metric for how well the system organizes parking behavior.

Parking turnover rate → The number of times each parking spot is used within a specific time frame.

Relationship with the Independent Variable:

As the technology used (independent variable) changes—such as sensor type or app interface—it affects these dependent indicators, allowing for an evaluation of the smart system's effectiveness compared to traditional methods.

2.4. Conclusion

In conclusion, this project successfully designed and developed a specialized website for software sales, aiming to meet user needs in terms of easy navigation, clear product presentation, and fast access. The project focused on building an efficient user interface that enhances user experience and contributes to increased engagement and purchase rates. Modern technologies were adopted to ensure high performance, security, and future scalability. This website represents a significant step toward advancing digital commerce in the software domain and serves as a practical and adaptable model for various environments.

The project also highlights the importance of digital transformation in the transportation and public services sector, and its role in supporting Saudi Arabia's Vision 2030 toward smart and sustainable cities. Based on the anticipated outcomes, this model can be expanded and adapted to cover wider areas, with the potential to integrate with other intelligent transportation systems for a fully connected traffic management ecosystem.

In light of the achievements, it is recommended to continue developing the system by:

- Enhancing the accuracy of sensors and algorithms.
- Improving user experience through intuitive interfaces.
- Expanding the application to include accessible parking and multi-level facilities.

The Smart Parking Project is not merely a technical solution, it is a model of innovation aligned with societal needs, paving the way for a more organized and intelligent future.

3. References

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