NextGen Wheelchair: A Semi-Autonomous Approach for Disabled People Using Head Motion and Digital Twin Technology

Project Planning Document

Project Planning Report

CSE – 460

Group: A1

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1. Introduction

1.1 Documentation Purpose

Project plan documentation is a comprehensive guide for carrying out and managing a project, outlining its goals, objectives, schedule, available resources, and milestones. It makes collaboration, risk, and resource management easier and offers an outline for assessing success. Recording the project plan is essential to ensuring that everyone involved is working toward the same goals and following an organized strategy to completion.

1.2 Associated Documents

Additional documents made and associated with the project strategy include the Software Requirements Specification (SRS), Project Proposal, ER/Schema Diagram, Project Scheduling, and Project Workflow Diagram.

2. Project Scope

The scope of our project is to design and develop a wheelchair for individuals with physical disabilities who are unable to walk or talk. The wheelchair will be controlled using the user's head movements, with backup control methods such as the joystick and voice control. The project will involve the following steps:

1. Research and development of the head-controlled wheelchair system, including the hardware and software components.

2. Design and development of the joystick and voice control backup systems.

3. Design and Development of the Emergency System.

4. Integration of the head-controlled system with the backup control and emergency systems ensures seamless switching between control modes.

5. Design and creation of a web interface for patient monitoring.

6. Testing and validation of the wheelchair system to ensure safety, reliability, and performance.

7. Cost analysis and optimization of the system to ensure affordability and accessibility.

Although there is a huge scope for handicapped people, the project will have certain limitations, including:

1. The system will be designed for indoor and smooth surface use only, and may not be suitable for outdoor or rough terrain use.

2. The system will be designed for users with specific types of physical disabilities, and may not be suitable for all individuals with physical disabilities.

3. The system will have certain technical limitations, such as a limited range of motion for the head-controlled system and potential interference with other electronic devices.

Overall, the scope of our project is to develop a safe, reliable, and user-friendly wheelchair system that can be controlled using the user's head movements, providing greater mobility and independence for individuals with physical disabilities.

2.1 Objective

To increase the mobility and liberty of people who are physically unable to walk or speak, this project is focused on creating a wheelchair that can be operated by the user's head movements. By providing an alternative to traditional joystick controls or human assistance, we aim to empower individuals with physical disabilities to move around with greater freedom and dignity. We made the whole system accomplish some objectives such as:

2.1.1. To design and develop a wheelchair that can be controlled using the user's head movements.

2.1.2. To provide backup control methods, such as the joystick and voice control, to ensure that the user always has a method of control that works for them.

2.1.3. To be able to halt instantly when an emergency arises.

2.1.4. To develop and implement efficient decision-making algorithms that can identify obstacles and avoid them.

2.1.5. To be able to be controlled and monitored via a web interface.

2.1.6. To conduct rigorous testing and quality control measures to ensure that the wheelchair meets all necessary safety and performance standards.

2.1.7. To make the wheelchair affordable and accessible to as many people as possible, to improve the quality of life for those who are physically unable to move without assistance.

2.2 Success Criteria

The success criteria of the project are highlighted below –

2.2.1 The system shall be able to monitor from website navigation.

2.2.2 The system shall be halted in emergency situations.

2.2.3 The system shall be able to generate a buzzer alarm while detecting any obstacle.

2.2.4 The system shall be controlled through the patient's head motion.

2.2.5 The system shall be operated by two alternative modules – voice and manual joystick.

2.2.6 The system shall be able to control its speed whenever needed.

3. Deliverables

The NextGen Wheelchair will include a fully functional and secure process that will be integrated by both the patient and caregiver. The system will have a web-based platform by which the caregiver can monitor the patient. Besides, they can control the system from afar through the website navigation. The system provides security and safety to the patients as it makes an instant stop when detecting any kind of obstacle on the path. The caregiver can monitor the condition of

the patient continuously through real–time video feedback. Emergency situations will make the system halted which will make the system more reliable and usable. Additionally, documentation and training materials will be provided to ensure that users can efficiently and effectively operate the platform.

4. Project Approach

The agile methodology is adopted for the NextGen Wheelchair system. The system involves constant collaboration and working in iterations. Besides, the system can be continuously improved upon throughout its life cycle with changes being made as per user requirements. The agile approach allows us to make changes more quickly and accurately in the system.

Fig: Agile Method

4.1 Project Team Organization

We've divided our project into six parts and distributed the task among five group members as follows:

Equipment Collection	Saifur Rahman		Mohiuddin Bilwal	
Hardware	Shekh. Md. Saifur Rahman	Abrar Faiyaz Khan	M Rayhan Ferdous Faisal	
Software	Sheikh. Easin Arafat	M Rayhan Ferdous Faisal	Mohiuddin Bilwal	
Frontend	Sheikh. Easin Arafat	Mohiuddin Bilwal	Shekh. Md. Saifur Rahman	
Backend	Sheikh. Easin Arafat		Mohiuddin Bilwal	
Testing	Shekh. Md. Saifur Rahman	M Rayhan Ferdous Faisal	Mohiuddin Bilwal	Abrar Faiyaz Khan

5. Work Plan

It is quite convenient and efficient to plan ahead before starting a project. After selecting the idea for the project, we started looking into similar projects. In order to better understand the potential

of this project, we carried out a feasibility assessment and needs analysis. To improve the management of projects, we separated the work into smaller components and distributed them among the team members. We made an effort to stick closely to the timelines.

5.1 Work Breakdown Structure

For better understanding, the work structure has been deconstructed below:

5.1.1 Problem Statement Identification

1. Define the problem statement and user requirements.

2. Conduct a survey, interview, and research study to identify existing solutions and best practices.

5.1.2 SRS Preparation

1. Prepare a detailed Software Specification Requirement report that includes the functional and non – functional requirements, context diagram, use cases, sequence diagrams, and system architecture.

5.1.3 Developing the Front End and Back End

1. Develop a user–friendly interface for the system.

2. Design and implement the front end using appropriate technologies and frameworks.

3. Integrating the database with the front end.

5.1.4 Integrating Hardware Modules with Software

1. Integrate the hardware modules with the software parts to ensure data passing among themselves is smooth and quick.

2. Set up the appropriate hardware modules to operate the system.

5.1.5 Testing the System

1. Test and evaluate the system according to the requirements.

2. Continuously monitor the system to avoid any kind of uncertain occurrences.

5.2 Resources

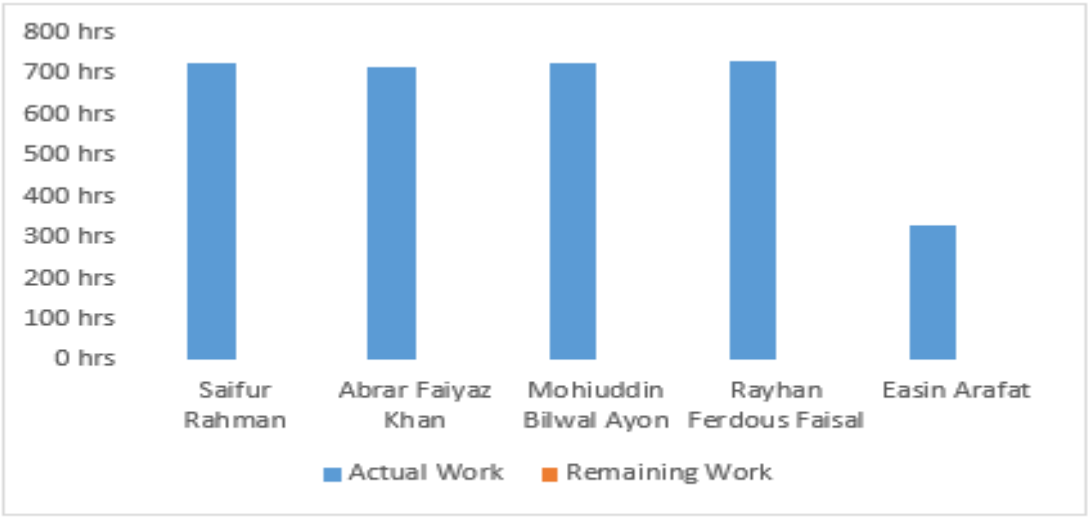

Fig: Resource Stats

6. Milestones

Name	Finish
Purchasing Necessary Equipments	Tue 28/02/23
Update Presentation	Tue 07/03/23
Design Update	Tue 14/03/23
Dataset Manipulation Update	Tue 21/03/23
Algorithm Update	Tue 28/03/23
Developed Code Presentation	Tue 04/04/23
Software Development Finish	Tue 11/04/23
Present Whelchair	Tue 04/04/23
Hardware Development Finish	Tue 11/04/23
Present Initial Integration Result	Tue 02/05/23
Integration Finish	Tue 09/05/23
Report Update	Tue 23/05/23
Submission of Report	Tue 30/05/23
Final Report Submission	Wed 21/06/23
Article Submission	Wed 21/06/23

Fig: Project Milestone

7. Risks, Constraints, and Assumptions

For a project to be developed successfully, risk factors and restrictions must be recognized and understood. When there are inconsistencies in the data, it is sometimes considered that several factors are at play. A project team can reduce possible problems and guarantee that the project is effectively finished by actively assessing and addressing these aspects.

7.1 Risks

There're some particular precautions that needed to be considered:

Risk Description	**Mitigation Plan (What to do to avoid the risk occurring)**	**Contingency Plan (What to do if the risk occurs)**	**Impact (What the impact will be on the project if the risk occurs)**
Obstacle detection doesn't work properly.	Sonar sensors should be connected properly to the system.	The system should be halted instantly.	Emergency situations like accidents and injuries may occur. So, the impact can be higher.
Raspberry Pi can't detect voice speech properly.	A high level of the platform can be used.	The system can be controlled through the other two modules.	The impact will be less.
Internet connection may not be available for long distances.	The system can be operated on a fixed range.	The system will have to be controlled by a continuous internet connection.	The impact will be less.

Fig: Resource Overview

7.2 Constraints

Like the other projects, we've also some limitations in our project. The known limitations are listed below:

1. The video streaming is really slow and sometimes it delivers very late to the user.

2. The obstacle detection operates based on the usability time of the modules.

3. Voice recognition may not work efficiently in noisy places.

4. In emergency situations, the system performs a bit late than expected.

7.3 Assumptions

There're some assumptions we've made during the development phase of the project. As follows:

1. The processing power of Raspberry Pi needs to be faster to operate such a heavy system.

2. To control the system smoothly, the system should have a high-speed internet connection.

8. Financial Plan

The project required the procurement of specific hardware components in order to meet the demand of implementing the project works. The project's complete financial strategy in given below:

Serial Number	Items	Quantity	Unit Cost (BDT)	Total Cost (BDT)
1	Joystick Module	1	100	100
2	Resistor (5K, 10K)	15	1	15
3	LED	30	1	30
4	Raspberry Pi Casing	1	900	900
5	SD Card	1	750	750
6	ESP32 Microcontroller	1	700	700
7	USB Soundcard	1	850	850
8	Push Button	18	40	720
9	Buck Converter	1	100	100
10	Jumper Wire	2 Set	50	100
11	4 LED 12V Battery Indicator	1	130	130
12	Buzzer	1	50	50
13	Double Sided Foam Tape	2	50	100
14	Anti-cutter	1	150	150
15	Glue Stick	6	5	30
16	Color Spray	1	150	150
17	Relay	2	35	70
18	Arduino UNO	2	1,100	2,200
Total				7,145 Tk

Besides, we've used other components which was issued from the department like sabertooth motor, motor driver, wheels, 12V battery etc. which are not added in the financial list.