Software Requirements Specification

for

<Project>

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1. Introduction

A robotic arm is a type of mechanical arm, usually programmable, with similar functions to a human arm; the arm may be the sum total of the mechanism or may be part of a more complex robot. The links of such a manipulator are connected by joints allowing either rotational motion (such as in an articulated robot) or translational (linear) displacement. The links of the manipulator can be considered to form a kinematic chain. The terminus of the kinematic chain of the manipulator is called the end effectorand it is analogous to the human handThe end effector, or robotic hand, can be designed to perform any desired task such as gripping, spinning etc., depending on the application. For example, robot arms in automotive assembly linesperform a variety of tasks such as weldingand parts rotation and placement during assembly. In some circumstances, close emulation of the human hand is desired, as in robots are designed itself.

- **Purpose**

  This robot is a mechanical arm, a manipulator designed to perform many different tasks and capable of repeated, variable programming. To perform its assigned tasks, the robot moves parts, objects, tools, and special devices by means of programmed motions and points. The robotic arm performs motions in space. Its function is to transfer objects or tools from point to point, as instructed by the controller in manufacturing industry and nuclear industry, a large fraction of the work is repetitive and judicious application of automation will most certainly result in optimum utilization of machine and manpower. Robot has been developed to achieve automation in applications where great sophistication is not needed and simple tasks like picking up of small parts at one location and placing them at another location can be done with great ease.

- **Document Conventions**

  When writing SRS document for robotic arm project the following terminologies are: To make the document more effective and readable I used Arial font style and font size 12 and headings are bold.

- **Intended Audience and Reading Suggestion**

  This document is written for the researchers, project managers, programmers, designers, developers, testers, documentation writers, users involved in the project development of Robotic Arm. This document consists of the various steps and procedures for the robotic arm. Following section describes the rest of the product function. Scope and other overall description. Finally, with the references.

- **Product Scope**
  - The machine will be of great use to perform repetitive tasks of picking and placing of small parts in an industrial production line.

- Its use can be used to do difficult tasks for industrial applications.

- It can be used to do small assembly work effectively due to its great added accuracy for placement of parts, which is further extended scope of our project. The end effect can be a pair of pneumatic grippers, a set of multiple grippers, magnetic pickup, vacuum pickup etc. The device has its own inbuilt logic and all the movements of the device are controlled by the combination of controller. The operating speed of the pickup arm can be varied to suit the requirement.

- **References**

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2. Overall Description

The mechanical design of the robot arm is based on a robot manipulator with similar functions to a human arm. Robotic arm system often consists of links, joints, actuators, sensors and controller. Robot base, and another end is equipped with a tool (hand, gripper, or end-effectors) which is analogous to human hand in order to perform assembly and other tasks and to interact with the environment. There are two types of joint which are prismatic and rotary joints and it connect neighbouring link. The links of the manipulator are connected by joints allowing rotational motion. A robotic arm with only four degrees of freedom is designed because it is adequate for most of the necessary movement. At the same time, it is competitive by its complexity and cost-saving as number of actuators in the robotic arm increases with degrees of freedom. In a robotic system, the number of degrees of freedom is determined by the number of independent joint variable.

- **Product Perspective**

  The Robotic Arm consists of three main components, Robot Simulator, Environment Control Panel and Environment Simulator. It requires two interfaces. One is the interface between communication model and environment simulator. This interface provides communication to simulated robots. The other interface is between communication model and Environment Control Panel. This interface provides input for some variables of the communication model, which are propagation delay time, broken links, and range limit of each simulated robot.

- **Hardware**
  - 4-DOF
  - 4-Servo Motor
  - Accelerometer
  - Bread board
  - F to F Connector (Jumper)
  - M to M Connector (Jumper)
  - Battery 9V
  - Screws
  - Marking Tape
  - Vinyl Sheet
  - Arduino UNO 3

- **Software**

  Arduino Language

- **Product Functions**

  A complex "brain" system would allow a robot to identify objects within the environment around it, based on the information gathered by the sensory systems. The "brain system" would then send signals to the muscle systems based on that information, enabling the robot to interact with the objects surrounding it.

- **Operating Environment**

  Many enterprises have trouble in training people to work with expensive equipment, which is needed for carrying out profitable work tasks (e.g., production line robots). Similar problems are found when work is of a complex and safety-critical nature (e.g., nuclear environments, explosive placement, surgery). A common problem faced by educational institutions concerns the limited availability of expensive robotics equipment, with which students in the didactic program can work, in order to acquire valuable "hands on" experience. This paper describes a method of education and training involving off-line usage of virtual reality environments for task planning. When tasks are developed to the satisfaction of the trainee, they are exported to remote physical hardware, via the Internet, for real-world execution. Development of the system and the training experiments is discussed, along with some of the issues raised for telerobotic and solutions to the problem of detecting collisions in the virtual world. The approach has been shown to be viable and increases the education and training possibilities for key workers while maintaining a low cost of ownership. The downtime of mission critical equipment is minimized while the gaining of valuable experience is maximized.

- **Design and Implementation Constraints**
    - This project will be designed to provide capability of moving objects which is not capable with bare human hand.
    - The design of the project should not rule out the web interface capability.
- **User Documentation**
    - Synopsis.
    - SRS (Software Requirement Specification).
    - Report.

- **Assumptions and Dependencies**

  We assume that all components are perfectly synchronized and worked perfectly.

3. System Features

- **Increased Efficiency**

  Industrial robots can complete certain tasks faster and better than people as they are designed to perform these tasks with a higher accuracy level. This and the fact that they are used to automate processes which previously might have taken significantly more time and resources means that you can often use industrial robots to increase the efficiency of your production line.

- **Higher Quality**

  Due to their high accuracy levels, robots can also be used to produce higher quality products which adhere to certain standards of quality, whilst also reducing the time needed for quality control.

- **Improved Working Environment**

  Industrial robots are often used for performing tasks which are deemed as dangerous for humans, as well as being able to perform highly laborious and repetitive tasks. Overall, by using industrial robots you can improve the working conditions and safety in your factory or production plant. Robots don’t get tired and make dangerous mistakes, neither do they suffer from repetitive strain injury.

- **Increased Profitability**
  By increasing the efficiency of your production process, reducing the resource and time needed to complete it, and achieving higher quality products, industrial robots can thus be used to achieve higher profitability levels overall, with a lower cost per product.

- **Prestige**
  You set yourself at the cutting edge of your industry and wow your customers when they come to see you. As a marketing tool robot are fantastic, boost your brand image, and have often been used simply for the PR even if they don't offer many benefits over a bespoke non-robotic system.

4. Other Non-functional Requirements

- **Performance Requirements**
  The level 4-DOF configuration will be controlled using different types of classical controllers and observer-based controllers. The system shall also perform disturbance rejection for a load. The specifications for the performance of this system for a step command of 90º.

- **Safety Requirements**
  - **Mechanical Hazards**
    - Overturning/tilting due to movement (caused by dynamic effects) overturning/tilting due to external forces (putting load to the robot, collisions, etc)
    - Collision due to movement of mobile platform.
    - Collision due to movement of manipulator.
    - Clamping/Crushing (e.g. due to openings or gaps with varying size).
    - Sharp edges Falling objects Rotating elements (e.g. power transmission elements)
  - **Electrical Hazards**
    - Short circuit.
    - Electrostatic hazards.
    - Live parts, terminals of battery.
    - Overload, overheating
    - Insufficient power supply
    - Loss of power

- **Hazards from Operational Environment**
    - Ingress of moisture or liquid.
    - Disturbance by electro-magnetic noise.
    - Heat source
    - Pets
    - Hazards from limited travers ability (steps, slippage, etc)
    - Conditions causing sensor errors (e.g. strong sunlight)

- **Hazards from User Interaction, Ergonomics**
    - Over-complicated operating instructions
    - Wrong design or location of indicators and visual displays units
    - Mental/cognitive overload of the user (wrong input, wrong interpretation of situation)
    - Limited visibility (especially regarding remote-control)
    - Change of control mode
    - Handing over a wrong (hazardous) object
    - Overload during object manipulation
    - Allergenicity/irritancy
- **Hazards due to Emissions**
    - Sound (including ultra-sound)
    - Light (including IR, laser)
    - Vibrations
    - Electro-magnetic noise

5. Other Requirements

The UI-PRO should be improved in further versions in order to make the software usable and accessible. Improvement related to remote control interface, aesthetics and grasping and bringing performance will be expected based on the recommendations to be specified in D6.2. Apart from usability and accessibility results of the UI-PRO, these trials have showed that the user acceptance of the interaction with the robotic arm is medium to high.

6. Appendix A: Glossary

Define all the terms necessary to properly interpret the SRS, including acronyms and abbreviations. You may wish to build a separate glossary that spans multiple projects or the entire organization, and just include terms specific to a single project in each SRS.

- **DOF:**
  The arm uses 4 deceleration stepper motors as effector. The original design was a 7 DOF robot, yet the motor can’t generate enough torque to drive the whole system. So, the number of joints was reduced to 4.

- **Arduino:**
  Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

- **Servo motor:**
  A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback.