**PROBLEM ANALYSIS**

After this we were tasked with performing research, with the topics largely being on automation and robotic arms. The research included: the definition of automation, the impacts of automation on the UK job market, the economic benefits/negatives of automation and an analysis of robot arm operation. We were also tasked with analysing the scientific properties of various robot components and also analysing the social, economic and environmental consequences of automation.

**PROBLEM SOLUTIONS**

The first task that we were presented with was to develop a robotic arm using the Arduino T05000 TinkerKit provided. The team grouped together to build the kit, with the arm being split into three sections with two people working on each section. This allowed the robot to be built in an efficient way, with the team then being able to focus on the other tasks at hand. When building we followed the instructions provided but when we began coding, we realised that we had installed the motors in slightly the wrong positions. This meant that the wrong motors were moving when we were writing commands, so we had to rebuild the robot and move the motors to the correct positions. Andrew and Syed were tasked with the rebuild.

After the robot was built, we were tasked with performing relevant research and analysis, mainly on automation and robotic arms. The research and analysis were set to give the team a good knowledge of the topics required to succeed with the project. It gave us a good background knowledge and allowed us to find out where and why autonomous robotic arms are used in real life. Andrew (project manager) decided that it would be best to split the research into equal parts for each group member to perform. This was to ensure that the research was performed as quickly and efficiently as possible, leaving more time to focus on the other aspects of the project.

We then moved to the mapping process, using the six degrees of movement of the arm to navigate to various artefacts located around a given area. The degrees of movement were accomplished using six servomotors located across the robot which had the ability to rotate between 0° and 180°. We ensured that during the coding process we did not enter any coordinates outside of these tolerances so as to avoid damaging the robot components or circuit board. We decided to use trial and error to find the coordinates of the artefacts, moving each component of the arm into the most beneficial position for the artefacts to be picked up. Safety and longevity were a concern here, ensuring that the movements of the robot were not likely to cause injury to anyone nearby and also ensuring that the robot was not tasked with any movements that may cause premature wear to the components. Andrew, Syed, Litos and Thanuyan were tasked with the mapping process.

When coding we used the Arduino software, which uses a coding language that is loosely based on C++. We began by creating a coding flow diagram, giving us a clear idea of the process that we were going to use when writing the code. This was useful to revisit when we were unsure whether we were writing the instructions for the robot to perform. When we wrote the code, we began by using the “YearZeroCodeItYourself” code (Blair, R. 2019) with Andrew, Syed, Thanuyan and Litos all helping to write the missing code and learn how to control the robot. Once we had a good idea of what to do, we moved on to “YearZeroRobotArmManualInstructions” (Blair, R. 2019). This code was used to find the coordinates of the balls manually. Once all of the coordinates had been plotted and the angles had been planned, we moved onto “YearZeroRobotArmMain” (Blair, R. 2019), allowing for fully autonomous movement from the robot. We wrote the code for the robot to perform all of the required tasks, using the base code as guidance and adding the pre-planned coordinates. The manual and autonomous code was written by Andrew and Syed.

Once the autonomous code had been written, we moved onto the testing phase of the project, carried out by Andrew and Syed. We carried out many tests to ensure that the code was right. When testing, we noted that the arm always struggled to return to the same position more than once. After performing research, we concluded that this was due to the servo-motor gearing, which made it hard for the servomotors to return to the same position (Apoorve, 2015). We also noted that, when trying to correct each motor individually for one movement, another movement would shift slightly and also need correcting. This led to a lot of time spent changing the coordinates by 1° - 2° each time through trial and error. After this, we finally made the robot work correctly prior to the final graded test.

On the presentation day of our project we proceeded to showcase our robot, showing that the project was a success. When testing the robot before the final showcase, a malfunction occurred. The robot moved to the 90° neutral position and proceeded to exert too much pressure onto the base, causing the retaining screws to rip out of the base and the robot to fall to the floor. This was a major setback to the project as this could have led to us failing the project. Before this happened, the robot testers (Andrew and Syed) used their initiative and decided to record the robot functioning correctly. This allowed us to show the recording to the lecturers, who decided that the robot functioned well enough to pass the showcase. If the group had not shown this initiative, then it would have caused a major setback and could have resulted in the group failing the robot showcase.

Once the showcase had been completed, we were required to give a presentation detailing the whole project to the lecturers. The reason for the presentation was for the group to gain experience in public speaking and also to allow us to build the skills required to present a design in the future. We had to design the presentation in a way that would be similar to a presentation given by a qualified engineer to an audience who they were trying to persuade to use their idea. The presentation had to be structured clearly as it would need to be in a real-life design proposal. The presentation was written by Thanuyan, Litos and Basit, and the group ensured that we practiced it heavily before presenting to the panel. This was to ensure that we were fully confident and prepared. Once the presentation had been completed, we were required to answer questions put to us by the lecturers. The questions were mainly technical in nature and were asked to ensure that the individuals in the group had a good knowledge of the topics set to them to speak about.

References:

Apoorve. CircuitDigest (2015) *Servomotor: Basics, Theory and Working Principle.* Available at: https://circuitdigest.com/article/servo-motor-basics (Accessed 06/02/2020)

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