Tuff Torq — Screening Questions

Candidate: Arjan Gupta

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- **Question 1:** Can you tell me about your relevant experience for this position?

  - **Answer:** Absolutely. First off, I have a Bachelor's degree in Computer Engineering from the University of Kansas, and 6+ years of experience as a software engineer. I am also working towards a Master's degree in Robotics Engineering from Worcester Polytechnic Institute, with a specialization in autonomous vehicles.

    My current position involves building a semi-autonomous motion system for an enormous agricultural machine called an irrigation pivot. I improve the system's ability to navigate the field including path planning, GPS dead-reckoning, and obstacle detection using on-board sensors. I mainly do this by writing C/C++ code for a complex embedded system on the machine. I write test scripts for the system in Python.

    Furthermore, in my Robotics Master's degree program, I'm working with a variety of robotics frameworks and libraries including ROS2, Gazebo, and TensorFlow. I am developing machine learning, deep learning, and reinforcement learning for both academic and personal projects. Here, I use Python extensively.

    I am also a Co-founder of a very early-stage company where I use PyTorch, OpenCV, and YOLOv7 to help daycare workers keep track of children that might have been left unattended. In this position, I write Python and JavaScript.

    Other notable and related experience includes my work with biometric facial recognition systems, which relied on a pipeline of computer vision and machine learning algorithms. Also, at a previous company, I have contributed to the 3 degree of freedom (DOF) motion planning of a robotic arm that used a LiDAR sensor to estimate the volume of grain in a silo.

- **Question 2:** What Specific Skills do you posses that make you a strong candidate for this role?

  - **Answer:** I have a strong background in software engineering and robotics. I am able to write C, C++, and Python code proficiently to develop software for various applications.

    I am comfortable with designing and implementing machine learning models, neural networks, and reinforcement learning algorithms. I can solve vision and path planning problems using OpenCV and ROS2. Because of my Master's program, I am familiar with SLAM (Simultaneous Localization and Mapping) techniques. Because of my experience in embedded systems, I have a strong understanding of sensors and sensor fusion.

    I am well-versed in using Git for version control, writing requirements and design documents, and writing unit tests for my code. I also mentor junior engineers and interns, and I am comfortable communicating with both technical and non-technical stakeholders.

- **Question 3:** How do you approach problem solving or handling challenges in the workplace?

  - **Answer:** I approach problem solving by first understanding the problem and its context. For example, if I am tasked with debugging a GPS dead-reckoning algorithm, I would first understand how the algorithm is being used on the system as a whole. I would collect information about the problem by asking what the unexpected and expected behaviors are. Then, I would formulate a hypothesis about the problem and test it. If the hypothesis is incorrect, I use what I've learned in testing the system so far to formulate a new hypothesis, and then repeat the process.

    However, sometimes the problem is not well understood, and the challenge is to understand the problem itself. In this case, I would use a similar approach, but I would also do research to understand the problem better. Sometimes this can involve studying a technology or sub-field of engineering that I am not familiar with. However, when I am comfortable with a certain level of understanding, I re-assess the problem and formulate a hypothesis on where to look next.

- **Question 4:** Can you provide an example of a project or accomplishment you are proud of?

  - **Answer:** I am proud of my work on the irrigation pivot project where I built a semi-autonomous motion system for an enormous agricultural machine. I collaborated with other engineers to build many

parts of this system. I wrote drivers for sensors and the network stack, so that information about the system could be communicated to the control system. I heavily improved the motion planning algorithm, which involved writing a path planner that can intelligently decide when to energize the motors to move the machine. This takes into account checking relays, checking the state of the machine, and checking the state of the motors. A mapping of the field is also used to determine the best path to take. Furthermore, I also wrote a GPS dead-reckoning algorithm that can estimate the position of the machine when GPS is not available.

- **Question 5:** How do you stay updated and continually improve your knowledge and skills in your field?

  - **Answer:** I have several ways of keeping my knowledge current. First of all, I am currently pursuing a Master's degree in Robotics Engineering, so taking new courses is one way I continually improve my knowledge and skills. However, my desire to learn new things extends beyond the degree. I have taken Coursera courses on machine learning and deep learning, and I have also taken Udemy courses on YOLOv7 and YOLOv8. I also read research papers on a variety of topics, including reinforcement learning, robot dynamics, and computer vision. My sister is also a PhD student in Neuroscience, so I often discuss research papers with her, even if they are not directly related to my field.

- **Question 6:** Describe a situation where you had to work collaboratively as part of a team to achieve a goal.

  - **Answer:** I have a few examples of working collaboratively as part of a team, but I will use the instance where I worked with a team of engineers to build a 3 degree of freedom (DOF) robotic arm that uses a LiDAR sensor to estimate the volume of grain in a silo.

    I was responsible for relaying the point cloud data from the LiDAR sensor so that it can be transmitted to the cloud via the cellular network on-board. I collaborated with a senior firmware engineer to retrieve information from the CAN bus interface for the LiDAR sensor. I also helped with the motion planning of the robotic arm where it needed to perform a sweep of the silo to estimate the volume of grain. Here, the simulation was done with a senior mechanical engineer, so we used the path planned by the simulation to implement the motion planning algorithm. This involved PWM control of the motors, as well as sensing the angles of the motors. We also collaborated with an electrical engineer to bring up the PCB for the robotic

arm, and tested the PCB with the motors and sensors.

- **Question 7:** How do you prioritize your work and manage your time effectively?

  - **Answer:** For me, the best way to do this is by breaking down the task at hand into smaller tasks. I then prioritize these tasks in a project management tool like Jira. I also use a Kanban board to visualize the tasks that I am working on. For each task, I estimate the time it will take to complete it, and I thereby also estimate the time it will take to complete the entire project. I also plan in time for unexpected tasks that might come up. Once I have planned, I schedule focus-time on my calendar to work on the tasks.

- **Question 8:** Can you share an experience where you demonstrated leadership skills or took initiative?

  - **Answer:** At my current position, we have recently hired a new engineer. The week that he started working with us, my team-lead was swamped with work, and this was causing the new-hire to sit idle for his first couple of days. The new-hire needed someone to help him get up to speed and guide him through some tasks. At this point, I took the initiative to mentor the new engineer. I had a set of tasks that I was working on, and I delegated some of these tasks to the new engineer. I also helped him get set up with the tools and software that we use. When I took on this initiative, I replaced the time I had allocated for the tasks I delegated with time for mentoring the new engineer, so that I could help him in an organized and effective manner. I also made sure to check in with him regularly to see if he needed any help. When he did need help, I would pair-program with him to help him get unstuck. I showed him many debugging techniques, and I also showed him how to perform professional code reviews. This made his first few weeks at our company very productive, and as a result, my team lead was impressed with both of our work. This way, not only did I finish my tasks in the time I had already allocated, but I also brought up a new engineer to speed, while creating a rapport with him.

- **Question 9:** How do you handle feedback and criticism from others?

  - **Answer:** The way I handle feedback and criticism from others is by seeking it deliberately and regularly. This way, I mentally prepare myself to receive the feedback, and even something harsh is not unexpected. To do this, I also attempt to keep the demeanor positive by simply asking, "How can I improve?" after working with someone on a project.

In general, I am always looking for ways to improve, so I attempt to keep an open mind when receiving feedback. When someone provides me with suggestions on how to improve, I take their perspective with empathy, and I try to understand why they are suggesting the change. I also try to understand the context of the feedback, and I try to understand the problem that the feedback is trying to solve. I then take the feedback and incorporate it into my work.

- **Question 10:** What interests you about this position and our organization?

  - **Answer:** It has been my dream to work in the field of autonomous machines, and I am very excited about the prospect of working at Tuff Torq. In particular, I am interested in the work that Tuff Torq is doing with off-road autonomous systems. I think this is a unique and exciting opportunity to build something that will have a positive impact on the world (usually, autonomous vehicles automatically means cars, but in this case, it is off-road and unique). I am also interested in the fact that Tuff Torq is a well-established company with a long history of innovation and excellence. I am excited to be a part of this tradition, and I look forward to contributing to the company's success.

- **Question 11:** How do you adapt to change and handle ambiguity?

  - **Answer:** Change is the only constant in life, and I have plenty of experience adapting to change. Let me provide a concrete example. All the companies I have worked for have been usually acquired by larger companies, and this has often resulted in a change in the company culture. Sometimes, there has been ambiguity in the work that needs to be done as well. However, I have found that keeping a positive attitude is key in these situations. Wearing a smile and having a good sense of humor can uplift the morale of the team. I have also found that being flexible and accommodating to the new situation is important. For example, if a new process is introduced, I try to understand the reason for the process, and I try to follow it to the best of my ability.

    When there is doubt in what needs to be done, I have found that taking initiative helping the company in any way I can is a good way to get started. For example, if there is ambiguity on how we need to organize the timeline of a project, it is best to take an initiative and schedule a meeting to discuss the timeline (as long as it is fine with my manager).

- **Question 12:** Describe a situation where you had to resolve a conflict with a colleague or team member.

– **Answer:** At my previous company, I was responsible for implementing the remote configuration of a device over the cellular network. Particularly, we wanted to send a large JSON file over a 3G cellular connection using a single MQTT message. I was tasked with implementing this feature, and found that the JSON file was too large to reliably send as a single message. We were going to be using this device in locations with spotty cellular coverage, so we needed to find a way to break-down the JSON file into smaller chunks, or download the file using a separate, persistent TCP connection than the MQTT connection.

When I approached the cloud-side engineer with this problem, he was adamant that the JSON file should be sent as a whole. He touted that the theoretical speed of the cellular network was enough to send the JSON file. He mentioned that he had read research papers that showed that the capabilities of the cellular network were far more than what we needed. However, I had seen some data transmission logs, and had seen speeds as low as 1 kbps. I also knew that the cellular network in some areas of physical installation of the device was just not reliable enough to retrieve the entire JSON file as a single MQTT message. When we tested the system in our office, the single MQTT message was able to be sent just fine, so it was hard to substantiate my claim.

This argument between me and the cloud-side engineer went on for a few days, and was hindering progress on the project. In order to resolve this issue, I approached an engineering manager and asked to organize a field trip to see a physical installation of the device. In any case we had been wanting to visit sites where the device was being used, so this was a good opportunity to do so. The trip was approved, and I took the cloud-side engineer with me. We went to the physical installation, where we saw that the cellular network was indeed unreliable. We also saw that the JSON file was unable to be retrieved as a single MQTT message. Then in the following days, designed a way to break-down the JSON file into smaller chunks, and implemented the feature. This was a good learning experience for us both, and we were able to resolve the conflict.

• **Question 13:** Can you provide an example of when you had to meet a tight deadline or work under pressure?

– **Answer:** In May 2023, I was working on a set of tasks to change the GPS data communication method. The plan was to try the improvement on a customer's machine in the field at the end of the month. However, the customer wanted to use the machine for the upcoming irrigation season, so we had a tight window to test the functionality

before the season started.

When we finally went to the field to test the new functionality, we found that the GPS data was not being communicated to the control system. If we did not get the issue fixed within the next few days, we would potentially not be able to test the functionality until after the irrigation season, which was several months away.

At this point, I had to work a few 12 hour days to get the issue resolved. The root cause of the issue was that we had set up our GPS simulator incorrectly, such that the packet of data that was being sent by the simulator was not the same as the packet of data that was being sent by the GPS receiver. When we fixed the issue and delivered it, our boss was very happy with our work, and rewarded us with a lunch at a local restaurant.

- **Question 14:** How do you ensure attention to detail and maintain accuracy in your work?

  – **Answer:** Accuracy is a paradigm that goes hand-in-hand with validation and verification. This comes by devising a set of requirements for the system, and having a team review and approve these requirements. Then, I design the system to meet these requirements, and I have a team review and approve the design. Next, the implementation details are then connected to test cases that verify that the system meets the requirements. Finally, the system is tested in a real-world environment to ensure that it meets the requirements.

    Attention to detail is a bit more nuanced. Usually, when working toward a requirement, it is possible to break down the requirement into smaller tasks. Usually, the more fine-grained the task, the more attention to detail is achieved. I always endeavor to break down my tasks into the smallest possible tasks, and I even set aside some of them as "nice-to-haves". If time allows, I will work on these "nice-to-haves" to ensure that my work is as detailed as possible. The final step to this is making sure that my code is readable and maintainable. This is done by having other engineers review my code, and by writing unit tests for my code.

- **Question 15:** What is your preferred work environment and management style?

  – **Answer:** I work best in situations where I have plenty of time to focus on my work. I prefer to work in a quiet environment, and I like to have a set of tasks that I can work on.

I prefer to work with a manager who is hands-off, but is available to answer questions and provide guidance when needed. I also prefer to work with a manager who is open to listening to my ideas and suggestions. At the same time, I appreciate when I get regular feedback from my manager, and recognizes when I have taken steps to act upon the feedback.

- **Question 16:** Can you describe a time when you had to handle multiple tasks simultaneously and how you manage them?

  - **Answer:** Currently, I have two different projects that I am working on in my current position. One of them is coordination of a consulting team that is based in India. I am helping them with the development of a new-generation of our product. The other project is the development of a new feature for our smart-pivot product that a proprietary idea to quickly figure out the alignment status of the pivot. For this feature, I am writing the software-level requirements, designing the software architecture, and implementing the software.

    The way I manage these tasks is by looking at the priority of the next upcoming deliverable. If a lot of progress can be made in a short amount of time, I take care of that task first. I make sure that on average in a week, I have divided my time between the two projects depending on the priority of the deliverables. In general, I have found that by planning my expectations for the week, I can manage my time effectively.

- **Question 17:** How do you handle failure or setbacks in your work?

  - **Answer:** Failures are the stepping stones to success. In order to turn this adage into a technical approach, I use the concept of "regression". When I encounter a failure, I first try to understand the root cause of the failure. Then, I try to understand why the failure was not caught earlier. I then devise a test case that will catch the failure in the future. This is fundamentally the concept of regression testing, and is the engineering equivalent of learning from your mistakes.

- **Question 18:** Can you share an example of how you have successfully handled a difficult client or customer?

  - **Answer:** At my first position after college, I worked on improving the computer vision systems for a biometric facial recognition system. The system was supposed to be integrated into an Indian payments app called PayTM. We traveled to India to assist the integration of

this app. In one of our meetings with the stakeholders of the integration project, the client asked to know how exactly our algorithms worked. We explained that we used a pipeline of machine learning and computer vision algorithms to detect the eye-region of a face, and then we used another pipeline to match the person's known information with the detected eye-region. The client was not satisfied with this answer, and probed with more questions. He said that in the case of a technology audit, we need to know exactly how the algorithms work, with a decision tree of the algorithm.

The research scientists and engineers on my team knew that this was not possible, because neural networks were viewed as black-boxes at the time. On top of this, we were not allowed to share the source code of our algorithms with the client. However, the client was adamant that we provide a detailed explanation of our algorithms.

The client convinced more of his team members that we were not being transparent with our algorithms, and this resulted in a lot of pressure on our team. We were also in a different country, and delays in our schedule meant higher costs for the company (travel, lodging, etc.).

At this point, I took the initiative to schedule a meeting with the client to discuss the issue directly with the product manager on our team. I explained the blocking issue to our product manager, who had recently flown in from the US. The product manager saw how this was an issue that would cause a lot of delays, and he decided to take the issue to the CEO of our company. The CEO then had a meeting with the CEO of PayTM. In this meeting, the CEO of our company explained the issue with the client's request, and the CEO of PayTM understood the issue. This eventually led to contractual changes that allowed us to continue with the project.

This was a situation which could have caused a lot of delays and costs for the company, but by taking the initiative to resolve the issue, I was able to help the company avoid these costs. I also learned that sometimes, it is important to take the initiative to resolve an issue, even if it is not directly related to my work.

- **Question 19:** What are your long term career goals, and how does this position align with them?

    – **Answer:** My ultimate career goal is to create autonomous systems that can help people in their daily lives, by giving them more time to do the things they love. So much of our time is taken up by doing mundane tasks, and I believe that we are happier when we have more

time to spend time with our loved ones or to pursue our passions. Furthermore, I am particularly interested in the field of autonomous vehicles.

This position at Tuff Torq combines both of these goals. Tuff Torq is working on autonomous systems that can help people in their daily lives. I'm very excited about the prospect of working at Tuff Torq, and I look forward to contributing to the company's success.

- **Question 20:** Do you have any questions for us about the position or the company?

  - **Answer:** Yes, I do have a few questions.
    * What is the company culture like at Tuff Torq?
    * To build autonomous systems, many teams are usually involved. What teams would I be working with?
    * What is the typical career path for someone in this position?
    * What do the engineers at Tuff Torq like most about working there?
    * What are the new and exciting projects that Tuff Torq is working on?