# Team 1: Indoor UAV Navigation and Tracking
# Team and Project Summary

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**Summary of project objectives**

The goal of this project is to track the three-dimensional trajectory of a fast-moving UAV. We want to locate the UAV indoors, where GPS is unreliable, using only the image sequences of a limited camera system. This system will be cost-effective, and easy to implement. Indoor motion-tracking can be applied in any domain; some examples include posture analysis in clinics, the study of animal movement in biomechanics, action sequences in the film industry, and indoor flight simulations for the military agencies. York University's Kinesiology students can take advantage of our technology to help improve posture and form in sports. However, we aim to start small and envision a solution targeted only to supporting the use of UAVs in constrained, GPS-denied, indoor spaces.

**Immediate, and potential broader, project stakeholders**

The target community is interested in a system to precisely track the trajectory of indoor moving objects. The user community is interested in the same goal, but for objects specific to their specialized field. The manufacturing community is interested in sales potential, and the design of the system. The regulatory community is interested in administering possible standards and laws. The project team is interested in successful project outcome, and providing possible future services to interested user communities.

The immediate stakeholders will be:
- The project team
- York University's Department of Earth, Space Science, and Engineering (target community)

The potential and broader project stakeholders will be:
- Sports scientists and trainers (user community)
- Athletes (user community)
- Animal scientists (user community)
- Medical specialists, such as Physiotherapists, Kinesiologists and Chiropractors (user community)
- Visual Effects and CGI Artists (user community)
- Animators (user community)
- Cinematographers (user community)
- Private security agencies (user community)
- Ontario's Ministry of Transportation (user and regulatory community)
- Hardware manufacturers for the system (manufacturing community)

**Team member roles/responsibilities**

The team members roles are:
- **Kevin:** Architecture and Engineering Design Manager (manages source code for the system)
- **Ariel:** Project Manager (ensures milestones are met and everyone is doing their part)
- **Jack:** Assets Manager (maintains all the hardware components)
- **Varsha:** Financial Analyst (sets our budget, and handles the financial resources)

The main tasks are divided into the following categories:
1) Requirements and analysis
    a) Material selection (cameras, microcontroller, UAVs, etc.)
    b) Research on software tools available
2) Designing prototype
3) Implementation of cameras, main microcontroller
    a) Synchronization of cameras
    b) Programming the microcontroller to record frame by frame of the UAV
4) Implementation of software for real-time modelling
5) Integration of hardware with software
6) Testing of the system
    a) Integration testing
    b) User acceptance testing

The team members have the following responsibilities:
- **Ariel:** Material selection (1.a), prototype design (2), synchronization of cameras (3.a), integration of hardware with software (5), integration testing (6.a)
- **Jack:** Material selection (1.a), prototype design (2), programming microcontroller to record frame by frame (3.b), integration of hardware with software (5), user acceptance testing (6.b)
- **Kevin:** Research on software tools (1.b), implementation of software for real-time modelling (3), integration of hardware with software (5), user acceptance testing (6.b)
- **Varsha:** Research on software tools (1.b), implementation of software for real-time modelling, integration of hardware with software (5), integration testing (6.a)

**Assessment of team strengths, weaknesses, diversity**

All the members of our team are hardworking, dedicated individuals who thrive to achieve perfection. Each member covers a specific discipline of engineering. Kevin and Varsha are studying Software Engineering, Ariel is taking Electrical Engineering, and Jack is taking Geomatics Engineering.

The strength of our team lies within the diverse discipline of studies that each member brings to the group. From hardware expertise, to theoretical knowledge of navigation and tracking, to software skills - we have covered every criteria needed for tracking a moving object indoors. Moreover, our team is also diverse in gender and culture. We will be able to acquire different viewpoints when we look at possible solutions to our project objective. Each member in our team is has experience in programming, which is useful as this project will focus primarily on building the software of the camera system. Lastly, we all know each other very well and have worked with each other in previous projects. We are all very comfortable with each other which means that scheduling meetings and communication will come easier.

Some of our weaknesses include our inexperience and lack of age diversity. None of us has worked with UAV (drones) nor have worked on projects that locate objects indoors, without GPS. Also, we are all engineering students in the 21-23 age range. We might not have been exposed to technologies that are already available and we might have overlooked non-engineering solutions. In

order to compensate for our weaknesses we will ask the Engineering Faculty staff (like our supervisor, Professor Armenakis) for guidance. We can also communicate with different stakeholders to understand some of the problems associated with tracking a moving object.

**Team curriculum vitae**

Ariel is currently in her fourth year of study in Electrical Engineering at York University. In the past, Ariel has worked on the design and assembly of an autonomous robot vehicle. She successfully created multiple working prototypes and programmed the robot to pass through an obstacle course, which tested the robot's speed, durability, and precision. Her experience with autonomous robots will prove beneficial when it comes to testing the camera system with a UAV (drone). Furthermore, most of Ariel's courses involve programming and testing hardware to achieve specific functions. She has worked with FPGA boards, microcontrollers, sensors, and actuators. Ariel has also worked as a research assistant in the Spacecraft Dynamics Control and Navigation laboratory. She was able to design the power supply circuit for the project's control box. She can apply her knowledge of electronic components, and analog circuit design during the material selection and the integration of hardware with software phases. Finally, Ariel has always been interested in UAVs (specifically FPV racing drones). She is very excited to experiment with the drone during the course of the project.

Presently, Jack is studying Geomatics Engineering. From his previous courses, Jack experienced and understands some aspect of indoor tracking. He has taken courses like photogrammetry and digital terrain modelling which deal with photo resection techniques, and determining and translating photo coordinates into real-world coordinates. These techniques along with software packages (provided by his courses) that are associated with the analysis of 2D and 3D photos will be advantageous to the team when it comes to determining the 3D position of a moving object. Moreover, Jack has worked at J.D. Barnes as a survey assistant and has experience in dealing with real world positioning of objects. This knowledge can aid the team in figuring out the problems that are associated with the tracking project- specifically the adjustment and accuracy of photo positioning of a 3D object. Jack has always had a fascination with drones and drone surveying in the real world. This project not only accomplishes the requirements of a capstone project, but it will also help Jack's career in the surveying industry in the near future.

Varsha is in her final year of Software Engineering. She has held onto a developer position during her 1-year experience working in CIBC, and 4-month experience working in TD. During this time, she has worked with Java, HTML, CSS, AngularJS, Swift, MySQL, and the J2EE framework. To broaden her skillset, she worked on other side projects and taught herself to develop smartphone applications (iOS and Android platform). During her co-op term at TD, she was required to learn and program with the AngularJS framework, for which Varsha did not have experience. Within two weeks, she rapidly learned the concepts and started working on multiple components. Her expertise and comfortability in front-end and back-end programming will prove to be an asset to the team. The ability to understand and work with new software tools, and frameworks will aid Varsha in this project as she will be exposed to new tools such as OpenCV, and ROSS when implementing software for real-time modelling.

Kevin is in his fourth year of Software Engineering. He has expertise in programming languages such as Java, Python, C, JavaScript, and Bash. He had a position as a software developer for 16 months at IBM. As a result, he has proficiency in server-side and cloud technologies such as Apache Tomcat, IBM WebSphere Application Server, IBM Bluemix, and Amazon Web Services. He has experience with other frameworks and technologies such as Spring, MongoDB, IBM DB2, Git, Bootstrap, and Eclipse. This experience, coupled along with his various side projects and completed courses makes him suitable for his role in the project. The experience Kevin has in previously working with large scale commercial software systems at IBM, as well as other open-source systems will prove useful in the architecture and design of the project's software system. Kevin has an interest in this project since he will be learning new software related concepts, such as 3D computer graphics modelling, as well as new frameworks and tools.

**Self-evaluation of Team and Project Summary**

| Criterion | Self-evaluation ranking | Justification (provide references to specific paragraphs in the report to justify each ranking) |
|---|---|---|
| Identify the stakeholders in an engineering task | **Marginally meeting criterion** | We have provided few immediate stakeholders and several broad stakeholders. |
| Contribute within the context of a multi- disciplinary team | **Meeting criterion** | We have identified team roles, workload distribution, and have planned how we will execute tasks, but we have not set milestone dates. |