Tata Makerthon Challenge

Note: *Both of the Problem Statements given below are Individual Problem statements from TATA SONs GTIO*

1. Computer vision-based target identification based on reference image

AIM: Develop a smart phone app capable of (a) tagging a (stationary) object in an image taken by its camera and (b) wirelessly transferring the tagged image to a computer vision board (CVB) for processing. The CVB is attached to a camera controller board (CCB) equipped with a gimbal control algorithm. Develop software and firmware on the CVB to (a) use the gimbal control algorithm running on CCB to maneuver and operate the on-board camera (b) search for *target* in images taken by on-board camera and (c) upon successful match, display the tagged and on-board camera images to the user.

ASSUMPTIONS:

- Students can choose any smart phone, i.e., any mobile OS meeting performance requirements listed below. Smart phone will not be provided by the organizers.
- CVB hardware and software requirements will be identified and shared by the student teams in Round 1. For Round 2, teams may use low-end prototyping boards, cloud-based image processing, or any other technique to demonstrate the PoC. In Round 3 (Finals) organizers will procure and provide the CVB specified by the teams in their Round 1 report.
- CCB is an off-the-shelf PixHawk board running PX4 firmware with the gimbal control algorithm sitting on top of it. For Round 2, teams may use low-end prototyping boards, software-in-loop, or any other technique to demonstrate the PoC. In Round 3 organizers will procure and provide the PixHawk 4 running PX4 to finalists. Organizers will also provide the camera and gimbal setup to finalists.

- Students can select any of the available PX4 camera control algorithms supporting 360-degree scanning or develop a new algorithm for integration.
- Smart phone and (CVB+CCB) system are co-located such that they have identical LOS views.
- Only one *target* can be tagged in the smart phone image and *target* remains stationary during entire operation.
- *Targets* are of regular shape and of minimum size 0.5m×0.5m. Example include buildings, poles, trees, chair etc.
- *Target* can be located at minimum 20m and maximum 40 m distance from the cameras.
- Day light operation only.
- Images and video from the on-board camera are transmitted directly to the CVB for processing and matching with image received from smart phone.
- Both CVB and CCB implement detailed logs for debugging

DETAILS:

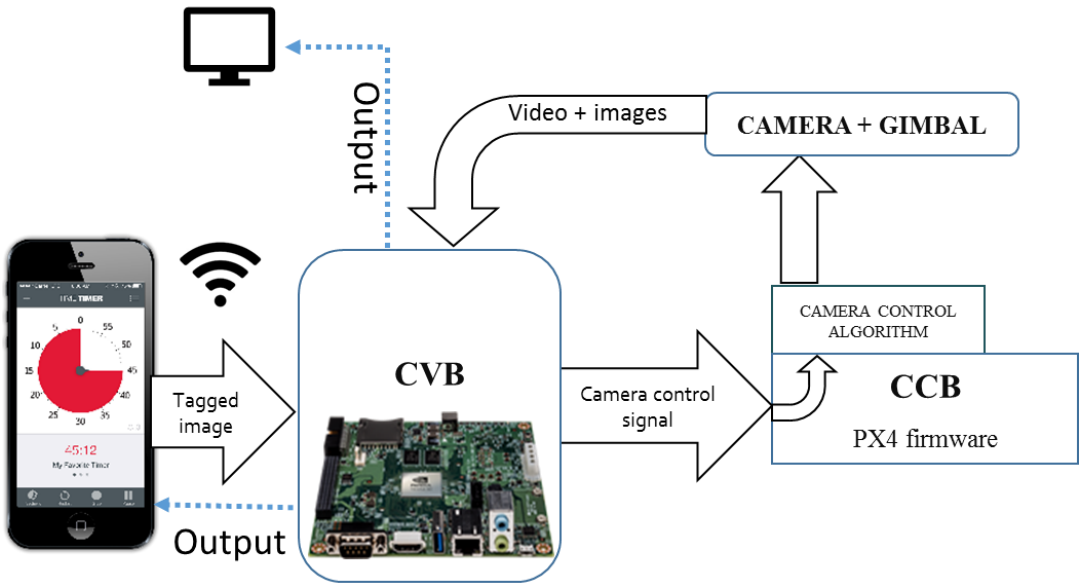
Develop a smart phone application (*App*) which takes an image using phone's camera and allows user to tag an object (target) in it. Tagging is done by drawing free form boundary around the target. When user presses a "*Submit*" button, *App* must locally store a copy of the tagged image before sending it over wireless to the CVB. Bonus points will be awarded to student teams using cross-platform app development tools to ensure App is portable across different mobile OS and devices.

CVB must store the received image in its on-board memory and use the camera control algorithm and underlying PX4 firmware to maneuver the camera mounted on 2-axis gimbal to perform 360-degree scan of LoS environment. Images and video from camera are sent directly to CVB for processing and are matched against the received image to locate the target. Once a match has been found, both received and matched images are either transmitted back to the smart phone

App or to an external monitor connected to CVB for display. In case a match is not found, system must display an error message. Bonus points will be awarded for in-*App* display. The proposed solution must also detect and report the orientation (degrees) of target's location with respect to home position of the gimbal.

SCORING CRITERIA:

- Performance metrics: speed of detection, accuracy across range of coverage, accuracy across range of light conditions
- Gimbal position feedback: Accuracy of orientation (azimuth and elevation) of gimbal position with respect to its home position.
- Application development: Choice of cross-platform or native implementation. Cross-platform solution will be awarded bonus points.
- Output demonstration: Choice of in-app or external monitor. Displaying in-app will be awarded bonus points.



2. Design and integrate safety check module for UAV

AIM: Goal of design is to enhance the pre-flight safety checks in UAVs to include validation of operational parameters.

Develop and integrate a modular unit (*Safety Compliance Unit - SCU*) which receives operational parameters from the flight controller (FC), carries out internal checks on a sub-set of received parameters and upon successful validation transmits all operation parameters to an external supervisory controller (SC). Develop and integrate SC with the SCU to perform additional checks on the received parameters to either grant or deny approval for operation. The flight controller must wait to receive approval from SC via SCU before initialization.

ASSUMPTIONS:

1. FC is PixHawk board running ***PX 4 firmware*** which wirelessly receives the operation parameters listed in table 1 from a ground control system application running on a laptop. For Round 2, teams may use low-end prototyping boards, software-in-loop, or any other technique to demonstrate the PoC. In Round 3 organizers will procure and provide the PixHawk 4 running PX4 to finalists.
2. Only PX4 state machine must be modified to add a safety check state which is exercised immediately after powering up**.** Rest of the flight control firmware is out of scope.
3. SCU communicates with FC over wired protocol and with SC over GSM protocol respectively. It must meet system design requirements listed below, including capability to reprogram the threshold values via SC. The hardware and software requirements will be identified and shared by the student teams in Round 1. For Round 2, teams may use low-end prototyping boards or any other technique to demonstrate the PoC. In Round 3 (Finals) organizers will procure and provide the hardware specified by the teams in their Round 1 report
4. SC is a cloud-based application with support for capability to reprogram threshold values.
5. All safety checks are based on pre-defined threshold values.
6. Both SC and SCU implement detailed logs for debugging

DETAILS:

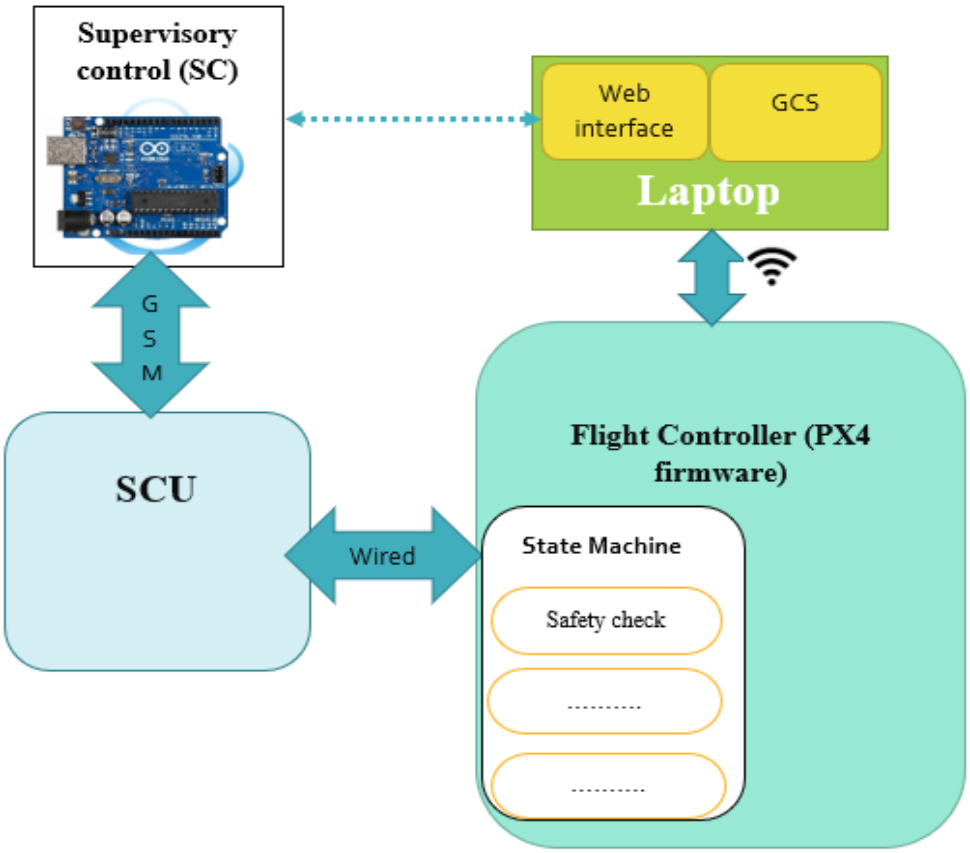
- SC and SCU are initialized with default safety threshold values shown in table 1. The SC app must provide the capability to protect and update the threshold values with login ('admin') and password ('techfest2018') using a web interface. The web interface also provides a visual summary of all threshold parameters and their default values to the operator. The SC app must be run before either GCS or UAV is powered on.
- Modify **the state machine of** PixHawk flight controller to add a new **safety check** state which is executed immediately following powering up of FC. It begins by detecting if SCU is connected or not. If SCU is missing, operation must be aborted, and system must generate an error message in GCS. Student can use existing error reporting mechanisms of PX4 firmware. Else, the state proceeds to forward pre-defined subset of operational parameters (see **Error! Not a valid bookmark self-reference.**) received from GCS to SCU for safety checks.
- SCU stores the received parameters and checks maximum and minimum altitude values against set threshold valves in SCU. Post successful validation it forwards all parameters to SC for further validation against set threshold values in SC. SC validates the operational radius and ground speed against corresponding set thresholds. Upon successful validation SC sends an approval message to SCU, which in turn forwards it to the flight controller. The flight controller must wait for this approval before proceeding with the pre-flight tests. In case of denial, an error message must be sent back to GCS prompting user to modify parameters to meet the pre-set thresholds.

Table 1 Mission parameters

Mission parameters	Threshold
Minimum altitude	5 feet
Maximum altitude	200 feet
UAV speed	5 m/s
Operating radius	20 feet

SCORING CRITERIA:

- Performance –measure of time taken to run the safety checks.
- Cross-platform portability – capability to access web interface across different devices running different browsers.
- Scalability- capability to support revised list of safety check parameters listed in table 1. Teams which device and demonstrate an efficient scheme to update the parameters list will be awarded bonus point.



STRUCTURE AND TIMELINE:

Townhall will be held on 20th Aug (Monday) between 3.00 to 4.00pm. This is to answer all the queries the students might have regarding the problem statements, competition or any other general questions. Further details regarding this will be updated before the session.

1. **Problem Statement 1**

- **Round 1 (**Due date 25-Sept-2018**):** Submission of abstract of proposed solution, including image processing algorithm(s), CVB hardware and software, selected camera control algorithm, cross-platform development tool, block diagram/flowchart. Report should not exceed more than 2 pages.

- **Round 2 (**Due date 30-Oct-2018**):** Submit a video demonstrating lab Prototype / PoC of the proposed solution. Submit a comprehensive report containing the design details, schematics, simulation results, algorithms, flowcharts etc. as applicable. Report should not exceed more than 6 pages.

- **Round 3 (**14-16 dec-2018**)**: Present the proposed solution (not exceeding10 slides) and demonstrate final prototype to the panel of external reviewers. Submit updated comprehensive report not exceeding 6 pages, all source codes and log files.

2. **Problem Statement 2**

- **Round 1 (**Due date 25-Sept-2018**):** Submission of abstract of proposed solution, including scalable scheme for locating and forwarding safety check parameters, SC *App* architecture and cross-platform development tool, block diagram/flowchart for SC and SCU communication. Report should not exceed more than 2 pages.

- **Round 2 (**Due date 30-Oct-2018**):** Submit a video demonstrating lab Prototype / PoC of the proposed solution. Submit a comprehensive report containing the design details, schematics, simulation results, algorithms, flowcharts etc. as applicable. Report should not exceed more than 6 pages.

- **Round 3 (**14-16 dec-2018**)**: Present the proposed solution (not exceeding10 slides) and demonstrate final prototype to the panel of external reviewers. Submit updated comprehensive report not exceeding 6 pages, all source codes and log files.

REGISTRATION AND SUBMISSION:

The Participants have to register on the official Techfest Website and fill all the necessary details: www.techfest.org > Competitions > Tata Makerthon Challenge-> Explore More-> Register

- **Abstract Submission**-
  Teams will be required to submit one report to tatamchallenge@techfest.org. This report should contain the idea they are looking forward to work on.

- **Submission Format**-
  The project report should be emailed to tatamchallenge@techfest.org with the subject Tata Makerthon ChallengeReport: Team Id (For example: Tata Makerthon Challenge: TM1234). Teams must follow the following details for the submission:
  - The abstract must be submitted in pdf format only
  - Font: Arial
  - Size: 11
  - Spacing between two lines: 6 pts
  - Spacing between two paragraphs: 10 pts
  - Bottom margin: 1 inch

SHORTLISTING:

Top teams will be selected and would get the chance to participate in the Final Round at Techfest, IIT Bombay which is from 14th-16th December, 2018

GENERAL RULES:

1. Every team has to register online on our website for the competition. A Team ID will be allocated to the team on registration which shall be used for future references.
2. A team can register at any point of time before 31st August 2018 and can submit final abstract and video (as mentioned in the structure).
3. **The decision of the organizers or judges shall be treated as final and binding on all. Techfest has all the rights to verify the identity and accuracy of the details provided by the participants**.
4. No responsibility will be held by Techfest, IIT Bombay for any late, lost or misdirected entries.
5. **The idea presented by the teams should be original** (not protected by means of patent/copyright/technical publication by anyone).

6. Note that at any point of time the latest information will be that which is on the website. However, registered participants will be informed through mail about any changes.

ELIGIBILITY:

All students with a valid identity card of their respective educational institutions are eligible to participate.

TEAM SPECIFICATIONS:

- One team can have a maximum of 4 members.
- Students from different institutes can be in the same team.

CERTIFICATE POLICY:

- Top three teams in the grand finale will be awarded Certificate of Excellence.
- E-Certificate of participation will be given to the teams scoring more than the critical marks which will be decided later.

PRIZES:

The Prize money will be awarded to Winners via NEFT and will be processed within 20 working days after the receiving the Prize Money from Sponsors.
The Winner have to mail the following information (immediately after announcement of results) to rohan@techfest.org
Subject: Tata Makerthon Challenge, team id- your position (example- Tata Makerthon Challenge, TM1003- 3rd Position)
Body of mail-

- Account Holder's Name
- Account Number
- Bank name and Branch name.
- IFSC Code