Remote Control Tractors

Team 2

Stage 2 - Generate

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Group Demos

- Ge
    1. **Nest Temperature Sensor Remote Control:**
       https://www.youtube.com/watch?v=2PBWy9zRQuk
       Nest Temperature Sensor is a widely-adopted temperature sensor and air conditioner controller at home, which can be operated well via mobile app. The app is designed with attractive characteristics such as simplicity for humans to learn, appealing UI, and schedule list for further actions. This is a good UI design example for us to learn.
    2. **Cetus Play: The Best Android TV Box Remote Control App 2018**:
       https://www.youtube.com/watch?v=OOJWJbXbUjY
       Cetus Play is an app used for TV box remote control. It is designed with functions that are similar to some useful physical controller people get used to, including a joystick, slide bar, mouse, and keyboard, etc. This is a great example since the current tractor remote controller is designed as a joysticker but awkward to bring and we hope our design can be simple and easy-to-learn. Thus, we could get useful and fundamental design ideas from this product.

- Rithish
    1. **Mercedes Mbrace: https://www.youtube.com/watch?v=d2r4Ks0FKSA**
       Developed by Georgia-based Hughes Telematics, Mbrace allows you to use your iPhone or BlackBerry to find your car in a crowded lot, lock the doors from any distance (provided you have a cell signal), lead you to a nearby dealership, or track your car in case of theft. The app will get more features over time, starting with real-time traffic information
    2. **Self-driving Corvette, Bjorn Harms:**
       https://www.youtube.com/watch?v=g3ruVMeQ2Ss
       Using his self-made universal motor controller, he could control different motors that he had attached to various controls of the car. He used a 4-channel transmitter to braking, gear changing, throttle, and steering. He also built a fail-safe system so, when the car gets out of the transmitter's range, the vehicle starts braking automatically.

- Srinivas
    1. **Phantom Auto:** https://www.youtube.com/watch?v=9sgetWQGYxY
       Phantom Auto is a start-up developing technology that helps to control a car using a drive set-up that is remote. The drive-setup has visual data from the car

projected and has controls sending signals to the hardware of the car. The drive set-up is a complete simulation of the driver's controls having controls from steering, accelerator to microphone and camera.

2. **Remote Control Range Rover Sport:**
   https://www.youtube.com/watch?v=gw0zRdlhI8M
   This Range Rover Sport car demonstrates how a driver could drive the vehicle from outside the car via their smartphone. The smartphone app includes control of steering, accelerator, and brakes as well as changing from high and low range. By walking alongside the car, the driver could continually check ramp, approach and departure angles and allow precise positioning of the vehicle when rock crawling. It could also be an invaluable aid when the vehicle is fording a stream or traversing sections made slippery by mud or snow. The system uses sensors to assess available space and to avoid pedestrians, vehicles and other objects.

- Yudong
  1. **DJI Mavic Mini**: https://www.youtube.com/watch?v=mI31SUeHpAY
     Mavic Mini is a portable drone developed by DJI. With a remote controller and customized DJI Fly App, users can easily operate a Mavic Mini to fly and take photos. After connecting a smartphone and a remote controller through cable, you can change directions through joystick on the remote controller and perform other operations like taking photos with DJI Fly App.
  2. **Nissan GT-R /C**
     https://www.youtube.com/watch?v=jxKTBRcVROw&feature=emb_title
     Reading:
     https://www.topgear.com/car-news/big-reads/driving-nissans-remote-control-gt-rc
     Nissan GT-R/C is a race car that can be operated with a PlayStation controller. It is built to celebrate the release of Gran Turismo Sport for the PlayStation 4. While it looks like a cool idea to drive a race car with a remote controller, it's hard to drive without a camera on the car. In the reading material from TopGear, drivers even had to operate from the helicopter to get a clear view.

- Shreya
  1. **Voysys LTE teleoperation of RC car from distant dome:**
     https://www.youtube.com/watch?v=FQHB3-TFtLY
     Voysys visual system for teleoperation of autonomous vehicles and machines offer a unique render engine for the driving station/control tower powered by their own open-architecture 3D engine. It can do stitching, de-warping, bird-eye views, chroma-keying, Augmented Reality, projector edge blending and everything else a 3D engine can be used for. The latency peaks due to rough network conditions

are the worst threat to safety. Voysys beat these latency peaks by using redundant links and a super-fast congestion control algorithm. They have the lowest latency on the market, down to 60 ms glass-to-glass over 4G/LTE.

2. **Phantom 4 Pro V2.0: https://www.dji.com/phantom-4-pro-v2/video**
   The Phantom 4 Pro V2.0 is a complete aerial imaging solution, designed for the professional creator. The Phantom 4 Pro V2.0's remote controller uses OcuSync 2.0 which ensures stable connectivity and reliability, five directions of obstacle sensing ensures additional safety and a dedicated remote controller with a built-in screen grants even greater precision and control. A wide array of intelligent features makes flying that much easier. Its camera has an optimized f/2.8 wide-angle lens, ensuring consistently detailed photos and videos that remain vivid and sharp while maintaining color accuracy.

- Hongyi
  1. **Bobcat's MaxControl system**
     https://www.bobcat.com/loaders/features/max-control-remote-control-operation
     https://www.youtube.com/watch?v=bAziFcibSe8
     Bobcat MaxControl Remote Operation is an iOS app. The operator uses a smartphone or tablet and an optional gaming controller to control the tractor, standing near the tractor.
  2. **Caterpillar's remote operator station**
     https://www.cat.com/en_US/news/machine-press-releases/cat-command-for-dozing-offers-efficient-and-safe-remote-operation-of-d8t-dozer.html
     https://www.youtube.com/watch?v=kjvcSFGJOhI&list=PLYhpH-jRjrIGzGCWXG6YoQYwRIqOD6ln7&index=4&t=0s
     The station itself is modeled on the actual cab of the machine, with all ergonomic controls, alarms, and features operating as they do in the dozer. The system can be equipped for line-of-sight operation or for teleremote operation with the addition of video and audio feeds from the site and dozer. The design of the remote operator station allows it to be configured for easy transport in a truck or trailer, which adds flexibility in its application.

Ideas

- Ge
  1. Keep operating-pattern consistency with the current remote controller for tractors. In another word, mobile apps can mimic other physical controllers such as joysticks, thus both new and old customers can easily understand and use.

2. The functions for controlling tractors to dig can be designed with object boundary detection and notify users by applying push resistance on the button/slide bar for controlling the bracket. With this function, tractors can avoid damaging city facilities or digging a huge stone.
3. Adding sound player on remote control mobile app to collect sounds in tractors' surroundings. Users can hear possible positive/negative sounds at once. For instance, they might hear bird songs and have a better mood while working. Or they could hear people standing on a blind spot ask for a stop. Users can also use this function to keep contact with other users.
4. Smell mimic function can be added to our remote control app with two main reasons: 1) smell would bring users immersive experience; 2) users can better understand tractors' environment combined with my idea 3. Also, sometimes it won't be enough for tractors only with object sensors since some city pipelines are brittle and hard to be detected. With smell, users can have an integral comprehension of the environment tractors are working in.

- Rithish
    1. **Using universal motor controller:**
       The use of a universal motor controller to remotely control various motors of the vehicle has been proven to be a working method.
    2. **Radar Sensors**:
       The vehicle in the discussion is meant to be operated on construction sites where the terrain is usually uneven, rugged and rough. So, the operators need to be mindful of the area they are working in and any obstacles they may encounter. Radar sensors on the vehicle will detect surroundings like nearby trees and alert the driver by displaying warning signs on the controller/mobile screen when obstacles are too close to the vehicle.
    3. **Secure Login:**
       If a mobile app is being used, we can make use of the fingerprint sensor or faceID sensors to authenticate a particular user to operate the vehicle.
    4. **Fail-Safe System:**
       As safety is the top priority, we need to build a fail-safe system. We can ensure that the brakes shall be automatically applied when the vehicle goes out of the controller/mobile application's range or the mobile turns off.
    5. **Training using a simulation software:**
       A software can be developed which simulates the experience of controlling the vehicle using a controller. This software can be used to train new users.

- Srinivas
    1. **Remote drive-setup**
       Setup that has acceleration, camera, braking, and skid-steer controls and provides visuals on screen to the user.

2. **Sensors around the vehicle**
   Sensors that signal the user when there is an obstacle if it is in the way of the skid-steer, helping to avoid any potential accidents.
3. **Camera - 360° view**
   The visuals streamed to the drive setup are captured from the 360° view camera which guides the remote driver to control the vehicle and perform different operations of the skid-steer effectively.
4. **Secure authorization and locking**
   In order to avoid unauthorized access to the skid-steer, it is essential to have a double-locking system, one lock at the actual skid-steer and one at the drive-setup that is remote.
5. **Vehicle alignment scale**
   Skid-steer operates in construction environments varying between different heights, a vehicle alignment scale gives the horizontal and vertical position of the skid-steer to the operator avoiding the skid-steer to topple.

- Yudong
  1. **Remote controller with joystick**
     A remote controller with joystick can be used to perform basic operations like start-up, speeding up and altering directions.
  2. **Assistive mobile App**
     A mobile app can be used with a remote controller to perform other essential functions. As there are currently 47 functions of the skid-steer loader dashboard, we can use an app to properly organize them for easier usage.
  3. **Cameras and 360-degree view**
     With cameras installed on the exterior of skid-steer loaders, we can offer a 360-degree view within the mobile app.
  4. **Vehicle perception system**
     We can use image recognition technology together with cameras to build a perception system to enhance the safety of remote control skid-steer loaders. Whenever people or other vehicles show up and may bring danger, users will be alerted.
  5. **Weight tracking system (for bucket)**
     With sensors installed in the buckets of skid-steer loaders, users can detect weight in the bucket, which can help solve the visibility issue. With proper data visualization techniques, we can track the weight with our mobile app.
  6. **Tutoring system for inexperienced users**

We can design a tutoring system within the mobile app to teach new users how to drive a skid-steer loader. With proper visual and audio guidance, we can make the learning fun and effective.

7. **Networking with other vehicles**
   Not sure if it's useful, but we can add a networking function to the app so that users of different vehicles can communicate with each other. Exchanged information like the number of vehicles in the vicinity may be helpful.
8. **Enhance user experience with AI**
   We can also add AI features in the mobile app to enhance user experience. For example, we can embed a virtual assistant(like Siri) inside the app so that users can control vehicles even easier.

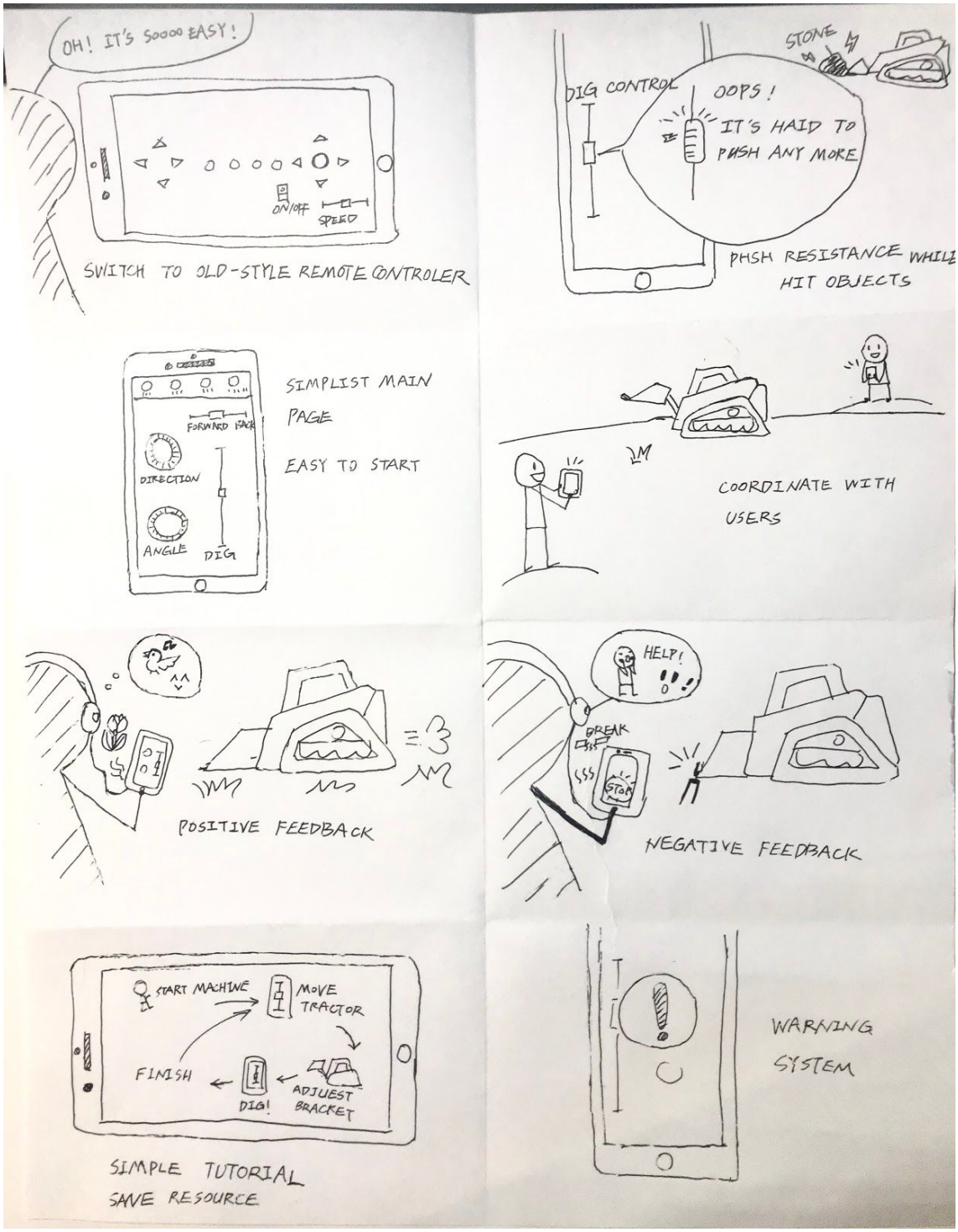
- Shreya:
  1. **Incredible 360 degree Camera:** Having a nice onboard camera on the skid-steer loader, with a wide lens that will capture detailed photos as well as videos with perfect color accuracy. They can be de-warped and stitched to produce a correct view to the driver no matter the lenses and camera positioning used on the vehicle/machine. The camera can also prevent collision back and front.
  2. **Live Streaming Video:** We can use OcuSync to get proper live streaming up to a distance of several kilometers maybe like eight kilometers. This feature will really help a person sitting far off to see what is exactly going on.
  3. **Intelligent battery of the remote controller:** An advanced battery management system can be used to prevent overcharging and over-draining of the controller. If placed in long term storage, batteries will discharge power to maintain good health.
  4. **Sensing the Obstacles:** The camera should be able to detect obstacles in any of the directions and can send an alarm using a sensor. Hence, then it can improve the overall movement or prevent any accident. Also, if the tractor's rear cargo load is collecting some straps or waste material, it can sense that too.
  5. **Onboard Payload Sensor:** Also, the sensors should be able to detect the weight in the payload and it should reflect that weight reading in the . If the weight is beyond the limit, the driver is alerted on the dashboard and that is quite effective because Onboard weighing creates more efficient loading and allows material movements to be tracked
  6. **Speedometer & Voice Assistant:** The remote controller or the CAT vehicle can have a system to maintain the speed. Speed is important as it will prevent accidents or some kind of jerky turns. Speed can also be detected by some voice assistants inside the machine and this will prevent the driver to look at the dashboard again and again.

7. **Sophisticated Mobile App:** An attractive mobile app can be designed in integration with a remote controller to perform some functions like moving to and fro, starting or stopping the machine. Also, it can be configured to get any notification regarding some accident or some kind of emergency.
8. **Communication:** Since it's a large area where the construction is done, we can have an inbuilt communication system installed in the vehicle so that the driver or the operator can talk, communicate with another operator. The controls can be simple and easy to use and it should not need much technical knowledge to operate.
9. **Panic/Emergency Button:** Emergency stop mechanism to bring the vehicle to complete halt in case of danger.

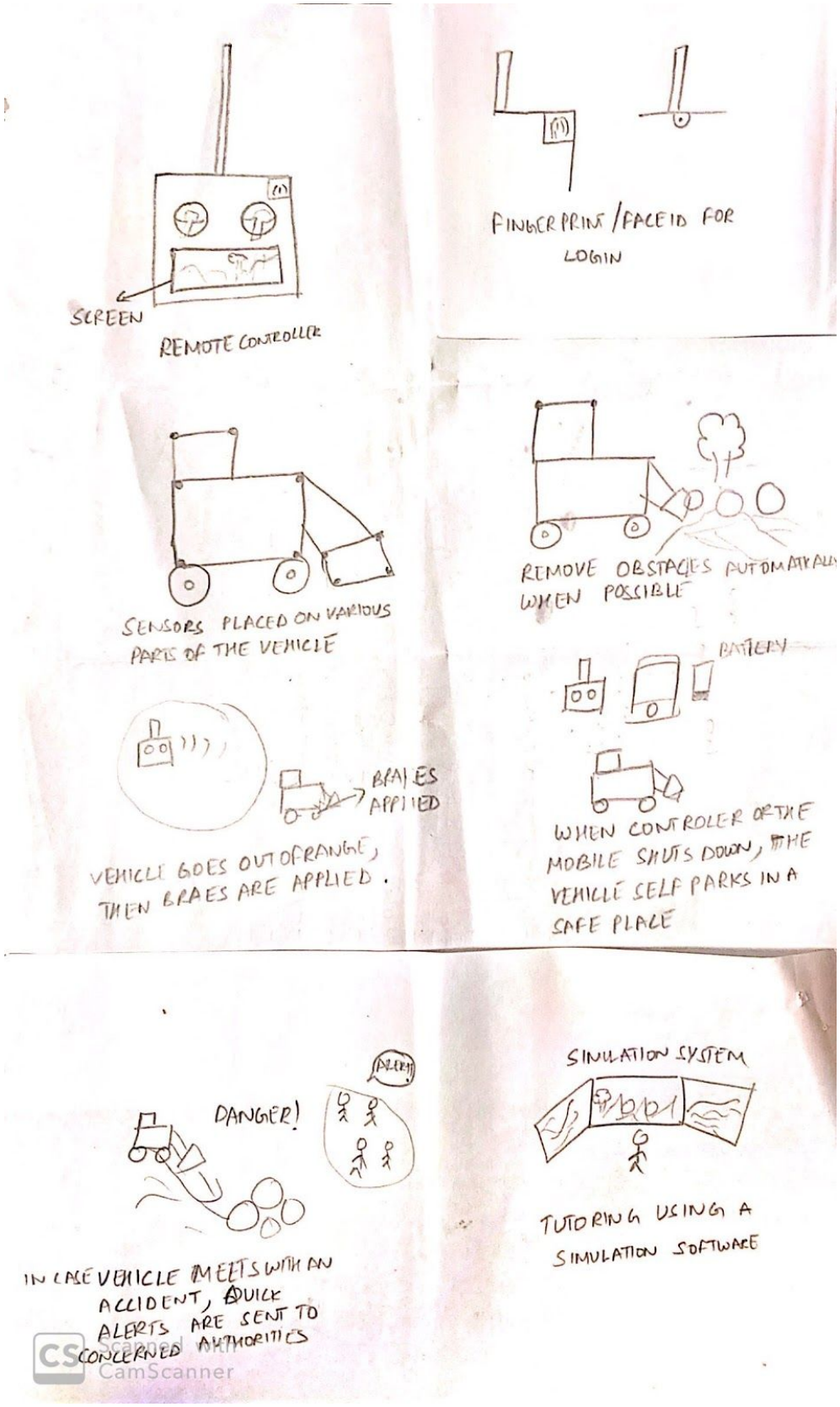
- Hongyi
    1. **Remote control with mobile app**
       A configurable user interface enables users to monitor live video feed and control the tractor.
    2. **VR control station**
       Simulate the cabin environment so the operator can seamlessly convert from actual tractor driving to remote.
    3. **3D surround view of tractor with multiple cameras**
       Let the operator see through the cabin or see the vehicle with a third-person view.

Variations (Crazy Eights)

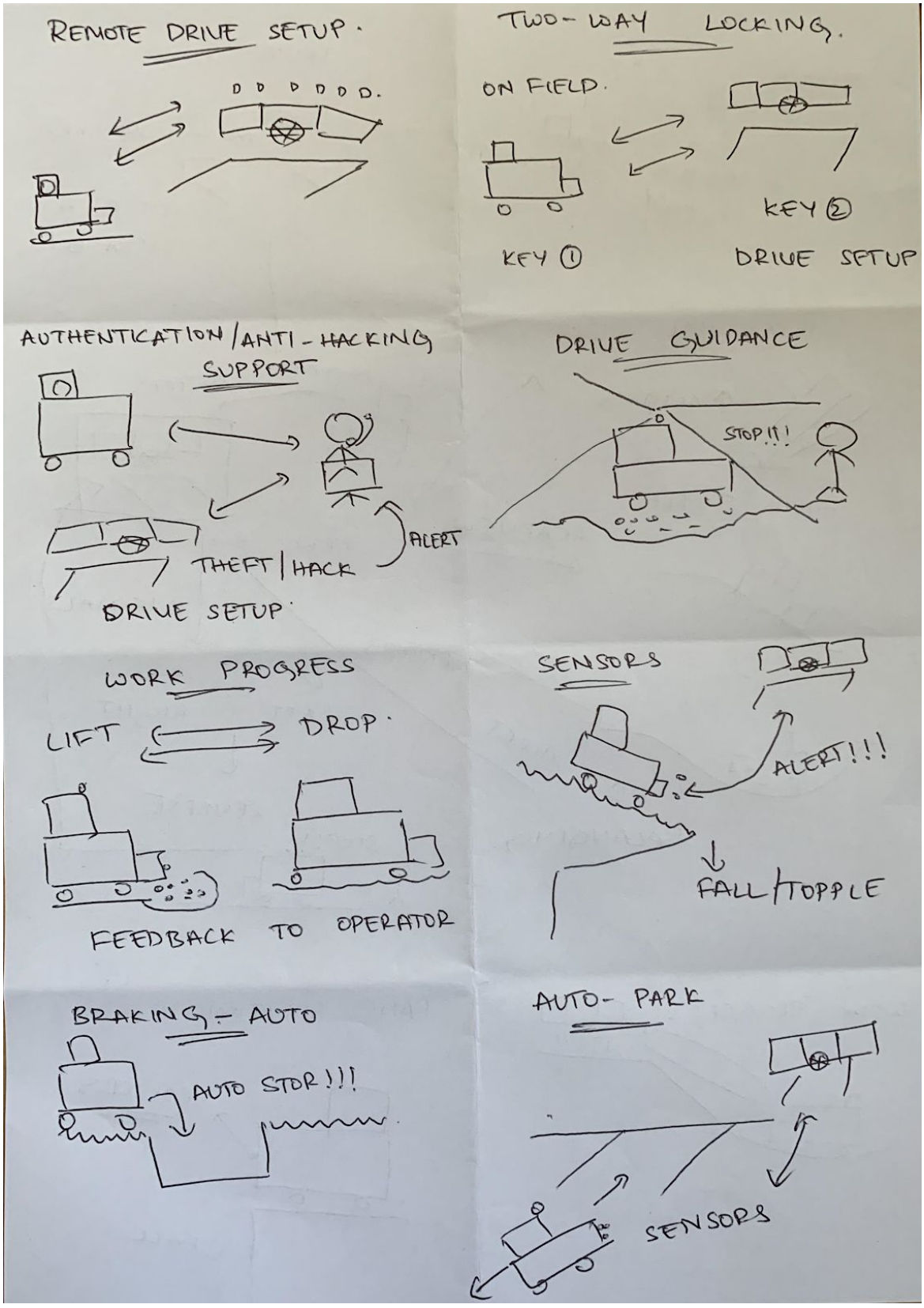
- Ge



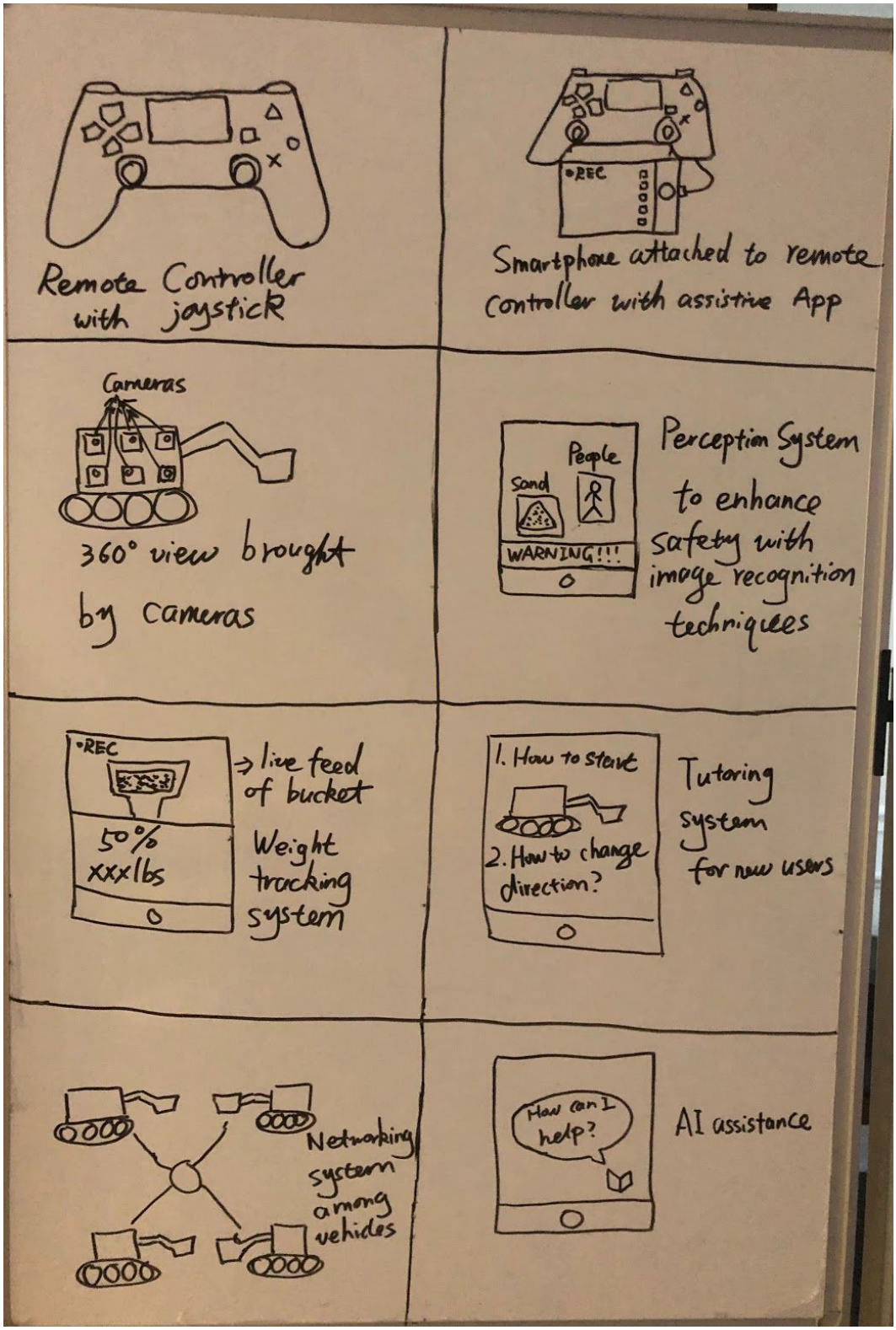
- Rithish



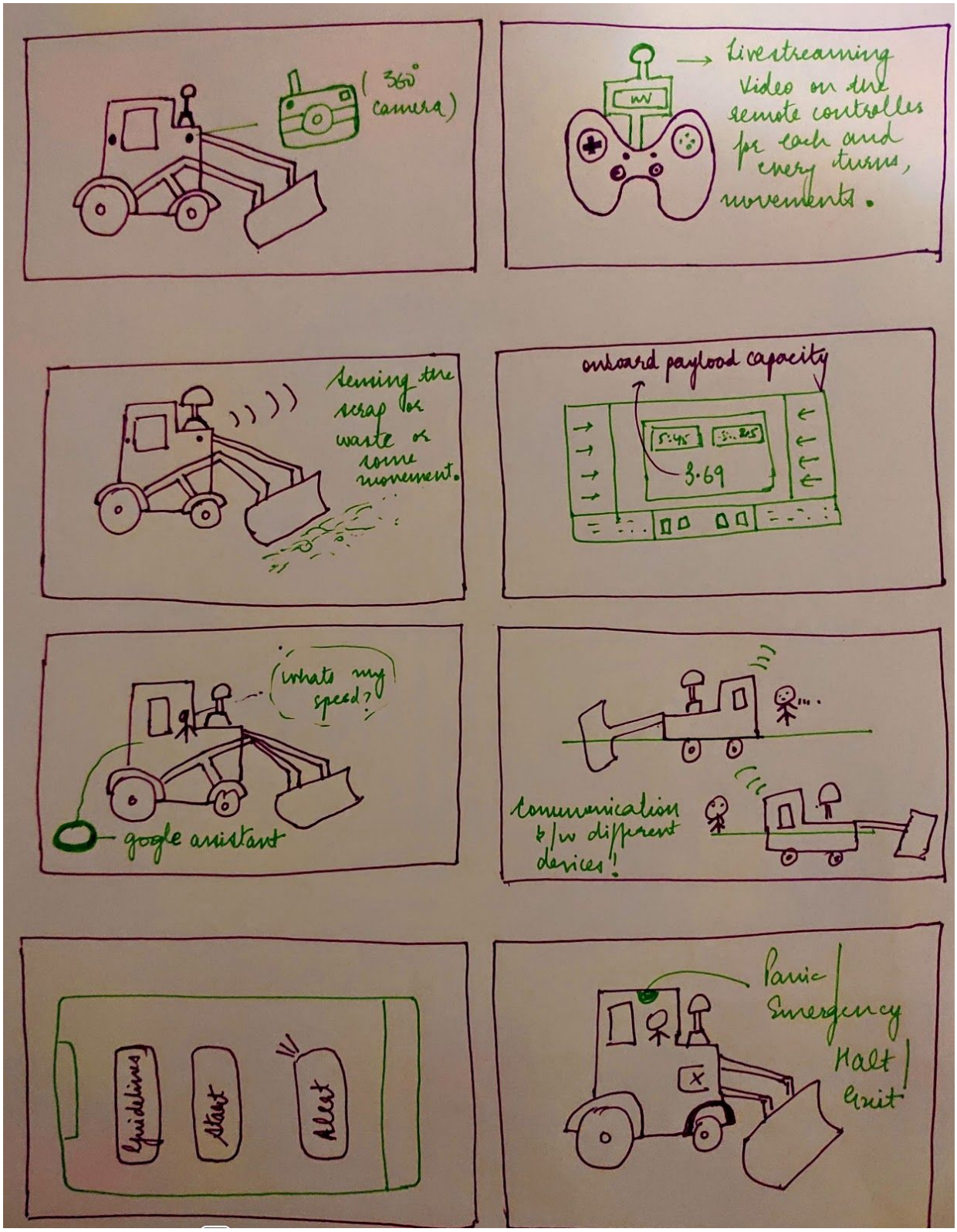
- Srinivas


REMOTE DRIVE SETUP.
TWO-WAY LOCKING.
ON FIELD.
KEY ①
KEY ②
DRIVE SETUP
AUTHENTICATION/ANTI-HACKING SUPPORT
THEFT/HACK
ALERT
DRIVE SETUP.
DRIVE GUIDANCE
STOP!!!
WORK PROGRESS
LIFT
DROP.
FEEDBACK TO OPERATOR
SENSORS
ALERT!!!
FALL/TOPPLE
BRAKING - AUTO
AUTO STOP!!!
AUTO-PARK
SENSORS

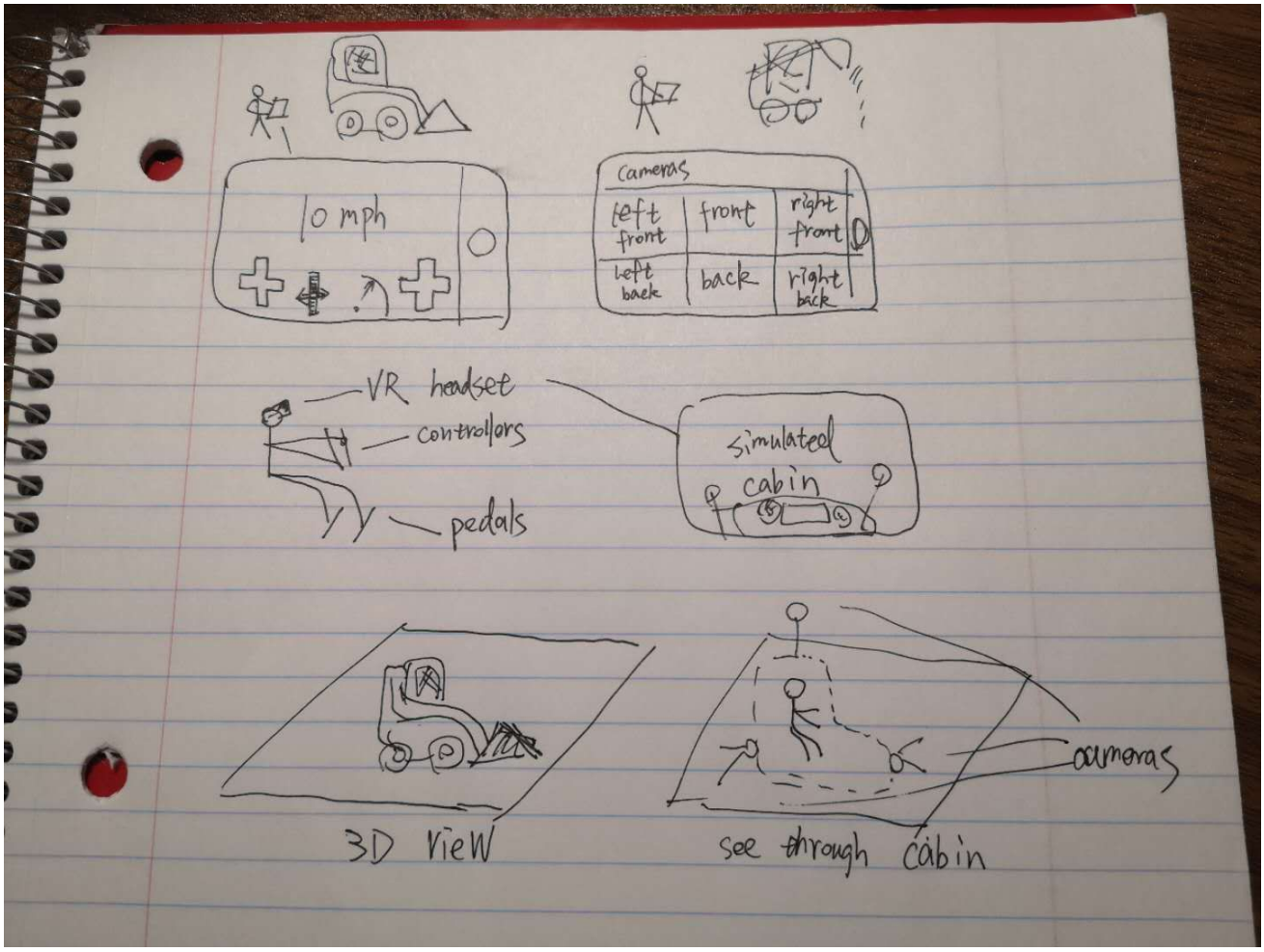
- Yudong


Remote Controller with joystick
•REC
Smartphone attached to remote controller with assistive App
Cameras
360° view brought by cameras
People
Sand
WARNING!!!
Perception System to enhance safety with image recognition techniques
•REC
⇒ live feed of bucket
50%
xxxlbs
Weight tracking system
1. How to start
2. How to change direction?
Tutoring system for new users
Networking system among vehicles
How can I help?
AI assistance

- Shreya:

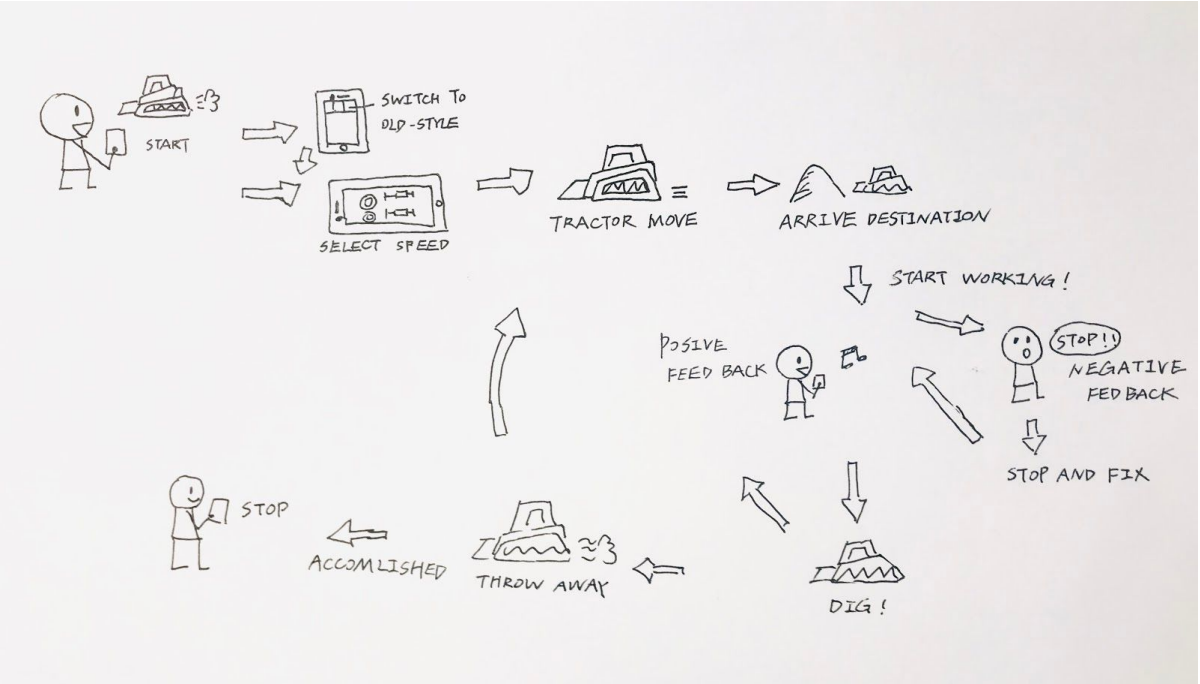

(360° camera)
Livestreaming video on the remote controller for each and every turns, movements.
Sensing the scrap or waste or some movement.
onboard payload capacity
3.69
what my speed?
google assistant
communication b/w different devices!
Guidelines
Start
Alert
Panic
Emergency
Halt
Exit

- Hongyi

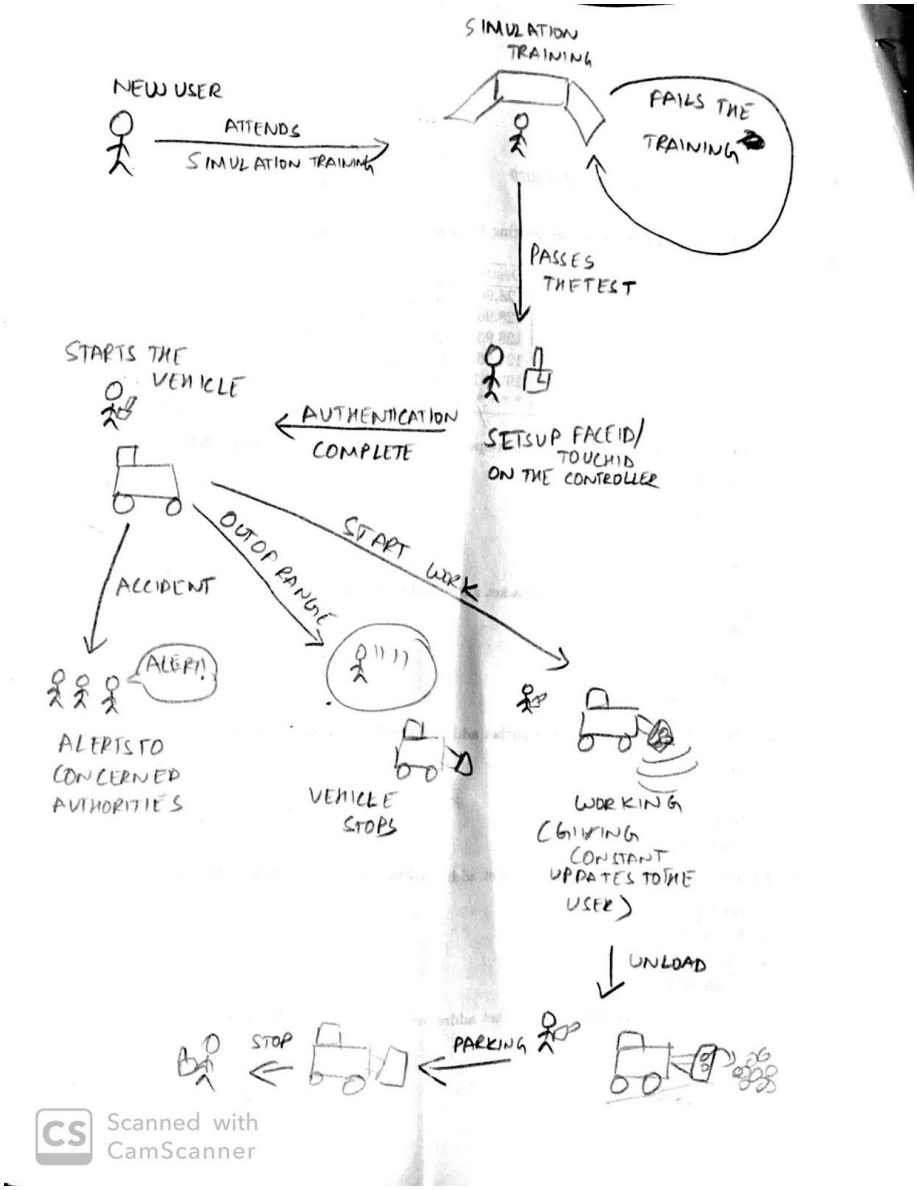

10 mph
cameras
left front
front
right front
left back
back
right back
VR headset
controllers
pedals
simulated cabin
3D view
cameras
see through cabin

Storyboards

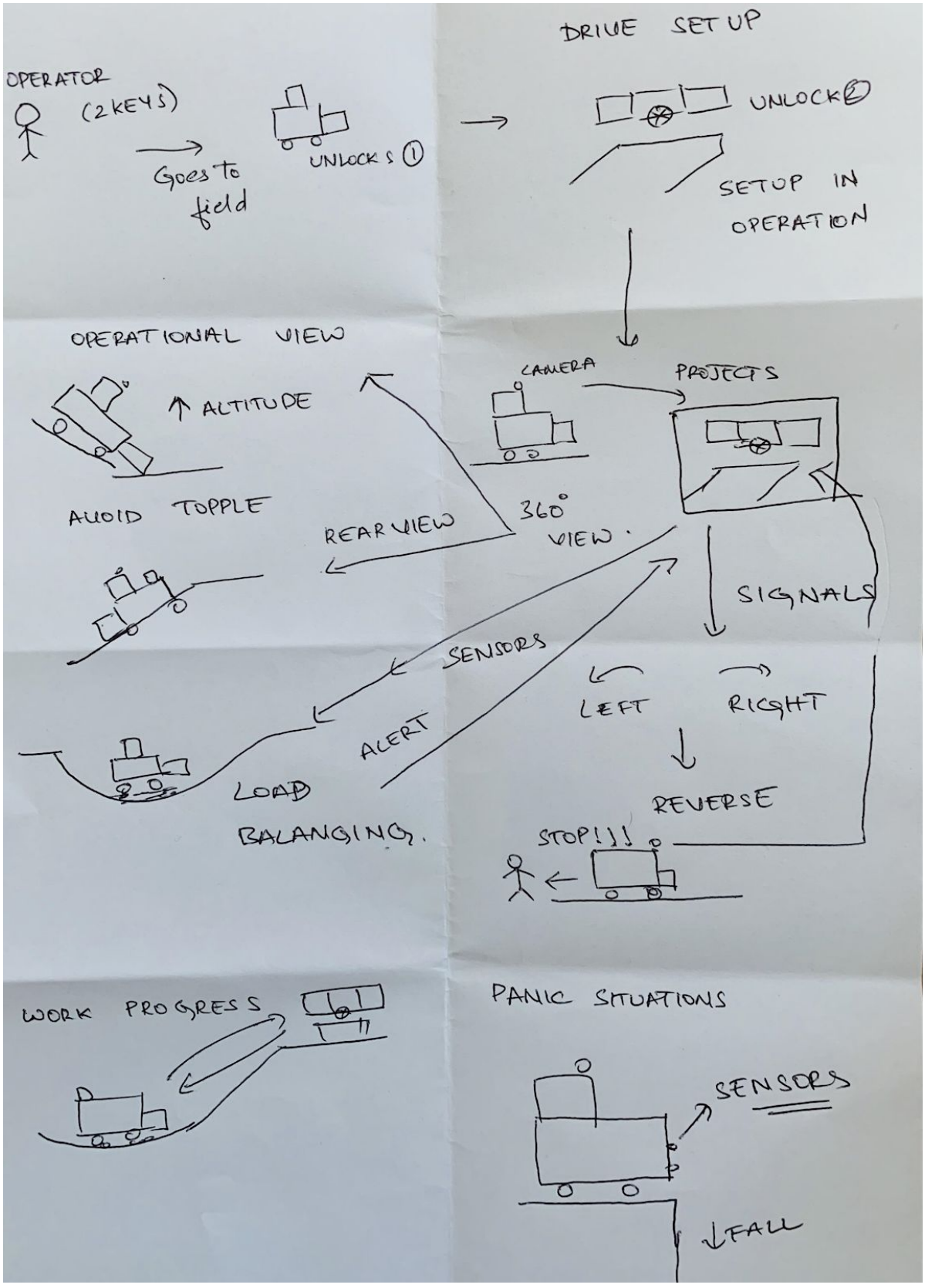
- Ge



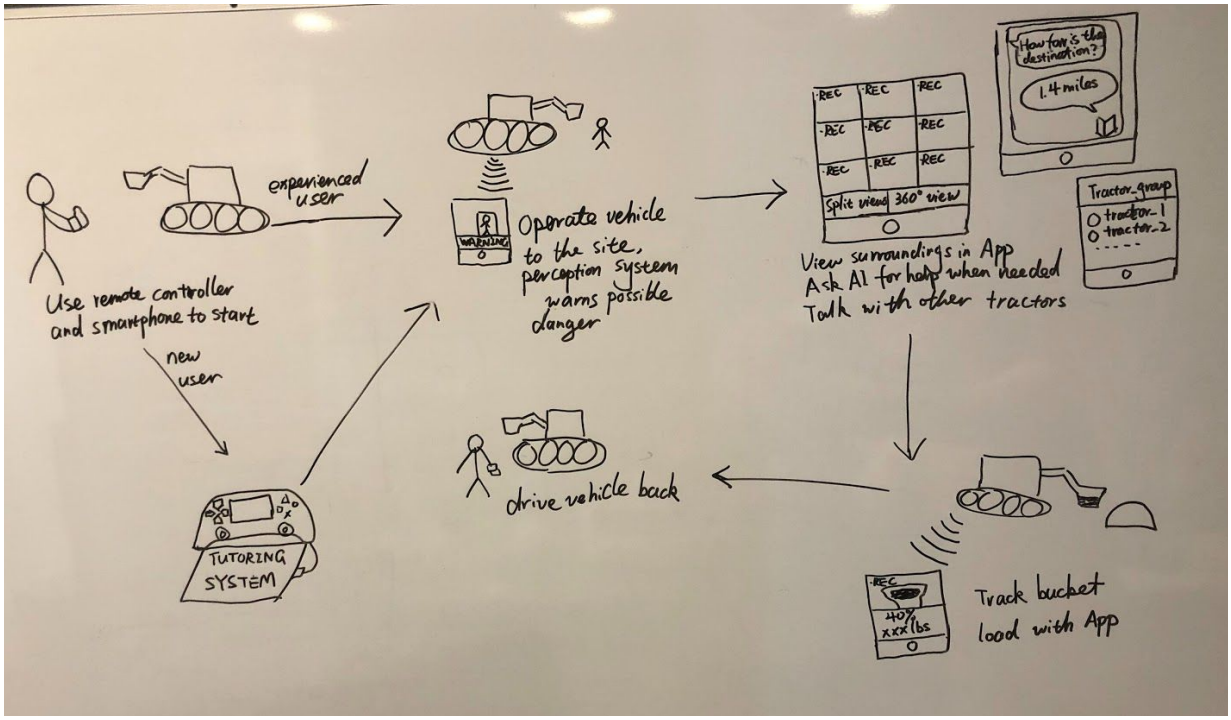
- Rithish



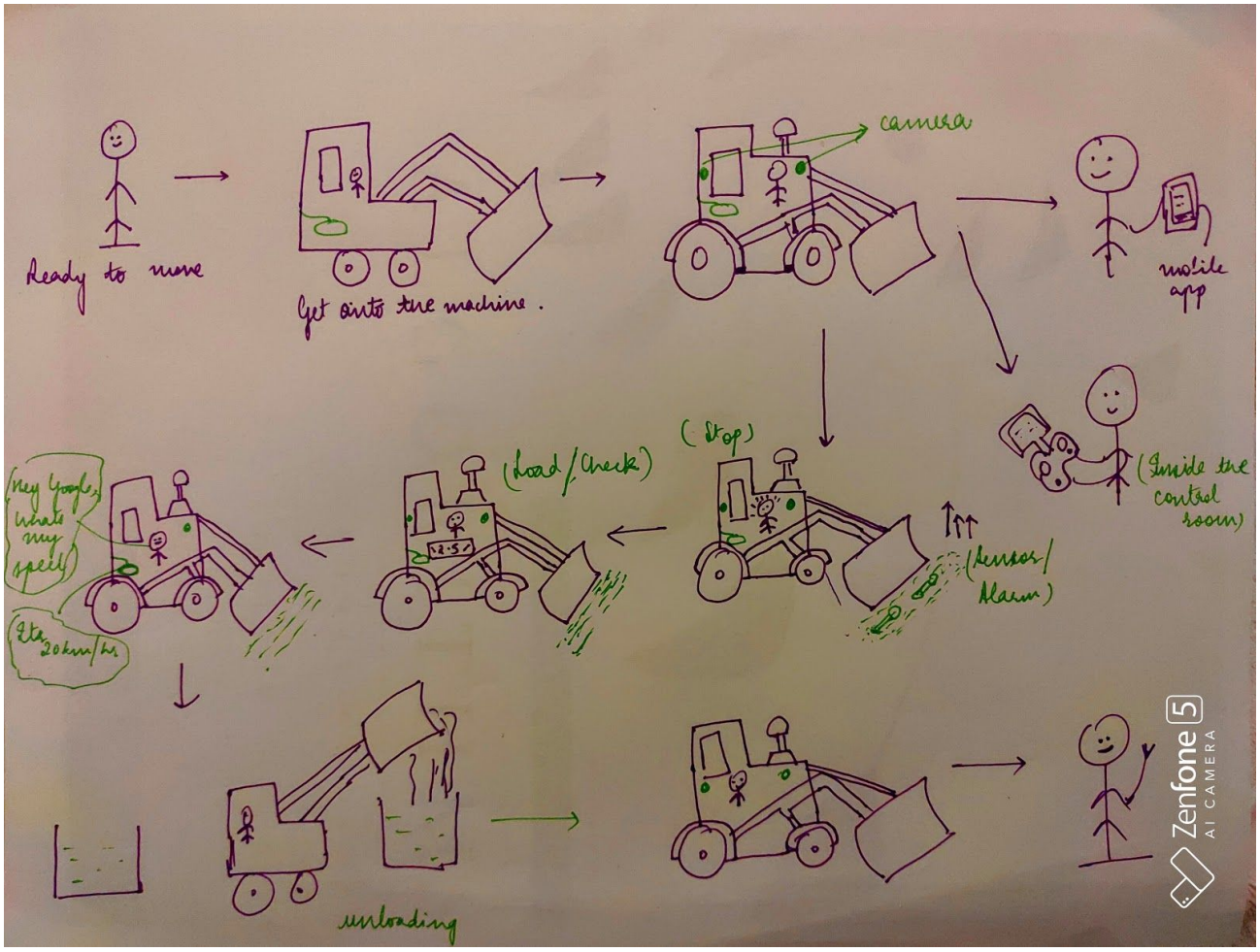
- Srinivas


DRIVE SETUP
OPERATOR
(2 KEYS)
Goes to field
UNLOCKS ①
UNLOCKED ②
SETUP IN OPERATION
OPERATIONAL VIEW
ALTITUDE
AVOID TOPPLE
CAMERA
PROJECTS
360° VIEW.
REAR VIEW
SIGNALS
SENSORS
ALERT
LOAD BALANCING.
LEFT
RIGHT
REVERSE
STOP!!!
WORK PROGRESS
PANIC SITUATIONS
SENSORS
FALL

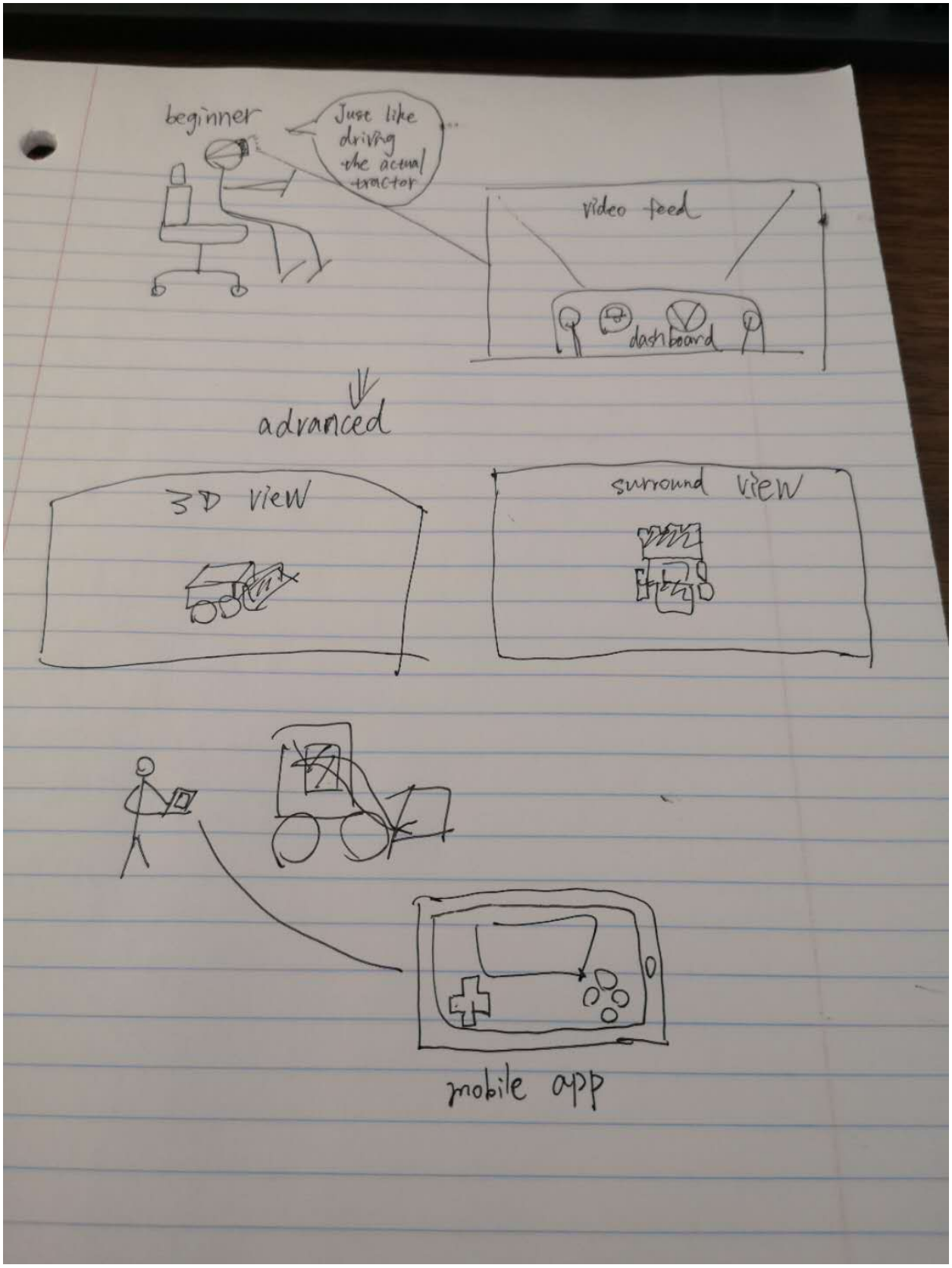
- Yudong


experienced user
Use remote controller and smartphone to start
new user
TUTORING SYSTEM
Operate vehicle to the site, perception system warns possible danger
WARNING
REC
Split view
360° view
How far is the destination?
1.4 miles
Tractor_group
tractor_1
tractor_2
View surroundings in App
Ask AI for help when needed
Talk with other tractors
drive vehicle back
Track bucket load with App
xxx lbs

- Shreya:


Ready to move
Get into the machine.
camera
mobile app
(Inside the control room)
(Stop)
(Load/Check)
(Sensor/Alarm)
Hey Google, what is my speed
Eta 20km/hr
unloading
Zenfone 5
AI CAMERA

- Hongyi


beginner
Just like driving the actual tractor
video feed
dashboard
advanced
3D view
surround view
mobile app

1. **Embed phone app with physical controler**
2. **Sensor to detect objects: give feedback to users easy**
3. Sounds and smells immersive experience
4. Universal controller
5. Secure login
6. Fail-Safe System
7. **Tutoring system for inexperienced users**
8. 360 view cameras
9. Vehicle alignment scale
10. Weight tracking system (for bucket)
11. Networking with other vehicles
12. Enhance user experience with AI
13. Intelligent battery of the remote controller
14. VR control station