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Linköping University

Documentation Of all five weeks

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Documentation of Week 2

Description about that ALL technology: So, our exploration is based on the assigned company Adaptive Liquid crystal lenses (ALL) that is mainly focused on the liquid crystal technology formulated on the flat tunable lenses with no moving parts. Up till now, they have been workingon the linear polariser with two (liquid crystal) devices that can be usable for mainly consumer and technical products.

Jobs that are being done from week one:

- *Tunable focal length.* Lens technology is doing a job with the application of the focal length can be changed with the help of voltages. As it is important for the purpose of contrasting the images and focusing on the speed and accuracy of capturing the picture. Moreover, spiral-shaped electrodes generate a device that helps the LC on focal length.
- *Color distortion (Eliminate chromatic aberrations).* The lens can be optimized for each primary color by successive shots. They are then combined so that chromatic aberrations are eliminated to the greatest extent possible.
- *Miniature and lightweight.* Lenses are doing a job that by the increase in technology brings forward lightweight lenses for the consumers and makes their life easier. By increasing the specification and producing lenses trouble-free to carry as compared to theconventional one.
- *Affordability (Low cost) ALL lenses* are highly cost-efficient and can do a job in mass production because they have a mature market, especially in electronic devices. Moreover, due to the affordability of the lenses it would automatically reduce the price at which these devices are sold in the market and reduce the cost of production for manufactures.

- *Emulate different lenses.* The Liquid crystal lenses change the focal length and angle of view by controlling the lenses to simulate their work, such as: wide-angle lens, telephoto lens, macro lens, etc.
- *Measure distance.* Electronically tunable Lenses can manage the jobs about the distance for the purpose of the faster and capture and have view in a distant way. Additionally, lenses can do several jobs with the purpose of further zooming in with the help of thefocal distance.

Products/ industries where these jobs tried to solve the problems:

Liquid crystal lenses have a wide range of applications and can be used in several industries with several purposes. Most of them have already been applied and solved the problems of the consumer. As in the industry of consumer electronics liquid crystal lenses have been helpful over the period.

 Liquid Crystal technology - Liquid crystal performs the job in eyewear industry as it carries out the job with the purpose of changing the shape of the lens to obtain the zoom effect in spectacles, like the lens of our human eye, by changing the shape. It does not exist focal length, the change in shape leads to a non-stop change in focal length, and thusit does not exist zoom multiplier, if the focus is on the scene, a second or two later, the lens will automatically focus.

 Lossing the ability of the eyesight - Eyeglasses The first spectacles that appeared for the correction of presbyopia were single-vision spectacles. This type of lens has only onefocal point in the entire lens area that corresponds to the distance of the object being viewed, so it can only solve, there is a clear line of division between the different areas, and some patients may have difficulty adjusting to it and experience dizziness and eyestrain. Therefore, to cater to the needs of patients, progressive spectacles have emerged. These progressive spectacles already have a good transition between the near and far viewing areas, but with this comes a blurred area on the lower left and right foot.

- *Subsequent sizes to meet the need end-users -* In the consumer industry lenses are used significantly like mobile phone cameras and solve the problem of the users as it becomes convenient for them to have face time with their family and to capture the images. As now, they do not put make efforts to carry around the separate digital camera because mobile phone cameras perform the similar jobs. Just as, it appears that the extended optical zoom technology does not affect the image quality by cropping the captured image in-camera and subsequently enlarging it a certain number of times like digital zoom. Moreover, it is helpful to change the focal length of the lens by changing the relative position of the lenses in the zoom lens. This allows the angle of view and focal length to be changed, and more distant scenes become clearer. Similarly, laptop computercameras perform the job by reducing the size of the lenses as compared to the older version as it takes up a small area of space in the laptop and manufacturer creates the screen smarter and slim to carry around.

Existing Solutions:

- *Lenses in Spectacles.* Lens technology has been utilized for visual aids to correct vision problems.

Optical lenses in medical machines. Liquid crystal lenses have been applied in the medical field. Such as optical lenses have been used in the X-ray, ultrasound, and MRImachines are doing the jobs like they are detecting the abnormality in the human body.

- *Conventional Lens in the automobile industry.* Lenses in the manufacturing of automobile parts such as side mirrors, dash cams, and car black box recorders arecurrently being used in assisting drivers in the completion of several tasks.

- *Machine vision in the production field.* In the machine vision industry, the focus is on inspecting the drawbacks of products, judging the selecting objects, and applying automatic production lines for materials calibration and positioning. Moreover, machinevision jobs are being performed for the acquisition of images; processing and analysis ofimages; and output or display. Besides, these three systems are doing the job with the help of lenses.

- *Lenses in binoculars.* The lens technology has been used in binoculars to magnify the images and it also has close contact with your eyes like spectacles.

Strengths and weaknesses:

- *Optical zoom lens.* optical zoom lens can obtain high-quality images, because the optical zoom is to adjust the focal length by moving the position of the lens, so the resolution, pixels and image quality will not change, so that the object is not only larger, but also clearer. However, the optical zoom lens costs more, and in the process of moving the lensis accompanied by the wear and tear of the lens, reducing the service life.

- *Digital zoom lens.* the cost of digital zoom lens is cheaper, and digital zoom uses a lens fixed-focus lens; the lens does not move so the service life is longer. But digital zoom by cropping the original image size, so that the image on the display device becomes larger,which will reduce the resolution of the image and the number of pixels, so the image quality is worse.

- *Comparison With ALL technology*. Adaptive liquid crystal lens technology can be used to make varifocal glasses for presbyopia correction, thanks to its ability to change focus freely. Although ALL require electricity but has more powerful functions. The lens will no longer have blurred areas and no need to compromise on imaging. Also, because of its free focal length adjustment, patients do not have to go back for new presbyopia glasses every few years due to changes in diopters, a presbyopia glasses with ALL lenses can fit all diopters. Besides, ALL lens has a good function of eliminating chromatic aberration, which can present a more realistic image of color.

- *Liquid crystal lens vs Optical zoom lens*. A liquid crystal lens is close to the image quality of an optical zoom lens, the cost is significantly reduced, and by controlling the liquid crystal can achieve rapid auto-zoom. Compared to digital zoom lenses, LC lenses have higher image quality, cost, and digital zoom at the same level, and LCD lenses have a wide range of focal length adjustments without reducing image quality.

Discovered “Jobs to be done” approach areas:

So, due to the cost associated with medicated glasses people who are suffering from myopia, refractive errors and another fact is that they are unable to purchase these glasses because they are very expensive, especially in developing countries. If the manufacturer produces in a mass-market eventually It will influence the selling price. On the one hand, people complain about the discomfort that comes with wearing glasses because they tend to increase in size or how foggy they get during winters and rainy seasons also they are terrified because of the color distortion. Moreover, the surprising fact about existing products like contact lenses is that they have been commonly used among fashion models and even people without eye defects for beautification. Sunglasses are equally used not only to prevent sun rays from having a direct effect on the eye but also for beautification.

In the automobile industry, there have been countless complexities with the way cars or motorcycles are designed, because mostly cars have a manual system especially in developing countries. Most people would rather join public transportation than learn how to drive because they think people are struggling to see the road behind them. Also in auto mobile industry, dash cameras can also provide proof for police in hit- and-run situations. It could also capture pedestrians and cyclists who may be behaving in a way that endangers the driver’s life. Also, car black box recorders which are used to record the road in high quality and record drivers behind who may be driving under the influence of alcohol.

New markets for liquid crystal lenses:

When we purchase a thing, we are essentially "hiring" it to assist us in completing a task (Christensen et al., 2016). The usage of conventional lenses in the manufacturing of automobile parts such as side mirrors, dash cams, and car black box recorders is currently being used in assisting drivers in the completion of several tasks. Like, the side mirrors enhance the magnification of objects from afar by making them appear closer than they seem and improvingthe angle view. The users of vehicles tend to be satisfied in the long run. But liquid crystal lens technology can be used in wheeled cranes so it will be helpful for the workers for the purpose of lifting and placing containers to have a clear view and it creates efficiency in their jobs.

Also, liquid crystal lenses can create a market in the two-wheeled motorcycle as side-view mirrors take a lot of space on the roads and it leads to a higher number of accidents in developingcountries. With the help of the technology if cameras have been installed at the back of the seat and give a clear view with the help of the dashboard screen it will be an impactful solution for society. There is also a potential market for liquid crystal lenses in the Fishing and boating markets they could use lenses in the boats and fishing rods, as a waterproof camera where the fisher gets a clear a view of the deep-water spots where fishes can be hunted it makes their work easier and efficient also causes the lesser number of accidents that the professional fisherman faces usually.

Moreover, the smartwatches could be a new market where for the safety of children it can be used while parents leave them alone for the school or playing out. The technology can be used here by including a tiny camera that can record everything that would occur in their surroundings and keep track of their locations and notify their parents when there's being a major intrusion. Currently people have invented smart watches but there are a few limitations to these devices that the liquid crystal lenses would be able to solve. Smart watches have been used to read heart rates, listen to music, calculate footsteps and even to receive a phone call.

In the eyewear industry, adaptive liquid crystal lens technology can be used to make varifocal glasses for presbyopia correction, thanks to its ability to change focus freely. Although liquid crystal needs electricity but has more powerful functions. Then the lens will no longer have blurred areas and no need to compromise on imaging. Also, because of its free focal length adjustment, patients do not have to go back for new presbyopic glasses every few years due to changes in diopters. A presbyopic glasses with ALL lenses can fit all diopters. In addition, the liquid crystal lens has a good function of eliminating chromatic aberration, which can present a more realistic image of color. Also Depending on the needs, these lenses can also be made into nearsighted, farsighted, and astigmatic spectacles.

References:

Christensen, C. M., Hall, T., Dillon, K., & Duncan, D. S. (2021, December 3). Know Your Customers' "Jobs to Be Done." Harvard Business Review. Retrieved April 7, 2022, from https://hbr.org/2016/09/know-your-customers-jobs-to-be-done

Geday, M. A., Caño-García, M., Otón, J. M., Alcayde, A., & Quintana, X. Adaptive liquid crystal lenses (ALL) (n.d). Keeping focus with no moving parts.

Katz, J. A., Karpecki, P. M., Dorca, A., Chiva-Razavi, S., Floyd, H., Barnes, E., ... & Donnenfeld, E. (2021). Presbyopia–A Review of Current Treatment Options and Emerging Therapies. *Clinical Ophthalmology (Auckland, NZ)*, *15*, 2167.

https://imaging.nikon.com/lineup/sportoptics/how_to/guide/binoculars/technologies/technologies_04.htm.

https://www.transparencymarketresearch.com/optical-instruments-lenses.html.
https://nickhop.wordpress.com/2021/01/28/theory-as-a-lens-tool-or-musical-instrument/.
https://phase1.attract-eu.com/adaptive-liquid-crystal-revolution/.
https://www.stemmer-imaging.com/en/knowledge-base/optics/.
https://www.ldpetphotography.com/blog/lightweight-lenses-for-wildlife-photography.
https://www.stemmer-imaging.com/en/knowledge-base/optics/

https://www.opto-e.com/products/industrial-cameras

https://www.automate.org/blogs/understanding-optics-in-machine-vision-applications

https://www.cognex.com/what-is/machine-vision/what-is-machine-vision

https://zhuanlan.zhihu.com/p/37332613

https://www.eet-china.com/mp/a55307.html

Documentation for week # 3

Crane Truck: Research mode 1

Armchair Research

Crane Trucks are being used for various purposes and they are essential and dangerous vehicles on the worksite. For instance, they are used at the place of the transportation hub. As a Crane truck operator has been hired based on the contractors or Subcontractors, the obligation is drivers needed to be licensed and have some expertise to lift the heavy containers. Moreover**, 20** feet container takes around three hours for loading and 40 feet container takes six hours. Well, it is a stressful job when it comes to the safety of the workforce who are working on the floors because there is always a risk of imbalance or mechanical failure as it causes the materials or containers to slip.

https://www.hiab.com/en/products/loader-cranes/hiab-industry-applications.

Stakeholders:

Heavy Equipment Manufacturing → Aircraft; to carry the aircraft with the help of crane truck. Forestry; after lumberjack cuts the woods it will be transported to the manufacturing hub with the help of crane trucks. Cars; Crane trucks has been used for the purpose of the transportation of newly manufacture cars from hub to the showrooms without causing any damage.

Waste Management → Crane trucks been used for the purpose of sorting and recycling the waste.

Builders →Crane trucks has been used for the purpose of the Highrise window cleaning lift and construction sites.

Contractor and Subcontractor →Crane operators, training operator and site supervisor are the one responsible for safety at workforce and lifting the heavy objects.

As it was mentioned by Zhang and Hammad (2007) that the controlling the motion of the crane is one of the hardest parts of the job for the crane operator. And how these planning and communication conflicts and efficiency could be improved.

(PDF) Agent-based simulation for collaborative cranes | Chéng Zhang - Academia.edu

Research Mode 2

Since we have asked the below mentioned questions and the communication has been carried out informal ways. Since we contacted the known person.

Question asked to the crane truck user (waiting for his reply)

1- What are problems they face during the night duty?

2- Any particular problem they face while maintaining the communication with other crane agents?

3- What do you think as an operator if you get a view with the help of cameras does it increase efficiency in your work?

(Spectacles, contact lenses & sunglasses): Research mode 1:

Armchair Research

While most people hire glasses to cater for several of their needs, they are faced with a variety ofproblems such as; scratches on their lenses, filth from dust, discomfort from how bulky they could be, eye fatigue, loose frames, the cost involved in annual optometry and changing glasses either because they run out of fashion or that plastic frames easily break, night glare and blurredvision during rainy and cold seasons also make wearing glasses very unbearable.

The users →spectacles could be the eyewear manufacturers, the aged, the children, middle-aged people, fashion models, the blind, healthcare workers, medical institutes, ophthalmologists, and opticians. Some key players were identified as follows.

https://www.grandviewresearch.com

The benefits of wearing glasses vary among different users and the influence they have on eachother are explained below.
Eyeglasses boost productivity, raise earning potential, improve learning, and keep individuals safer on the road and at home. People who wear eyeglasses can see clearly and perform well. Eyeglasses are an effective instrument for social, economic, and personal development. While aconsiderable number of people wore glasses for fashion purposes and the innovation of sunglasses played a significant role in this craze, 2.7 billion people require them but lack accessto them. Below are some other benefits of wearing spectacles:

- Sharpness and health have improved.
- Protection against the eyes.
- Corrective eyewear that is both comfortable and effective.
- Cost-effective and simple to maintain.
- This is a fantastic fashion accessory.

https://visionspring.org

How prescription glasses are made
Plastic and glass lenses are made by a series of delicate grinding, polishing, and shaping phases.While lenses for telescopes, microscopes, binoculars, cameras, and various projectors are madeusing the same method, they are often larger and thicker, requiring more precision and power.

http://www.madehow.com

How do glasses help us see? - Andrew Bastawrous and Clare Gilbert

https://www.youtube.com/watch?time_continue=3&v=ypF037wlYZg&feature=emb_title

Spectacle users are faced with major challenges, and this is not because medicated glasses are not doing most of the jobs that users require or hire them to do. It is because most users have high expectations when getting glasses for the first time and when all their expectations are not met, they become pained. Spectacle users were faced with a major challenge especially during the COVID-19 era when wearing protective masks became the norm of the day. For some of us the tradeoff was to choose between protecting yourself from the deadly corona virus and risk notseeing your surroundings properly because of how foggy and blurred up these spectacles got from our breathe by taking the glasses off and for others they despised wearing them and wouldrather stay home than deal with the discomfort of a blurred vision even with the glasses on.
Below are some problems and even though they are common amongst most users they are alsodistinguished amongst them.

- They are very expensive.
- Annual optometry
- Plastic frames and lenses could easily break
- Bulkiness
- Scratches
- Loose frames
- Night glare
- Blurred vision
- Single function
- Eye fatigue
- Worsening eye conditions
- Headaches

https://www.inneseyeclinic.com

From our findings people like the idea of wearing spectacles, contact lenses or even getting lasertreatment, which is the most permanent form of eye treatment, but they also do not want to engage in the tradeoff between the cost of getting treated and the fact that they need them. Most

people are fascinated about the idea of wearing glasses because for some it is an addition to theirfashion statement, more like an ornament and are willing to pay the price just to look gorgeous.On the other hand, they are people living in very remote areas especially in developing countrieswho are in urgent need of medication but do not have the means to purchase these glasses.
Sometimes it is not because they are not aware of their medical condition, but because they do not see the need in getting them because of their superstitious beliefs.
We also found a major complaint about spectacles to be the problem of running out of fashion quickly since most people aside those who are in urgent need of medical treatment are wearingthem from fashion. Most eye manufacturers have seen the need to fulfil these fashion needs bydesigning new and trendy frames for that purpose. Sunglasses, contact lenses and spectacles arecommonly used among different age groups to add up to their fashion statements.

Some risks of laser eye surgery are: **Permanent dry eye**. Halos, glare, or double vision, makingit hard to drive at night. Over- or under-correction of vision, meaning you still need glasses or contacts.
https://www.webmd.com

Research mode 1:

Camera on vehicle

Job: decrease traffic accidents
How: improving the ability to detect different objects
Solution of the "how": improving the ability of cameras in different situations
Product improvement: ALL could improve the ability of cameras to detect objects

Area of use camera:
- Monitor the road ahead of the vehicle
- Record vehicle movement
- Reverse assist video
- AEB automatically applies brakes to avoid collisions
- Pedestrian detection camera
- Radar, infrared and camera hybrid platform

-Blind Zone Detection
-Fatigue warning
-Automatic parking

Example of existing solution : Tesla
Optical sensors: 8 cameras + 1 millimeter wave radar
- 3 front view cameras: wide view, main view, narrow view
- 2 side front view cameras
- 2 side rear view cameras
- 1 rear view camera

Source: https://www.tesla.cn/Autopilot

Problems of existing solution:

- In harsh environments, such as insufficient light at night, reflective daytime cameras, and lack of visibility on rainy and foggy days, the vehicle camera cannot recognize objects properly.
- When the light condition changes, the camera cannot adapt to the new light condition quickly and loses the ability to recognize objects.
- The high cost of cameras forces car manufacturers to increase the price of cars.

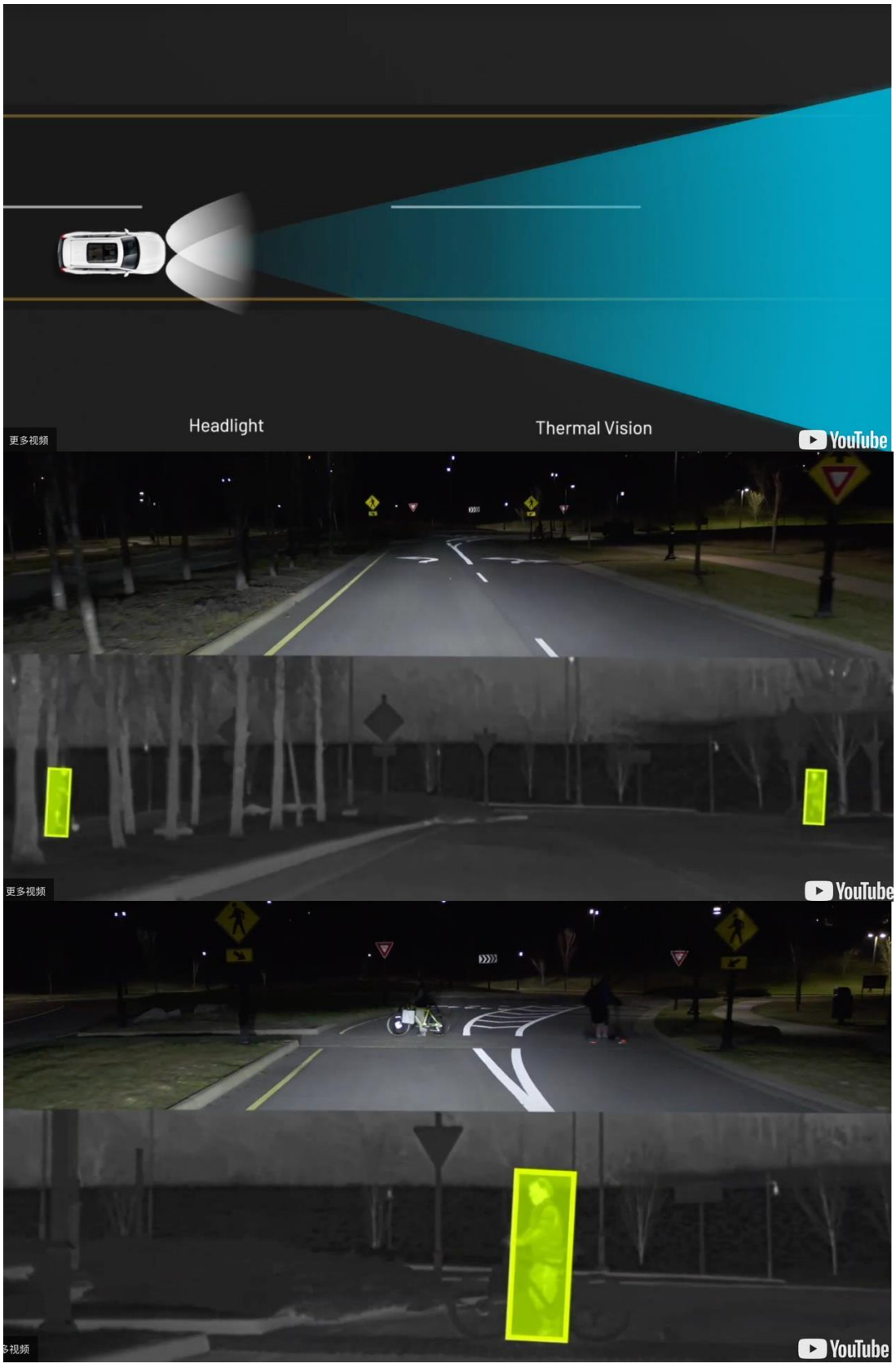
-At high speed, the camera is required to have the ability to identify objects quickly.Veoneer: Infrared camera

Veoneer's thermal sensing system uses an infrared camera mounted in the front grille of the vehicle that senses heat differences as sensitive as a tenth of a degree to create a highly detailed thermal image of the world out in front of the vehicle.

Source: https://www.veoneer.com/en/thermal-sensing

Advantages:

- Solve the problem of limited night driving vision
- Solve the problem of nighttime meeting glare
- Improve driving vision in bad weather (fog, haze, sandy weather)


Headlight
Thermal Vision
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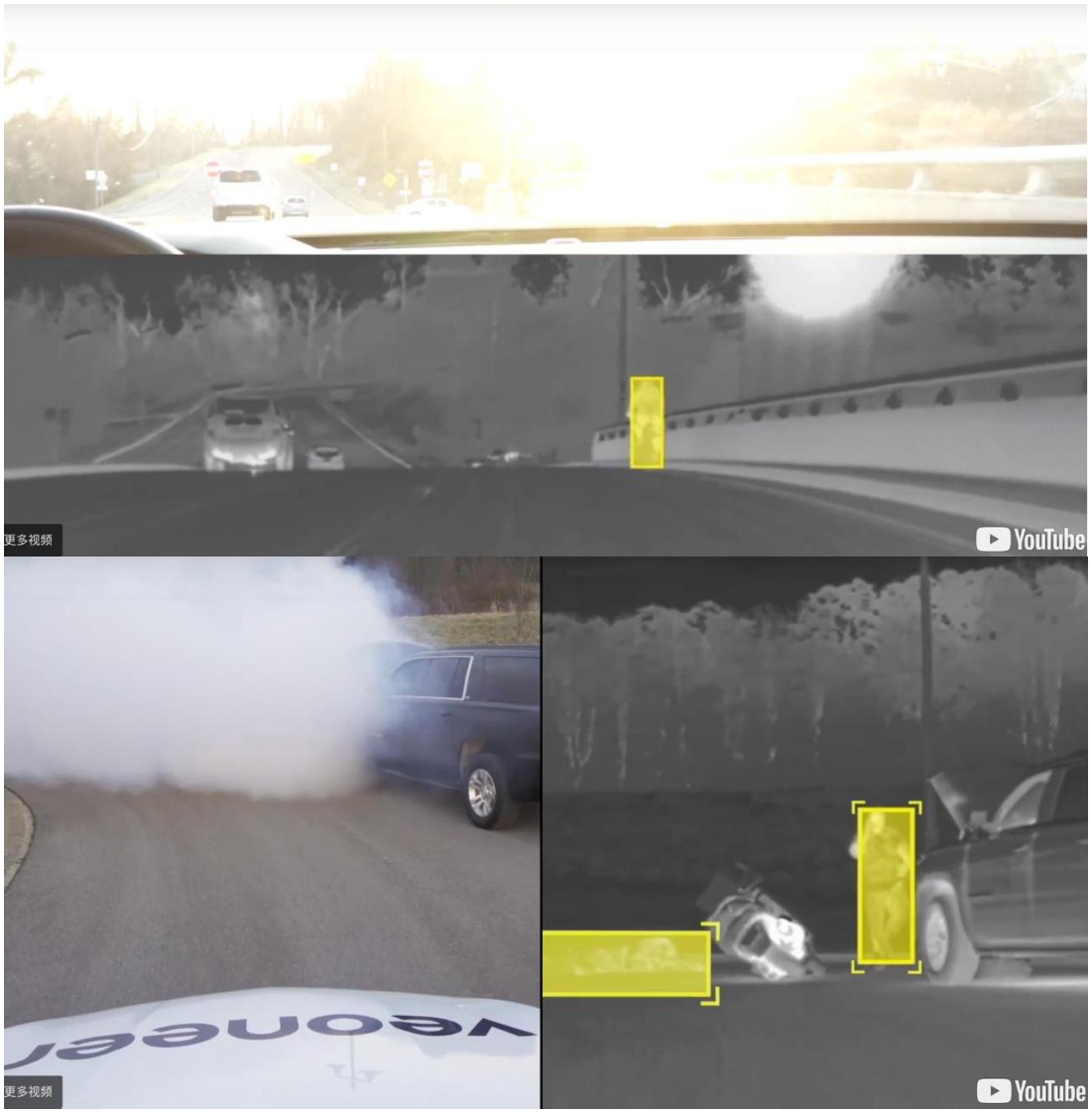


Disadvantages:

- High costs

Source: https://zhuanlan.zhihu.com/p/101424898

Who are the main users?

- Private car driver
- Public car driver
- Truck driver
- Other kinds of drivers

What drives them and how do they influence one another?

- Drivers want to improve their safety while driving the car.
- Influencers:
  - Car manufacturers
  - Car repair shop
  - Governments make laws

- Investors
  - banks and sponsors
- Competitors
  - Optical Lens provider
- Partners
- Suppliers
  - Liquid crystal provider
  - Glasses provider
  - Technology labs (university)

What kind of processes are involved? What do people do, what kind of tools and technology dothey use?

- Process (Driving the car from A to B)
  - Find their car and depart
    - Depend on their memory
    - Use the buzzer to make the car sound
  - Driving on the road
    - Use their eyes look around the car, avoid collision with other vehicles orpedestrians
    - Look at traffic signals with their eyes such as traffic lights, direction signs, road names, straight or turning lanes, etc.
  - Arrive at the destination and park the car

Research mode 2:

Questions had been asked to the car users and the respective answers that we received.

What are the main challenges, problems and pains that these users experience in existing solutions and processes (i.e. in what way do they do a poor job?)?

The cameras of existing parking assistance systems use wide-angle or fisheye cameras in pursuitof a wider view, but they also introduce varying degrees of distortion, making it difficult for newdrivers to measure the real distance and angle. The cameras of existing parking assistance systems use wide-angle or fisheye cameras in pursuit of a wider view, but they also introduce varying degrees of distortion, making it difficult for new drivers to measure the real distance and angle.

What is difficult to do?

As most existing car cameras use fixed-focus cameras, there are often multiple cameras even on the same side of a car to accommodate different focal lengths. So, reducing the number and cost of cameras becomes difficult.

Reference: https://visionspring.org

https://www.webmd.com

https://zhuanlan.zhihu.com/p/101424898

https://www.hiab.com/en/products/loader-cranes/hiab-industry-applications

https://www.demagcranes.com/en/industries/waste-management.

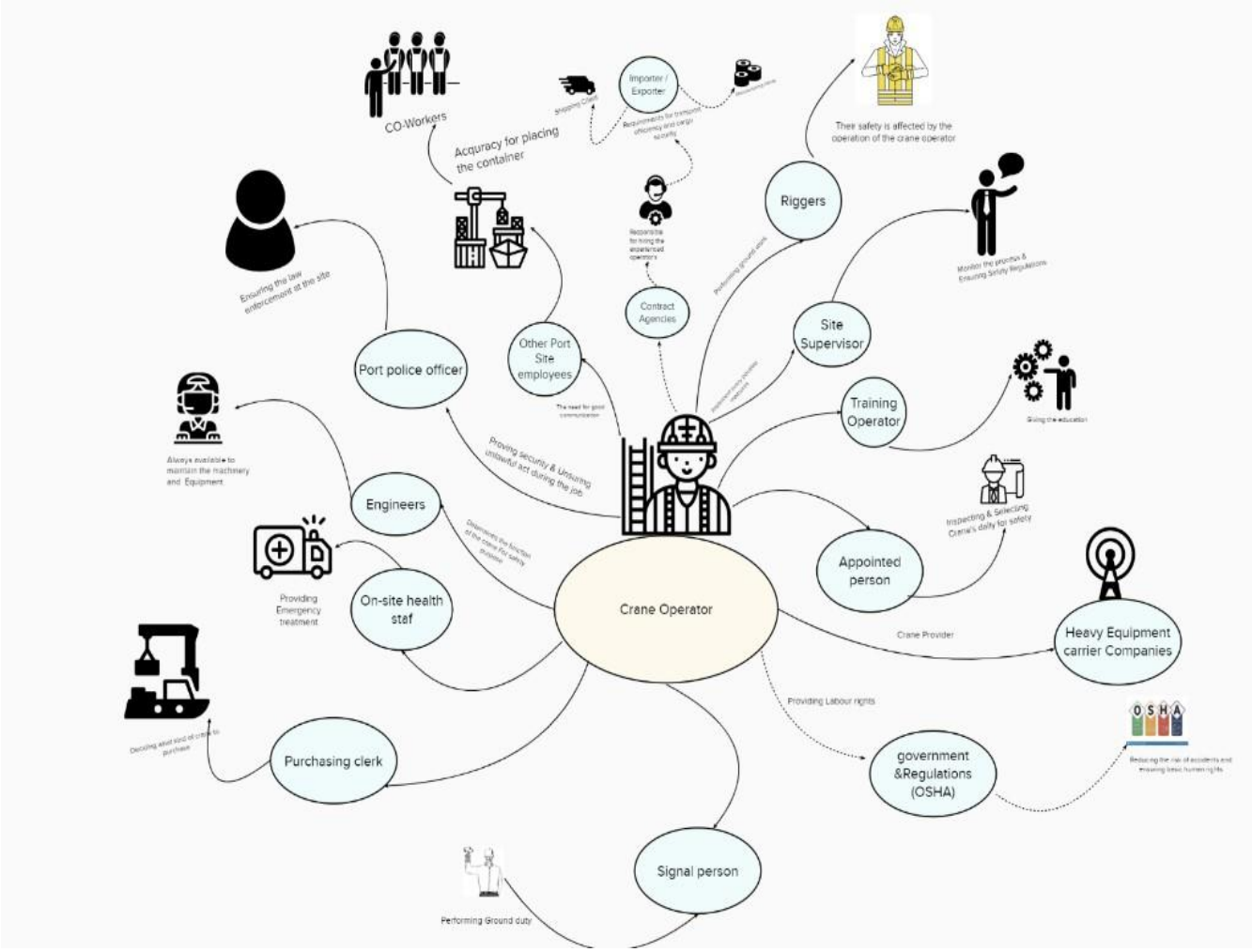
https://www.veoneer.com/en/thermal-sensing

Zhang, Cheng & Hammad, Amin & Zayed, Tarek & Wainer, Gabriel & Pang, Hong. (2007). Cell-based representation and analysis of spatial resources in construction simulation. Automation in Construction. 16. 436-448. 10.1016/j.autcon.2006.07.009.

Documentation for week # 4

Stakeholder + Synthesize & Define + Persona's Story & Journey Map + POV'S

Stakeholder's map



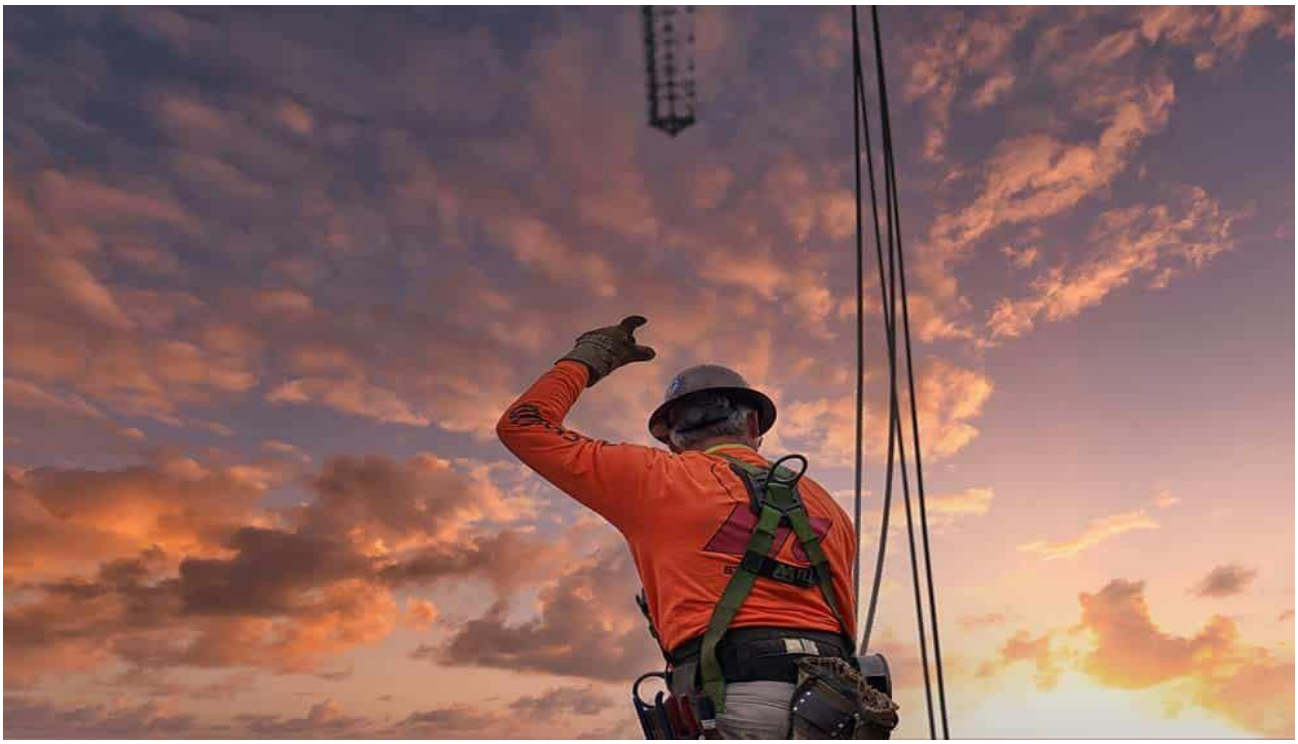
SYNTHESIZE & DEFINE

Define:

Efficiency & Safety for Crane operator's job

Originally, we design the challenge that Adaptive liquid crystal lenses would be used in cameras and as IALL lenses have a short and long focal length. This would enhance the vision of the crane operator and provide safety to the riggers and signal persons. Efficiency is also another major problem during crane truck operations. Moreover, the installation of cameras which would improve vision and enhance communication would cater for the delays during operation. For example, it takes crane operators at least 3 hours to discharge a 20ft container and 6 hours to discharge a 40ft container. The crane operator's efficiency has an impact on the terminal's overall productivity. The time wasted to discharge these containers could be reduced and increase crane productivity. Crane productivity would increase if crane operators could work with an unobstructed vision, and loading Layer-by-Layer would be an option (Drotz and Johansson, 2016). An unobstructed view would equally create a safe working

environment for riggers and signal persons



https://odr.chalmers.se/bitstream/20.500.12380/244983/1/244983.pdf

Through Discovery (Insight) we slightly changed our design challenges:

As majority of the crane operators couldn't able to communicate effectively because of the weak signals at the time of bad weather. Hence, it causes misalignment and site accidents.

For Reference → Clear communication and Good Visibility is essential for safely operating a crane. Communication between crane operators and riggers or signal persons are usually distorted due to the distance between them or even faulty walkie-talkies used during operation. Since riggers and signal persons have to stand at a safe distance away from the the cranes for safety incase of falling objects and that in itself is a problem because signals from signal persons cannot be understood clearly. For example, in the case of tower cranes that are already very high communication is usually done via a walkie-talkie which is usually faulty and espaecially where signals and directions have to be communicated by riggers and signal persons the distance becomes a major barrier between them.

https://www.canridge.com/mobile-cranes-in-severe-weather/

https://emersoncranes.com/operating-a-crane-in-extreme-weather-conditions/

Jersey crane rain - YouTube

Jersey crane rain

Jersey crane rain

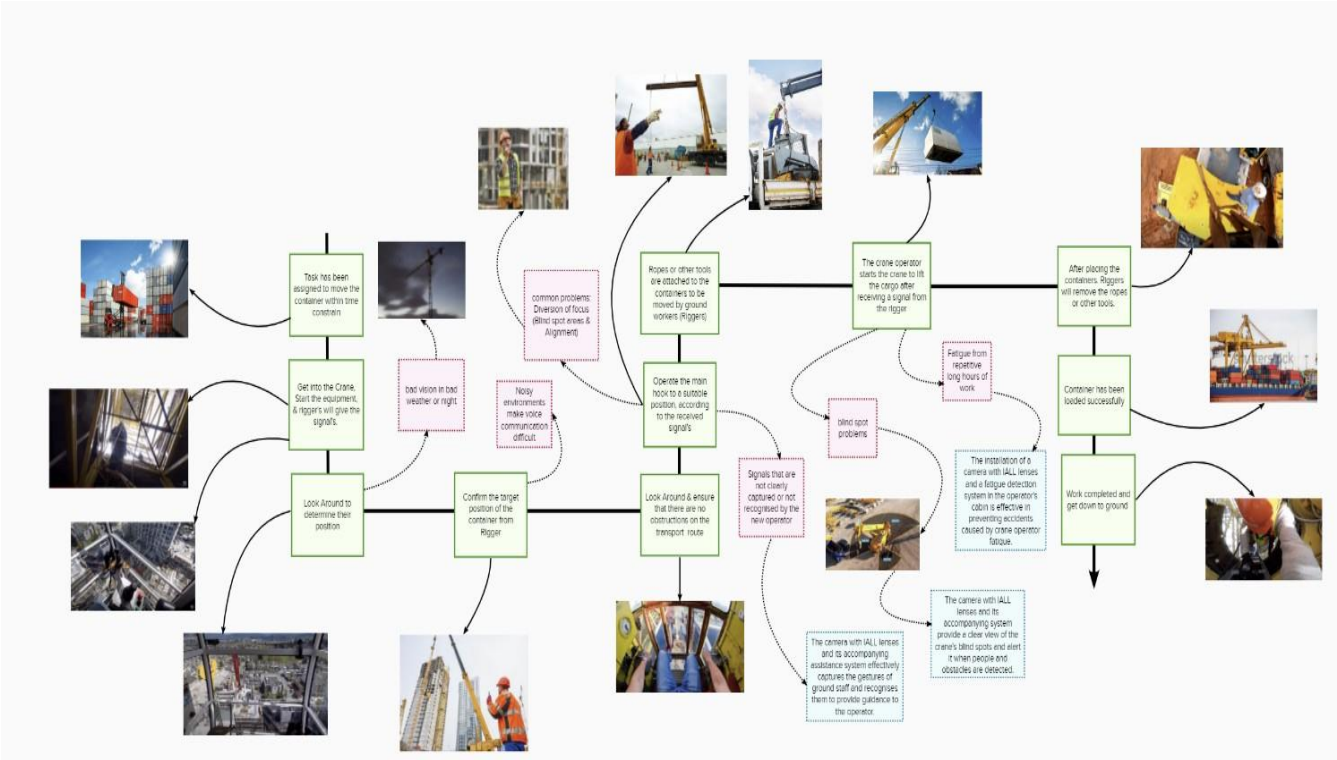
Persona # 1

Story ▸ Safi Ullah is 35 years old, he works as a crane operator at maritime city DMC, he has 10 years working experience on crane operation. He is not able to see the indicate from his collgues(rigger and signal person) when he set in a 40 feet crane because of safety distance, normally they are 100 meters away from Safi Ullah. They use walkie-talkie to convey the indicate of movement, but due to signal interference by crane and ship or other circumstance influence like noisy, the walkie-talkie frequent failure. In this situation, they must wait walkie-talkie back to work. Additionally, he is losing foucs when he controls movements of crane and communication with grounded employees at same time.

Persona # 2

Story ▸ Liu is 25 years old, in the Shanghai port to do crane maintenance work has been 5 years, every time he walking in the port are far away from the crane and the container, because in the container behind the 5 meters range and when crane around exist the blind spot, he often heard of collisions because the operator did not find the vehicle or pedestrian in the blind spot in time . He has often been told by operators that in rainy days and at night when their vision is disturbed, their work efficiency is reduced and the risk of accidents is increased because they cannot see the signals and have difficulty in judging the location of the containers.

Journey Map of Persona



Discovery: Synthesis POV (Point of View) -(Crane Operator 1)

Needs

User's needs are to have a reliable way to load and unload the container's without stressing out on maintaining the proper verbal and non-verbal communication also causing any serious damage.

Insight:

Greatest number of crane operators can make the human error if they lose focus because of the stress or fatigue it causes to harm ground workers life.

Discovery: Synthesis POV (Point of View) -(Crane Operator 2)

Needs

To have a way that help's Crane operator precisely recognize the location of the containers. Be able to work in a bad weather.

Insight:

Most crane operator's faces the same problem about the blind spot that causes the collision. Also, in the bad weather they have more than regular communication problem that causes to stop their work.

Research Mode:

Since we have asked the below mentioned questions and the communication has been carried out informal ways. Since we contacted the known person.

Question asked the crane truck user:

1. What are the problems they face during the night duty?
2. What are the main reasons for the accidents?
3. Any particular problem they face while maintaining the communication with Riggers?
4. Have you received any time to rest after one loading?
5. Are there any serious accidents caused by operational errors due to the work fatigue?
6. if there is a bad weather condition then how they carry forward your work?
7. If there is a delay of the prearranged time then what are the consequences you face?
8. Do you think if you increase your efficiency then you could get more rewards?
9. Do you think the view of crane is good enough or not, if not, what part could beimproved？

Answers we have received from Safi Ullah who is working at Maritime City DMC:

Problem's In general Identified

- *Alignment* → Over loading the crane can cause the accidents they are concern aboutthe alignment how it can carry the load. They must know the precise about the weightwhich can be carried out and rigger is the one who is measuring the weights with the radiator machines. Since containers has a high chance to fall if there is a wrong calculation or disbalance.
- *At night indistinct vision* → During the night duty they couldn't get the clear vision even though after the precise directions by riggers. There is always a chance ofdisbalance of the material. So, they use the red spot lights for the signals.
- *Diversion of focus* → While carrying the heavy containers it is so hard to maintain the proper communication with the help of walkie talkie. And it is essential to uphold the signals and communication from riggers to maintain the crane's movements at thesame time.
- *Accidents* → above-mentioned points and for the reason of Over-fatigue operationalerrors happening and resulting in serious accidents such as collisions, slips and falls.

Answers we have received from Qirui Liu who is working at Shanghai port:

Problems in general identified:

- *Communications* → Because the ship will interfere with the communication signal,can't use cell phones and other communication tools in the port, crane operators can only use walkie-talkies, but the signal of the walkie-talkies is also unstable, which hasa great impact on the work of the crane.
- *Fatigue* → Operators often work long hours, especially during busy periods when they can work for up to 12 hours straight, and many production accidents are

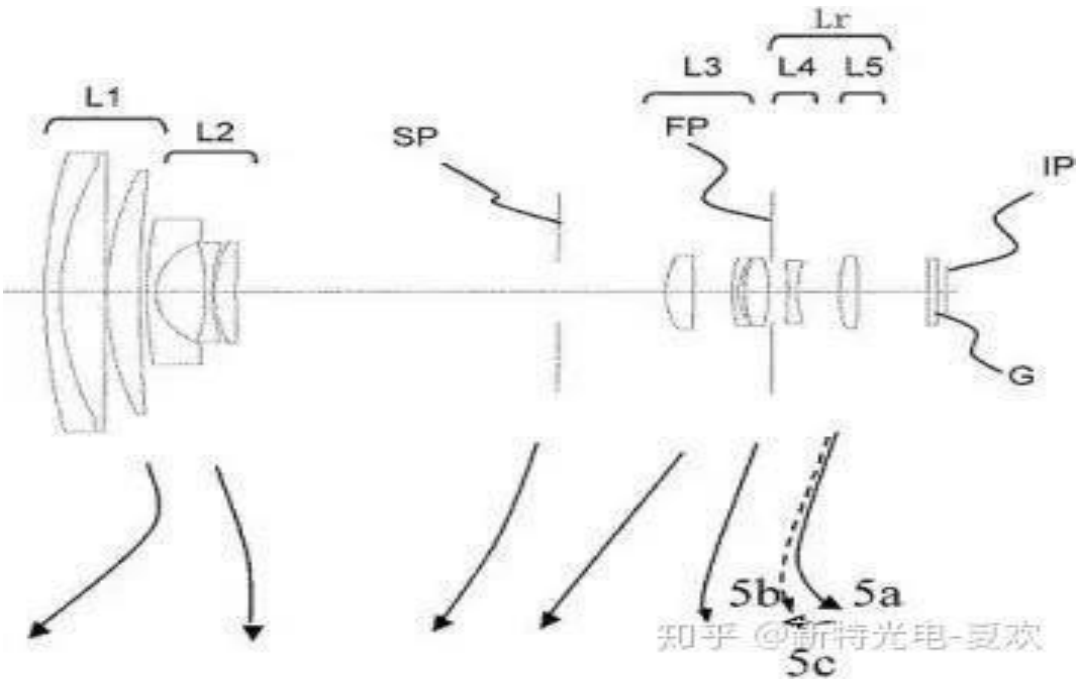
causedby operator fatigue.

Bad weather → in bad weather, such as high winds, fog and rain, it is more difficultto operate and the operator can hardly see the location of the container with the naked eye, which increases the risk of accidents and reduces productivity. So they stop theirwork.

- *Operating in the night* → it is often difficult to hang the output end of the hanger on the goods due to insufficient light, or the hanging position is unstable and difficultto detect due to insufficient spot light.
- *Blind spot* → in the container behind 5 meters when crane steering there is a blind spot, many accidents is due to people or objects in the cause of the blind spot and theoperator does not notice, resulting in serious collisions.

How IALL lenses will be helpful for above user's mentionedproblems:

1. *No moving parts;* That doesn't require the manual zoom in and out.
2. *Good image Quality:* As water is used in the liquid crystal lenses to ensure theimage quality.
3. *The smaller size;* but have a wider range of applications which means liquid crystal lenses reduces the size of camera.
4. *Focus is Faster:* As compare to conventional lenses, which means providing the larger distance focus length. As liquid lenses adjust the zoom in and out focus by changing the pressure of the focus.
5. *Mass production;* because of easy production process and the cost will be greatlyreduced.



Combination of lenses

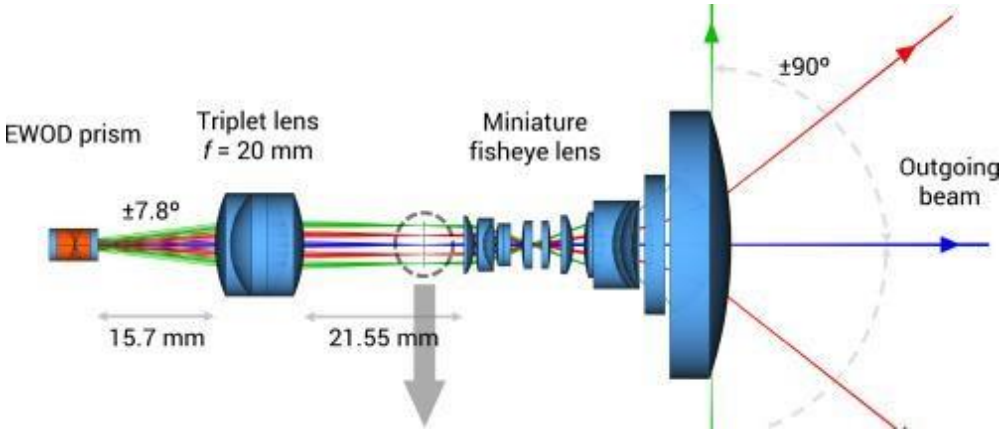
Source: https://zhuanlan.zhihu.com/p/264984804

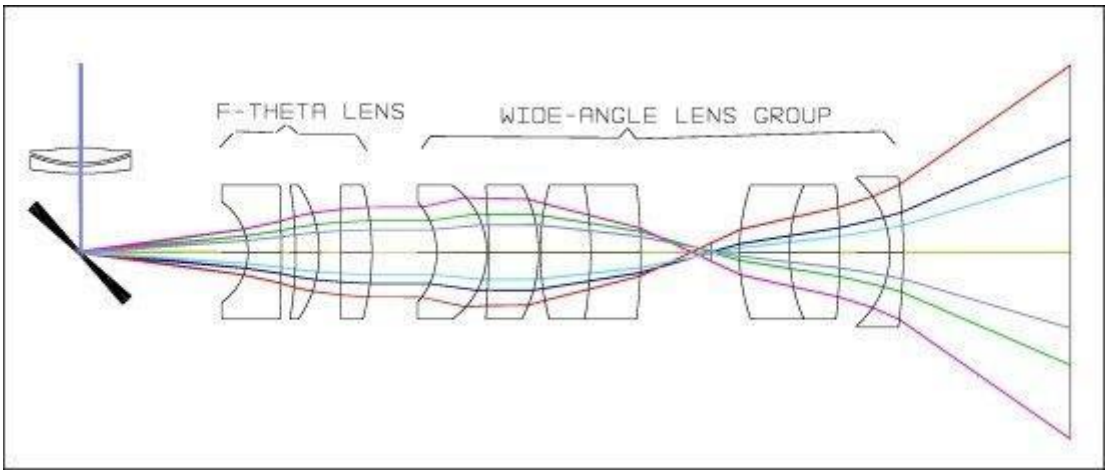
How IALL could improve it:

Liquid crystal lens can simulate various shapes of lenses to realize the control of light, using liquid crystal lens can effectively reduce the volume of LIDAR, quickly change the laser range, and reduce the processing difficulty and cost of LIDAR.

LIDAR:

LIDAR is usually used to identify objects in the dark, with high precision distance measurement, LIDAR lens is vital to provide high efficiency in sending light pulses and returning pulses, in LIDAR optical lens system, triple lens will scan the laser beam to form telecentric beam, and fisheye lens will enlarge the lens field of view to 180 degrees. LIDAR lens requires high threshold optical technology, which requires large through-aperture, high brightness, wide field of view, high contrast, low signal-to-noise ratio and other characteristics, as well as mechanical requirements for compact size, dust and water resistance, shock resistance and other characteristics, which are quite demanding for optical design and producing.



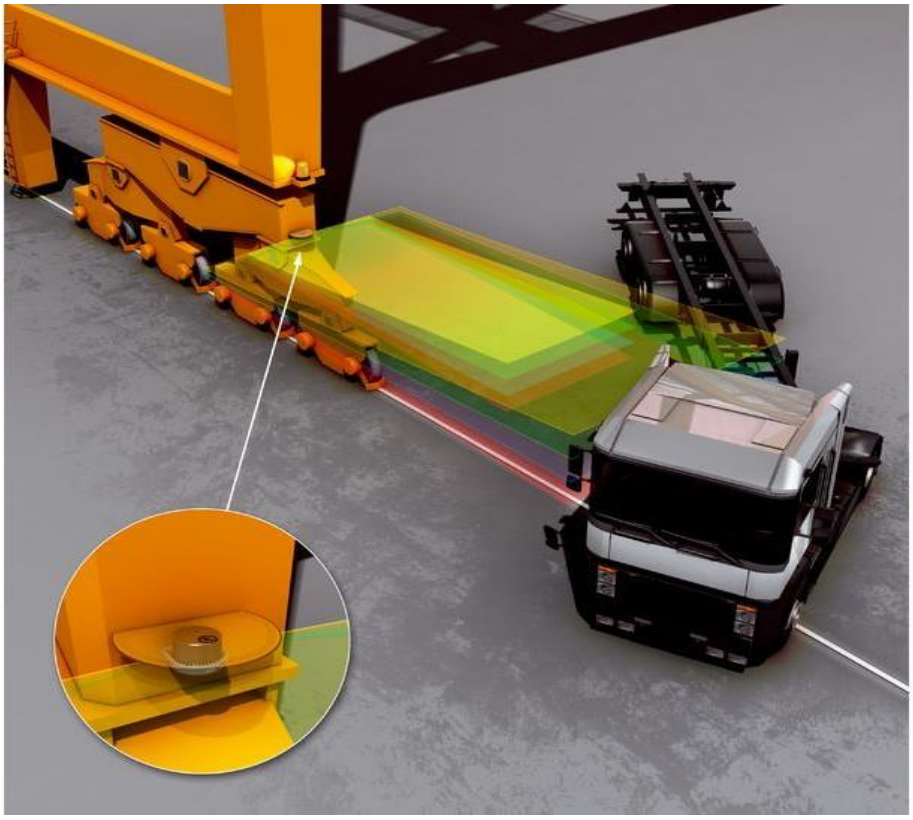


LIDAR lenses theory

Source: https://www.opticsforhire.com/blog/lidar-lens-design-optical-layout

LIDAR in Crane

Source: https://www.core77.com/firms/design1st/Extreme-Condition-3D-LiDar-Obstacle-Detection



3D-LIDAR collision avoidance in Crane

Source: https://www.sick.com/cz/en/industries/port/container-terminal/quay-area/quay-crane-and-quay-area/collision-avoidance-in-the-path-of-a-quay-crane-with-3d-lidar-sensors/c/p579950

Potential Solutions

The IALL lens-equipped camera has a fast focus feature that allows the operator to use it to see the state of the container in the normal field of view and use zoom in to see the signal of the indicator, and the IALL has a very fast focus speed that can effectively improve the efficiency of the operator.

In developed countries, cranes can be installed with multiple cameras to achieve a multi-angle view. Thus, reducing the communication between the operator and the instructor, the operator knows more clearly the current position of the container and reduce the difficulty of operation.

In developing countries, cranes install fewer cameras, mainly using fast zoom common capsule to help operators and instructors' better communication, and due to the low power

consumption of LCD lens, easy mass production characteristics, can effectively help reducecosts.

References:

https://www.canridge.com/mobile-cranes-in-severe-weather/
https://emersoncranes.com/operating-a-crane-in-extreme-weather-conditions/ Jersey crane rain - YouTube

https://zhuanlan.zhihu.com/p/264984804

https://www.core77.com/firms/design1st/Extreme-Condition-3D-LiDar-Obstacle-Detection

https://www.sick.com/cz/en/industries/port/container-terminal/quay-area/quay-crane-and-quay- area/collision-avoidance-in-the-path-of-a-quay-crane-with-3d-lidar-sensors/c/p579950

Documentation of Week 5

Documentation for Design Brief

Point of View (POV) with underlying problems:

Safi Ullah is 35 years old and holds a heavy equipment driving license plus 10 years working experience. He works in Dubai at marinetime City DMC. He is facing **diversion issues** as he mentioned that while performing his task, he needs to maintain the focus on crane movements and the communication with the grounded employees (rigger and signal person) at the same time.

What if?

- What if IALL (Adaptive liquid lenses) provide them with a clear visual?
- What if with the help of IALL lenses there will be less stress on communication with grounded people?
- What if with the help of IALL lenses there will be lower numbers of accidents?
- What if IALL could replace faulty walkie-talkies on site?
- What if IALL could reduce fatigue in order to increase efficiency at site work?

How might we?

How might we decrease the number of accidents with the help of IAll lenses?

How might IALL lenses make crane operator's job less stressful?

HMW use existing resources to improve efficiency and safety in crane produce processes?

HMW decreases the impact of bad communication and weather?

HMW makes vision of operators farther and clearer?

HMW identify and avoid accidents or risk before it happened?

HMW use cameras to increase the view of operators?

HMW provide automatic detective objective like driverless car?

HMW use cameras to communicate with rigger and signal person instead of walkie-talkie?

1. **What do we know about our problem?**

→ What is our guiding question? How might we

Our guiding question is, how might we, with the help of IALL lenses, decrease the rate of accidents during crane operations and increase productivity at a port terminal?

How might we use rear cameras with IALL lenses to improve communication between crane operator and the ground crew (rigger/signal personnel) in order to improve the efficiency of work and reduce the number of accidents?

Crane operators are faced with various challenges during operations be it on site during construction or at a harbor during material holding. Some of these problems are misalignment of containers, fatigue, poor vision at night and severe weather conditions but most especially inefficiency and elevated risk of accidents resulting from poor communication between crane operators and riggers or signal persons.

→ What is the problem we are trying to solve?

It takes crane operators three hours to load and discharge a 20 feet container and a whooping six hours to load and discharge a 40 feet container. Also, the issue of poor communication between crane operators and riggers or signal persons and their inability to see them or even hear them while operating crane trucks causes a lot of delays and even accidents.

Riggers and signal persons must stand meters away from the crane to avoid being accidentally struck by objects and this automatically causes mishaps while communicating to them via faulty walkie-talkies which sometimes loses signal when there's poor connection.

https://www.arnolditkin.com

→ Why is it an important problem to be solved?

The reason this problem needs to be solved is because OSHA records 45% accidents per each operation annually and it is important that everyone is kept safe during operations. Cranes are ubiquitous and used in every industry therefore the safety of the people who make manufacturing, construction, material holding and shipping a success feel safe in their workspace. It is also important that the problem is solved to increase productivity at port terminals to make it attractive for people to import and export goods, this would give them a competitive edge over others.

https://www.graphicproducts.com

→ What do we know of the context in which this problem is happening?

Riggers, site supervisors and signal persons suffer the most from accidents like materials slipping and misaligned objects during crane operations. They are mostly exposed to the threat of accidents and deaths. Crane operators on the other hand need this camera or dash cam to resolve issues of misalignments, blind spots, poor communication, risk of accidents and delays during crane operations.

→ Who is suffering from this problem?

Riggers and signal personnel

→ What are the consequences for these people?

They become ineffective because of fatigue.

https://www.worksafenb.ca

2. What do we know about our solution?

→ What is our goal? What is the desired outcome/goal/objective that the solution should achieve?

Our goal is to use IALL lenses to enhance the functionality of crane cameras to help crane operators have a more efficient and safe working experience. Therefore, the most desired outcome is through the application of IALL lenses on the crane camera, not only the communication between the crane operator and the ground worker is greatly enhanced, but also solves the problem of blind spots in the crane's field of vision, thus enhancing work efficiency and reducing the risk of accidents.

→ What do we know about tech?

IALL lenses can provide focal tunability without compromising image or light beam quality, and completely without moving parts. As compared to the traditional solid glass lenses that needed the manual movements for the focus or zoom. Adapted liquid lenses have liquid filled lenses and electro- witting effect that changes the surfaces of lenses by applying the voltage and these properties of liquid lenses help to have a clear and sharp visual image.

liquid lenses – lenses with "water" – know (zhihu.com)

→ How does it relate to our problem?

The lack getting a clear visual of the blind spot is one of the major factors in the problem of low efficiency and high accident rates in cranes. Since the IALL lens can greatly improve the focus speed and electronically tunable lenses in cameras, the use of crane cameras equipped with IALL lens can effectively alleviate our problems.

→ How can it be used?

The IALL lens camera can be used to monitor blind spots in the crane's field of view, and the ability to zoom quickly can be used with the system to quickly focus on obstacles or people to sound an alarm or stop the crane from moving in an emergency. And it reduces the number of accidents

The IALL lens camera can also be used to track the position of the container, thus enabling the crane operator to have a more accurate perception of the container's position and avoid accidents caused by visual errors.

The IALL lens camera can also quickly focus on the ground worker and recognize his or her gestures through the system, preventing communication problems caused by distances too great to distinguish gestures.

→ What are the requirements of the purposed solution?

Completed the optimization of the IALL lens camera so that it can be produced on a large scale.

Designing the software system to accompany the IALL lens camera to achieve the required functionality

By including the Lidar system in the lenses

Apply for government cooperation or subsidies

→ What are the limitations that should be taken into consideration?

Some of the cranes are already equipped with cameras, and the enhanced functionality of the IALL cameras may not be enough to entice consumers to replace their existing devices or the communication systems they carry forward.

Installing the cameras with IALL lenses will enhance the efficiency of crane operators work but it cannot completely exclude the communication with the ground workers. For instance, riggers, there is a still certain need for communication to apply the roping in the containers.

Benchmark about the direction:

Under OSHA’s regulations the distance between the crane and the signal person is around; 10 feet, 20 feet, 30 feet and swing will be used around 90 degrees and slowly lower down 10, 20, 30 feet.

Crane Accidents: Facts and Statistics (blockotoole.com)

ALL Lenses usage to address the problem:

The adaptive liquid crystal lenses (IALL) would be a useful device to make cameras for cranes that would improve the angle view of crane operators and enhance magnification of objects that are far away. They are lightweight, miniature and inexpensive meaning it would not occupy too much space and be used for large scale production. It is a technology that allows more light onto the sensor which makes it feasible to incorporate into the LiDAR sensor for the cameras which would improve vision at night since they produce their own light and capture people in blind spots easily.

The LiDAR system would enable crane operators to sense people and objects in blind spots so that they avoid those areas and prevent them from causing accidents.

Crane operators complained bitterly about poor vision at night and wished this could be improved to increase productivity at the port terminal because it is making them lose existing and potential customers. It also reduces the quality of the communication and signals sent from signal persons and riggers.

The current solution uses a fixed focal length wide-angle lens, which is a focal length shorter than the standard lens, the field of view is greater than the standard lens, the focal length of the ordinary wide-angle lens is generally 38-24 mm, the FOV of 60-84 degrees; ultra-wide angle lens focal length of 20-13 mm, the FOV of 94-118 degrees. Due to the short focal length of the wide-angle lens, the FOV is large, in a shorter range of shooting distance, can capture a larger area of the scene.

Compared with IALL's liquid crystal lens, wide-angle lens when shooting closer scenes, will happen perspective distortion, but also increase the sense of distance between the front and rear scenes. While the IALL lens can be quickly adjusted focal length to achieve the wide-angle lens function, but also to achieve the function of telephoto lens, when the need to observe the details around the target object, by zooming in on the focal length, so that the distant scene becomes closer, so that it fills the picture. And IALL lens also has the function of dynamic focus, when there are multiple objects in the picture, by controlling the liquid crystal can achieve rapid focus on different target objects.

https://baike.baidu.com/item/%E5%B9%BF%E8%A7%92%E9%95%9C%E5%A4%B4/278835#5

References:

https://www.arnolditkin.com

https://www.graphicproducts.com

https://www.worksafenb.ca

liquid lenses – lenses with "water" – know (zhihu.com)

Crane Accidents: Facts and Statistics (blockotoole.com)

https://baike.baidu.com/item/%E5%B9%BF%E8%A7%92%E9%95%9C%E5%A4%B4/278835#5