High Dynamic Range Augmented Reality (HDR AR)

Vivek Mogalapalli, Shariq Khalil Ahmed, Sarang Nerkar (Team 568)
Supervisor: Prof. Steve Mann, Administrator: Ross Gillett

The Edward S. Rogers Sr. Department
of Electrical & Computer Engineering
UNIVERSITY OF TORONTO

PROBLEM

- In our world, there are specific scenarios where objects are lit too brightly for the human eye to comfortably see. We are naturally unable to properly view environments with such objects.
- Existing solutions like sunglasses reduce the brightness of these objects but also reduce the brightness of the environment

Figure: Sunlight glare while driving

Figure: Bright light during welding

HIGH DYNAMIC RANGE AND CURRENT LIMITATIONS

- High Dynamic Range **(HDR)** images expose the details of dark and bright regions in a scene simultaneously
- Multiple images of the same scene are captured at different exposures which are combined into a single HDR image
- **Limitation 1:** Manual selection of optimal exposures for a scene
- **Limitation 2:** Not real-time due to slow and complex algorithms
- **Limitation 3:** Not mobile as the algorithms are energy intensive and require powerful processors

Bad Choice of Inputs

Composited HDR Image

Good Choice of Inputs

Composited HDR Image
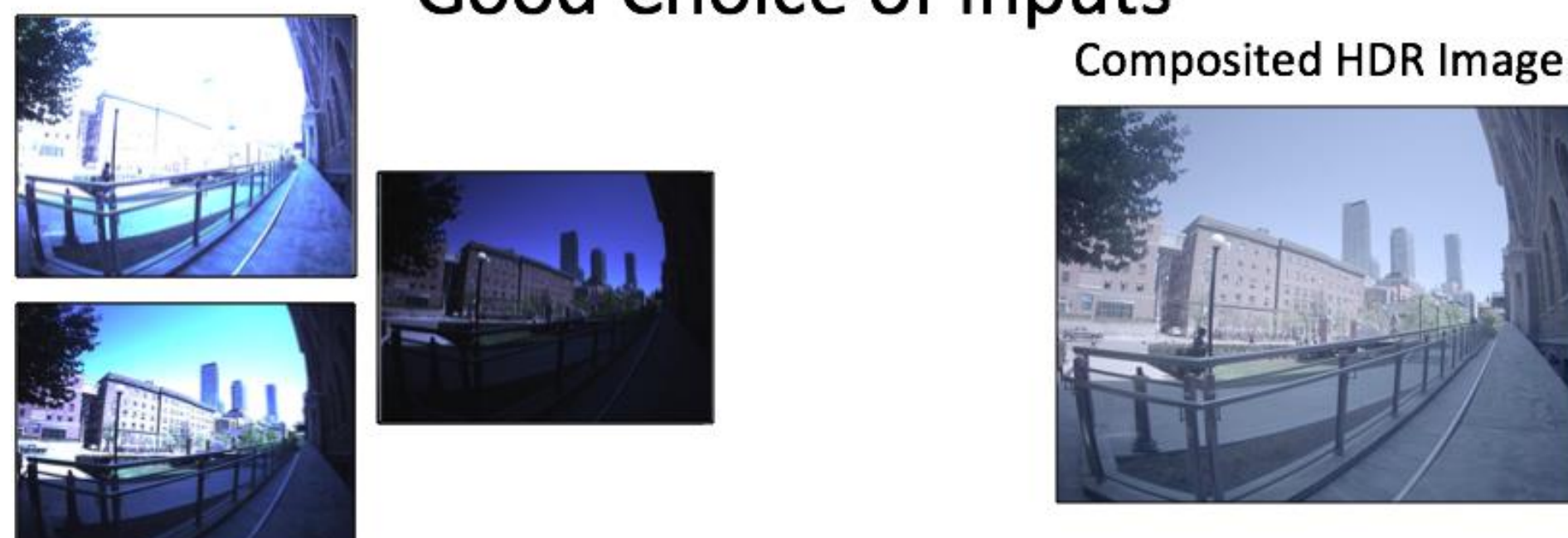
THE HDR REALITY HEADSET

- The headset consists of an Android Phone which runs our HDR Reality application
- The application creates an HDR image that captures all details of the scene by combining pictures taken at 3 different optimal exposures
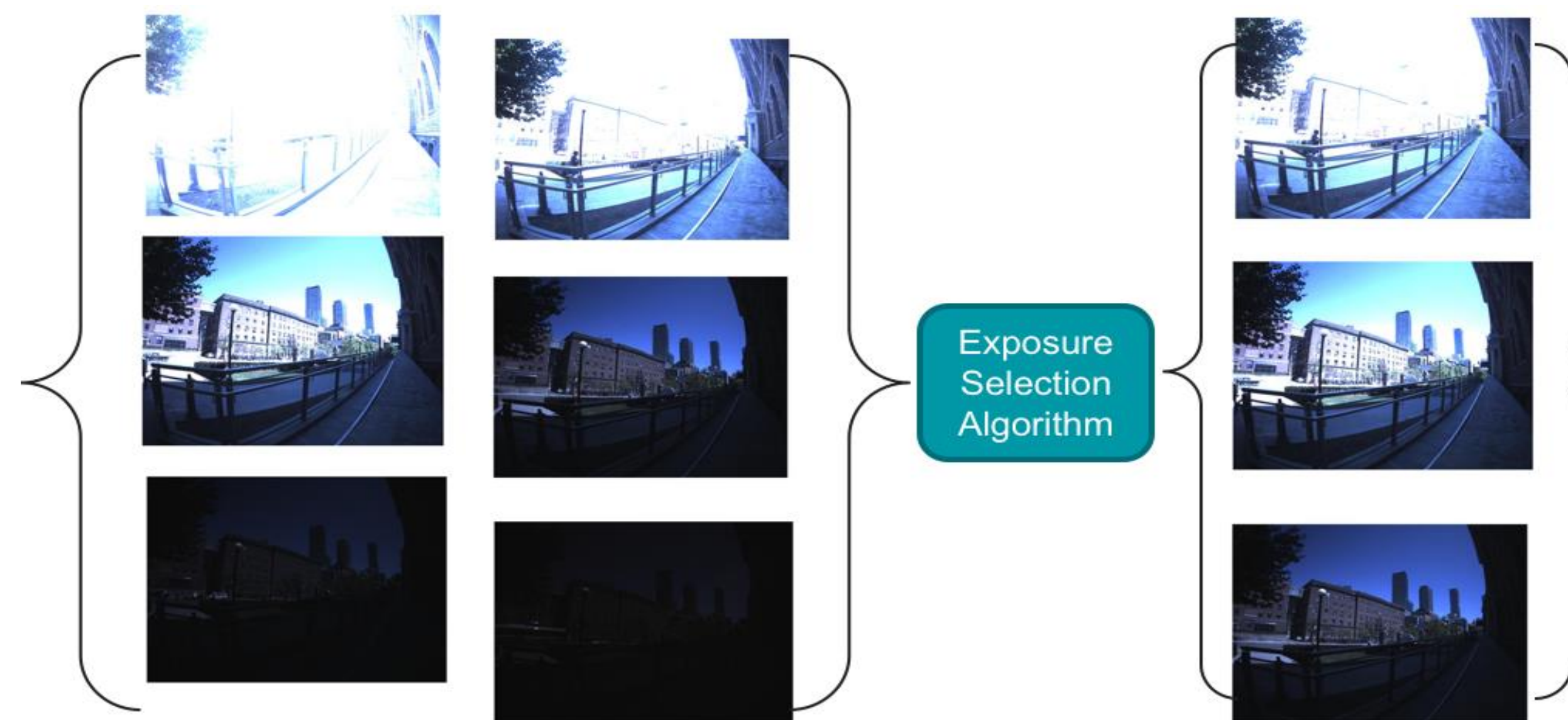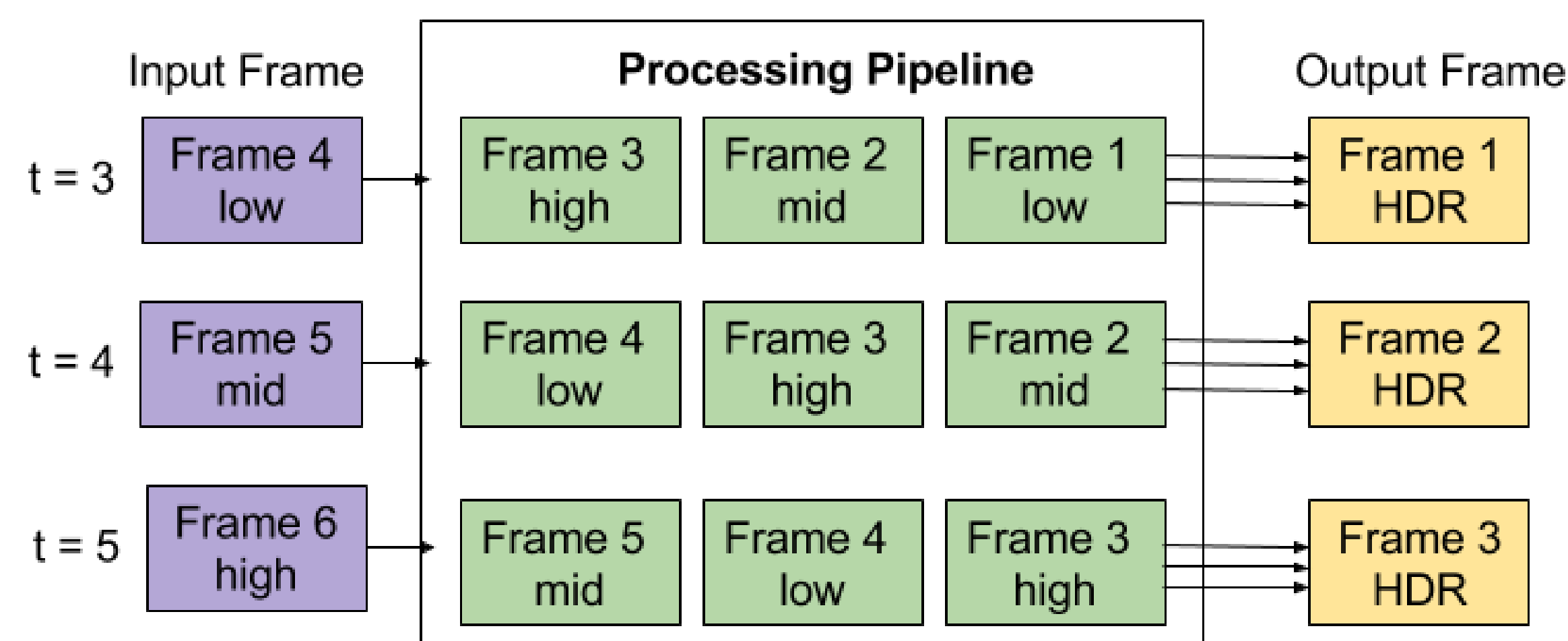
Figure: The headset

Figure: View through the headset

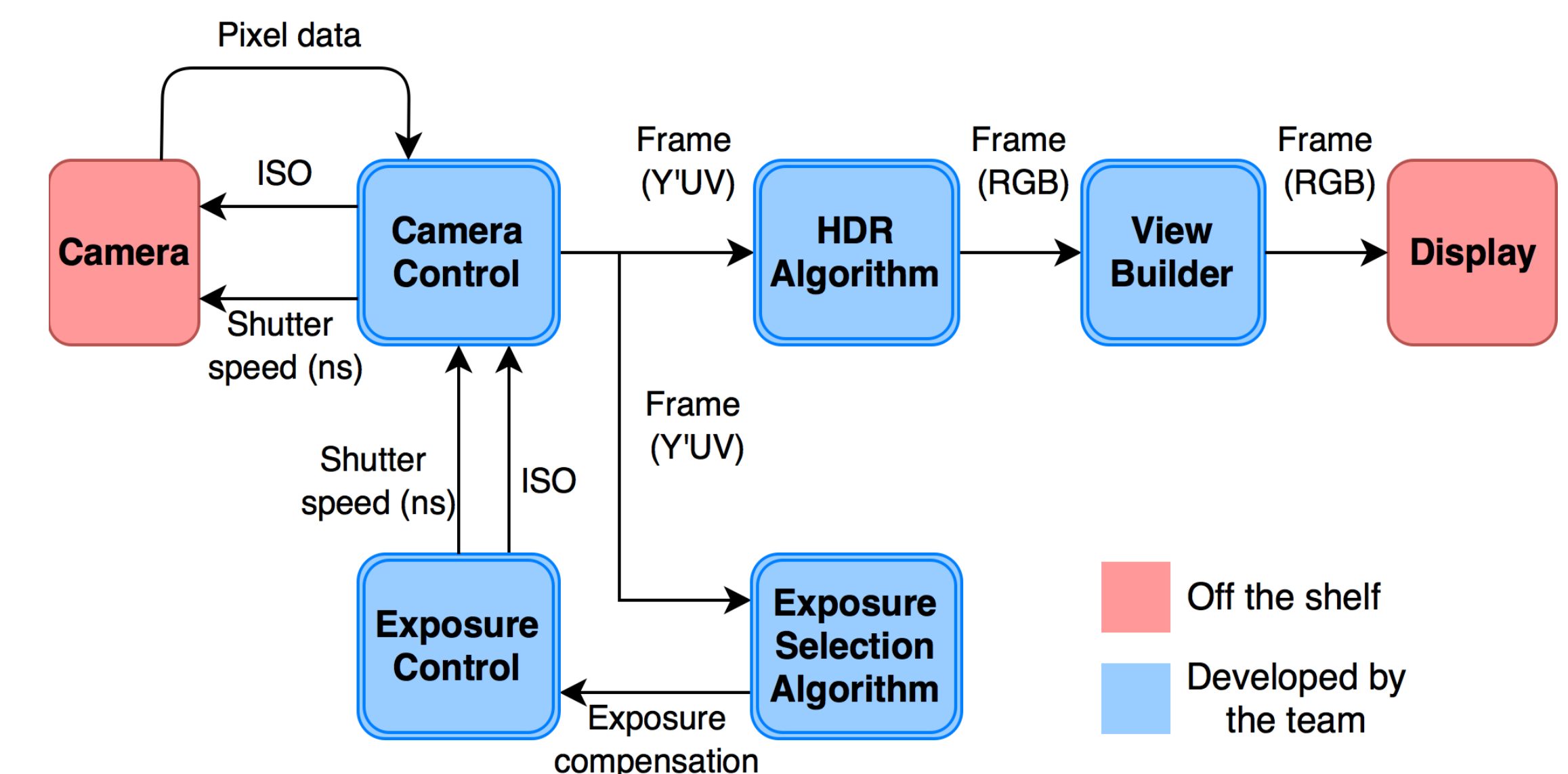- The optimal exposure values for the scene are **automatically** computed

Exposure Selection Algorithm

- The headset functions in **real-time** through parallelization on a GPU and a pipelined design

Processing Pipeline

Input Frame	Processing Pipeline			Output Frame
t = 3	Frame 4 low	Frame 3 high	Frame 2 mid	Frame 1 low	Frame 1 HDR
t = 4	Frame 5 mid	Frame 4 low	Frame 3 high	Frame 2 mid	Frame 2 HDR
t = 5	Frame 6 high	Frame 5 mid	Frame 4 low	Frame 3 high	Frame 3 HDR

- The algorithms are optimized for low powered mobile processors to make the headset untethered and **portable**

SYSTEM OVERVIEW

Pixel data

Camera — ISO / Shutter speed (ns) — Camera Control — Frame (Y'UV) — HDR Algorithm — Frame (RGB) — View Builder — Frame (RGB) — Display

Shutter speed (ns) / ISO — Frame (Y'UV) — Exposure Control — Exposure Selection Algorithm

Exposure compensation

- Off the shelf
- Developed by the team

FEATURES

- High frame rate: **30.37 FPS** (Frames per second)
- Low latency: **74.97 milliseconds**
- Adjusts to optimal exposures for any scene within **2 seconds**
- Operate outdoors without requiring external power for more than **2 hours 15 minutes**

CONCLUSION

- The HDR Reality headset offers a rare perception of the world in a different light
- The simplicity and low cost of our solution will enable HDR augmented reality to be a part of our everyday life
- Our solution is based on Android, which is an open and collaborative platform, enabling the possibilities of further contributions to our project

ACKNOWLEDGMENTS