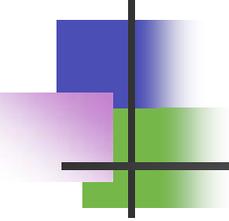# A Two-Input Polygraph

Archana Venkataraman

Christopher Buenrostro

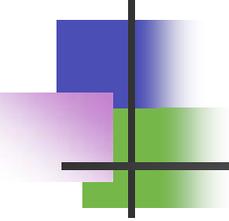*Isaac Rosmarin*

Outline

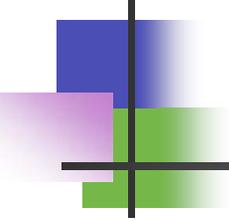- **Introduction**
- **Design Overview**
  - The Physiological Sensors
  - The Digital Decision-Making Unit (DDMU)
  - The Output Display
- **Conclusion**

Introduction

- The polygraph detects stress-related physiological responses commonly linked with deception

- Modern-day polygraphs rely on 4 major variables:

- The Foundation of a lie-detector examination is in its structure
  - Environmental Setting
  - Experience and Conduct of Examinator
  - Questions: Control, Irrelevant, and Relevant

- Decisions are based on the assumption that an innocent subject will react more strongly to the control questions and a guilty subject will react more strongly to the relevant questions
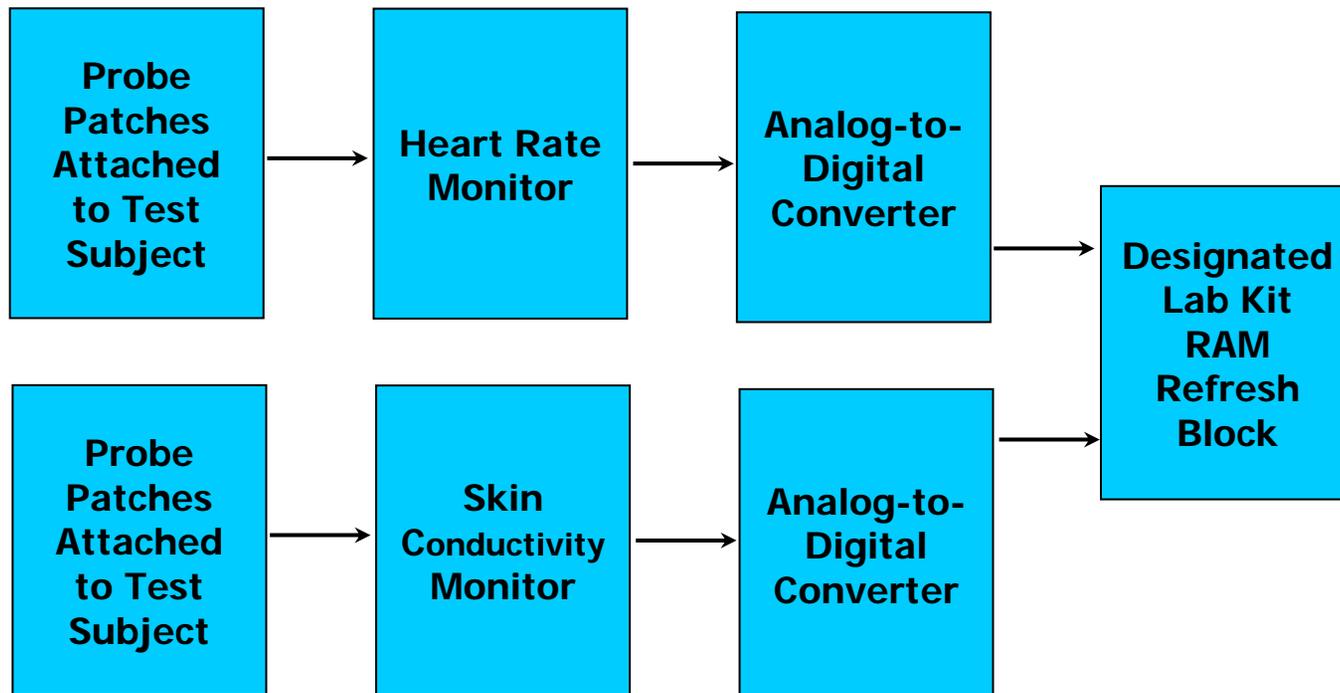
Introduction

- The project uses 2 inputs to make decision– heart rate and skin conductivity
  - Heart speeds up during times of emotional stress
  - Perspire during times of emotional stress – increases conductivity

- Project divided into three sections
  - The Physiological Sensors
  - The Digital Decision-Making Unit
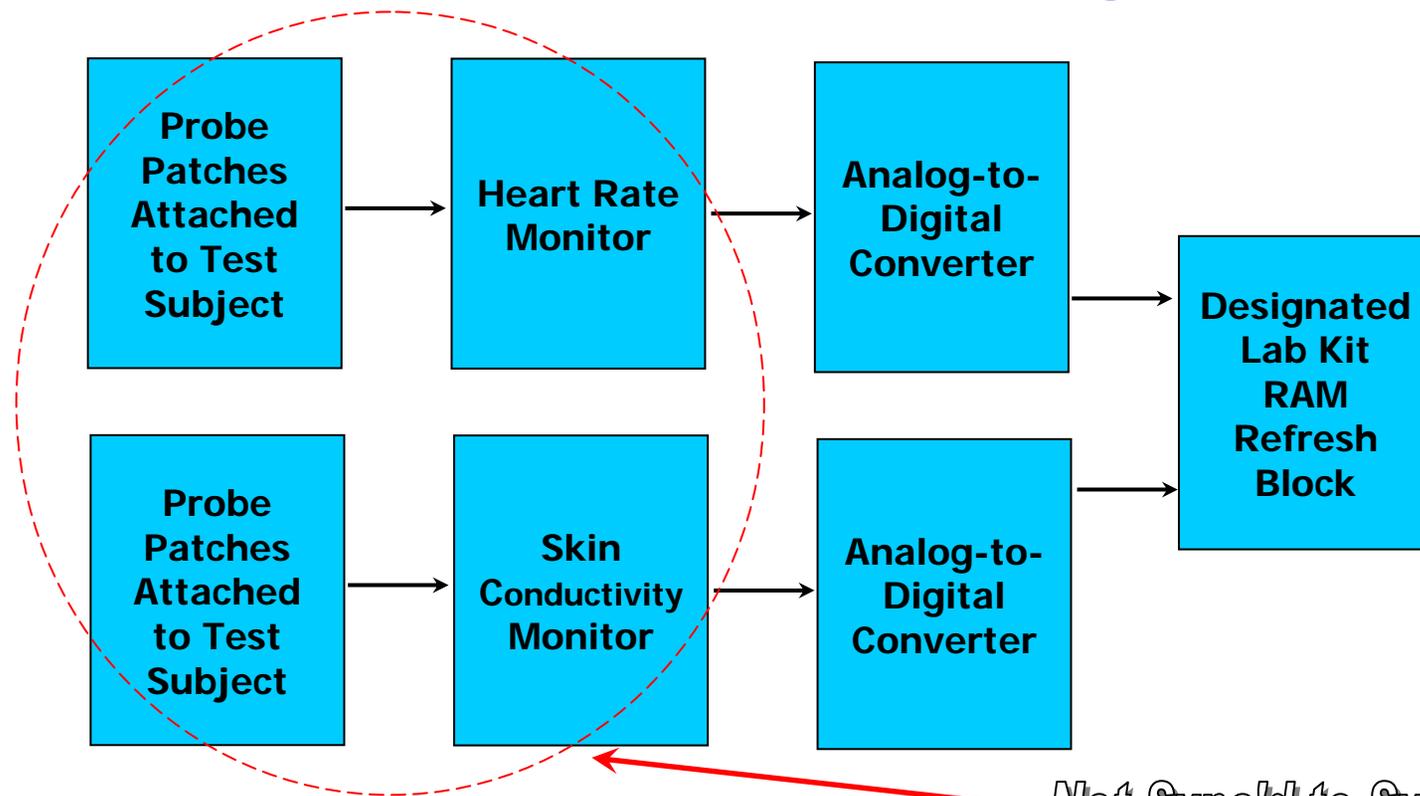 - The Output Display

Input Devices

Data Acquisition Flow Diagram

```
┌─────────────┐      ┌─────────────┐      ┌─────────────┐
│   Probe     │      │             │      │ Analog-to-  │
│   Patches   │ ───► │ Heart Rate  │ ───► │  Digital    │
│  Attached   │      │  Monitor    │      │ Converter   │
│  to Test    │      │             │      │             │
│  Subject    │      │             │      │             │        ┌─────────────┐
└─────────────┘      └─────────────┘      └─────────────┘ ─────► │ Designated  │
                                                                 │  Lab Kit    │
                                                                 │    RAM      │
┌─────────────┐      ┌─────────────┐      ┌─────────────┐        │  Refresh    │
│   Probe     │      │             │      │ Analog-to-  │        │   Block     │
│   Patches   │ ───► │    Skin     │ ───► │  Digital    │ ─────► └─────────────┘
│  Attached   │      │ Conductivity│      │ Converter   │
│  to Test    │      │  Monitor    │      │             │
│  Subject    │      │             │      │             │
└─────────────┘      └─────────────┘      └─────────────┘
```

Input Devices

Data Acquisition Flow Diagram

```
┌──────────────┐      ┌──────────────┐      ┌──────────────┐
│    Probe     │      │              │      │  Analog-to-  │
│   Patches    │ ───► │  Heart Rate  │ ───► │   Digital    │
│  Attached    │      │   Monitor    │      │  Converter   │
│  to Test     │      │              │      │              │
│   Subject    │      │              │      │              │
└──────────────┘      └──────────────┘      └──────────────┘
                                                             ┌──────────────┐
                                                             │  Designated  │
                                                             │   Lab Kit    │
                                                             │     RAM      │
                                                             │   Refresh    │
                                                             │    Block     │
┌──────────────┐      ┌──────────────┐      ┌──────────────┐ └──────────────┘
│    Probe     │      │              │      │  Analog-to-  │
│   Patches    │ ───► │     Skin     │ ───► │   Digital    │
│  Attached    │      │ Conductivity │      │  Converter   │
│  to Test     │      │   Monitor    │      │              │
│   Subject    │      │              │      │              │
└──────────────┘      └──────────────┘      └──────────────┘
```
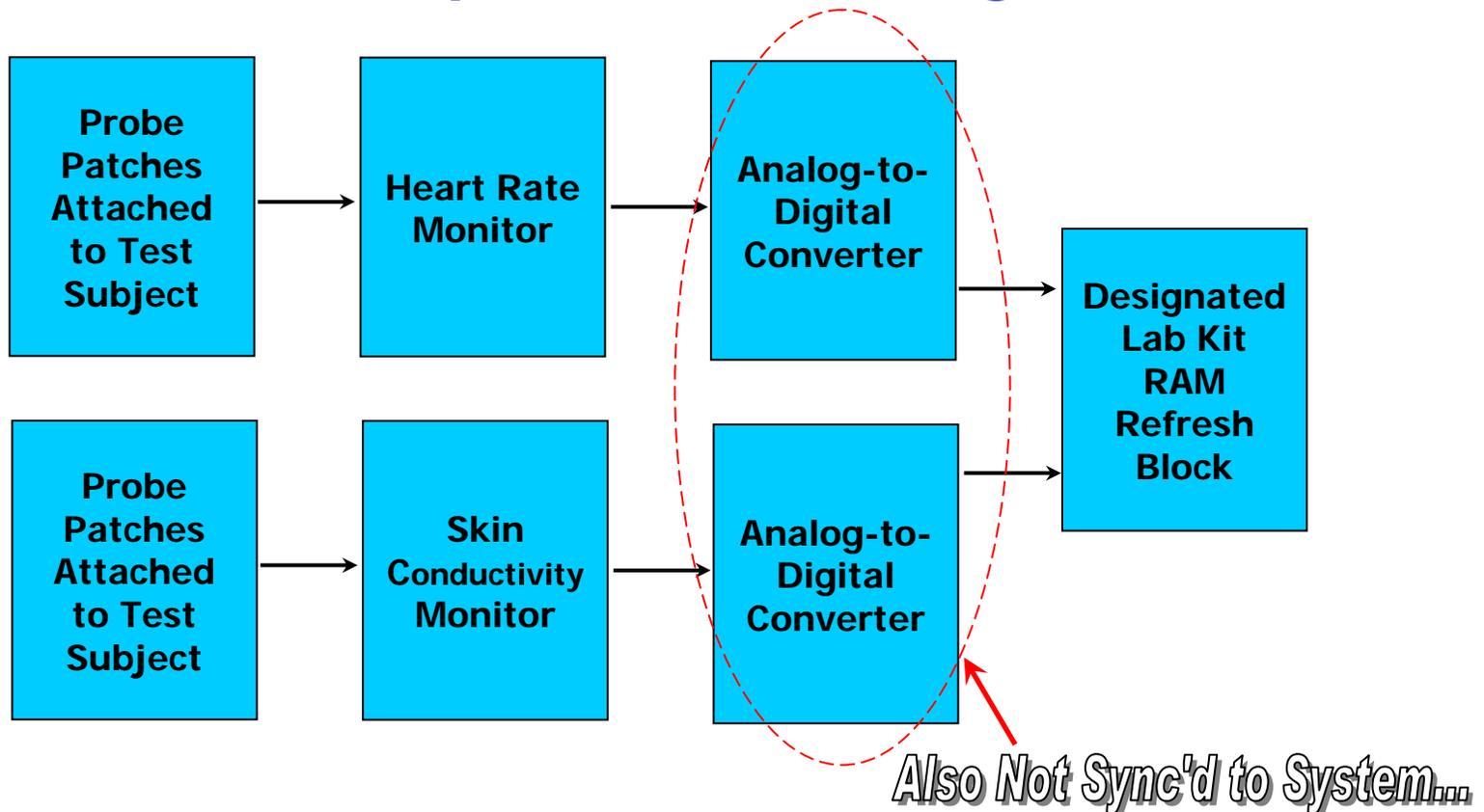
Not Sync'd to System...

Input Devices

Data Acquisition Flow Diagram

Input Devices
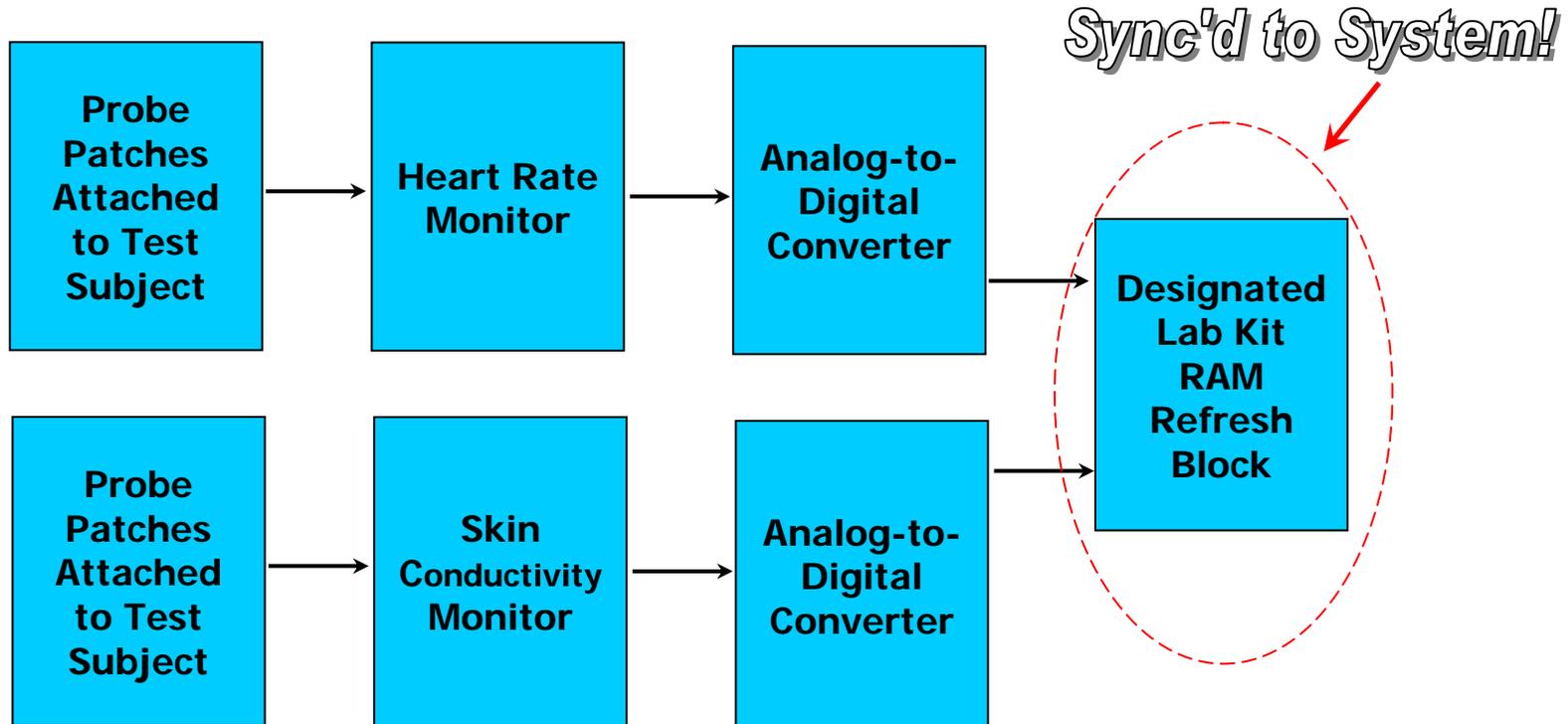
Data Acquisition Flow Diagram

Sync'd to System!

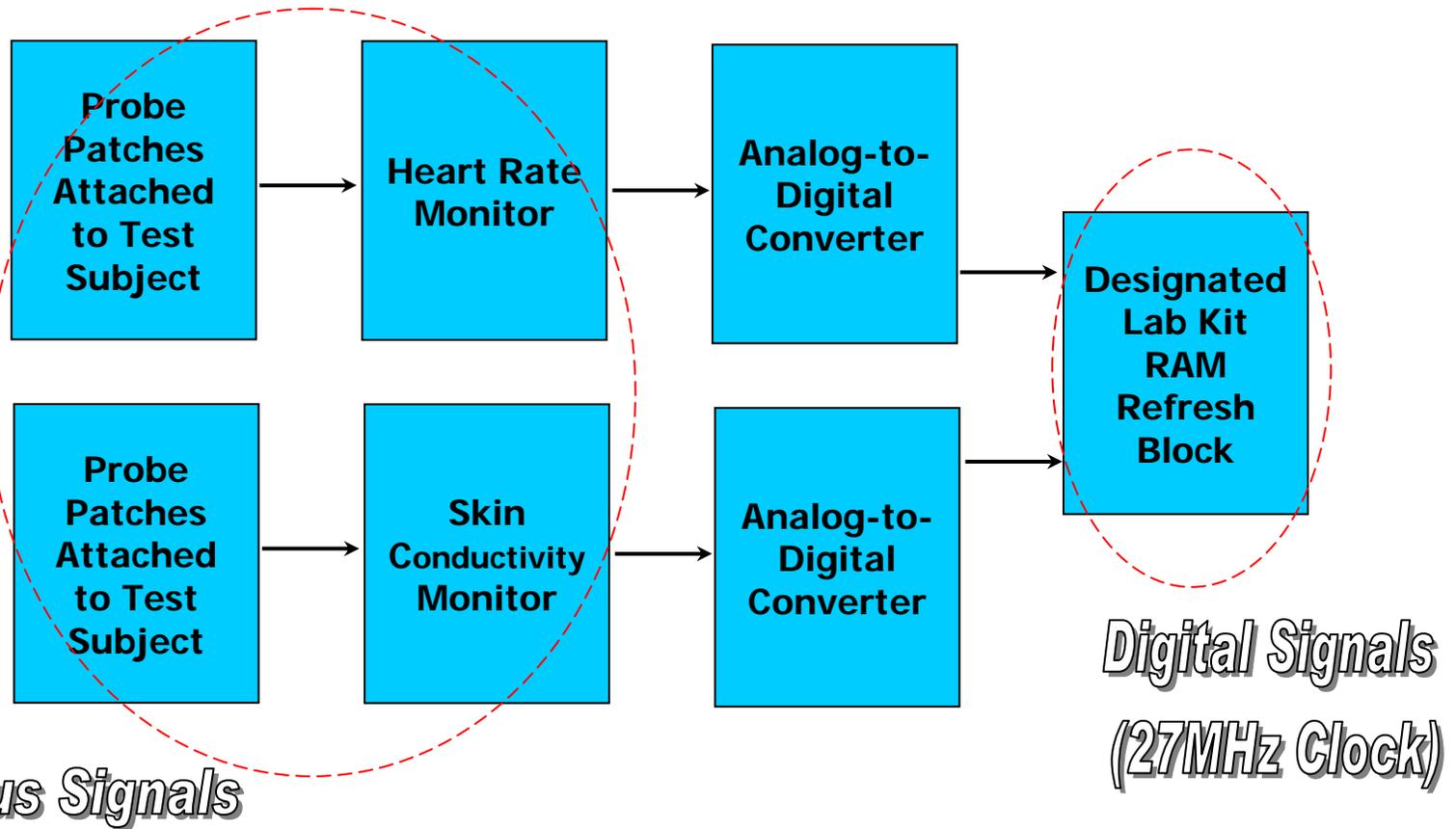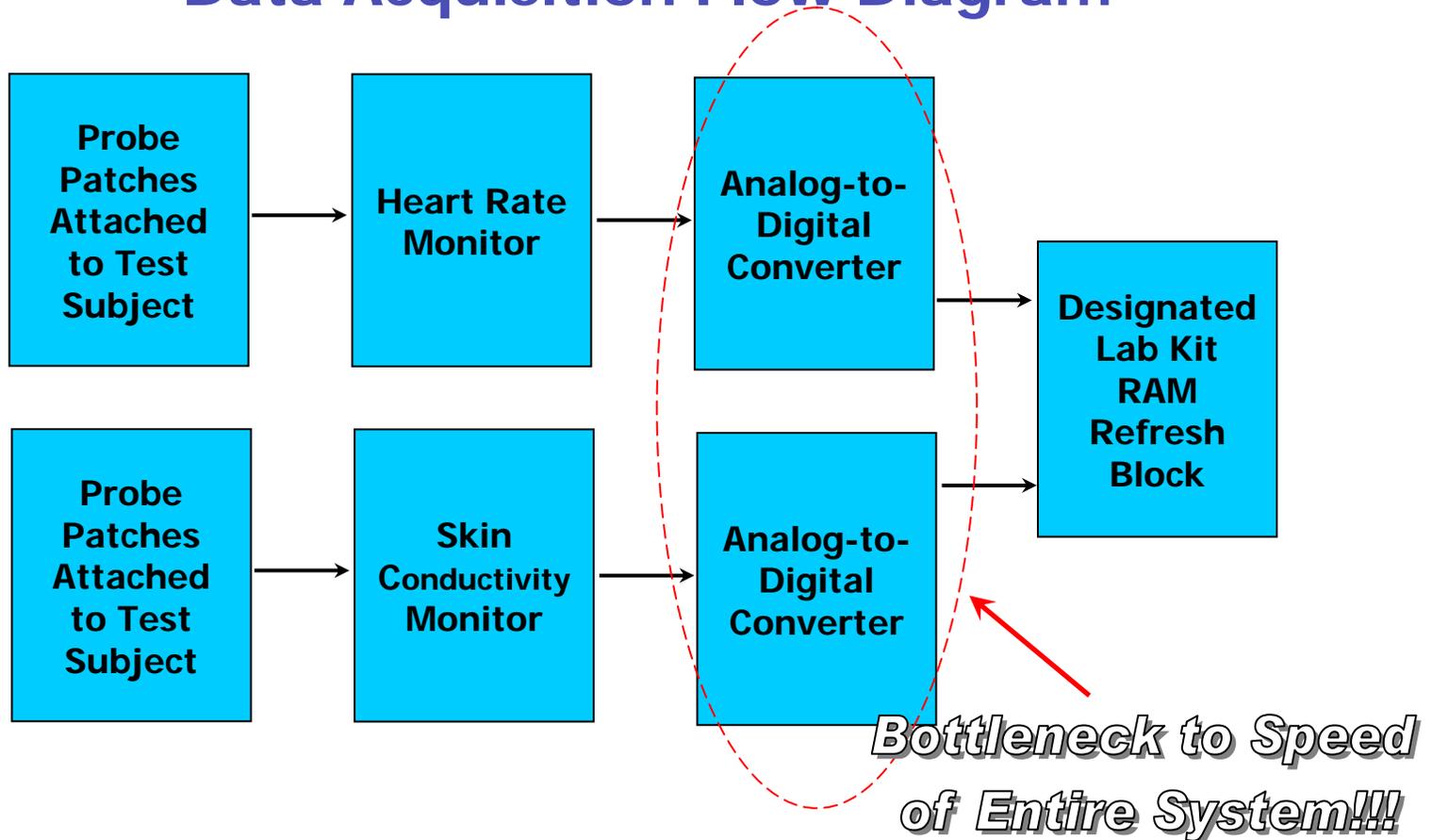|			
Probe Patches Attached to Test Subject	→	**Heart Rate Monitor**	→	**Analog-to-Digital Converter**	→
Probe Patches Attached to Test Subject	→	**Skin Conductivity Monitor**	→	**Analog-to-Digital Converter**	→

Designated Lab Kit RAM Refresh Block

Input Devices

Data Acquisition Flow Diagram

| Probe Patches Attached to Test Subject | → | Heart Rate Monitor | → | Analog-to-Digital Converter | → | |
| Probe Patches Attached to Test Subject | → | Skin Conductivity Monitor | → | Analog-to-Digital Converter | → | Designated Lab Kit RAM Refresh Block |

Continuous Signals

Digital Signals (27MHz Clock)

Input Devices

Data Acquisition Flow Diagram

Bottleneck to Speed of Entire System!!!

Electrocardiogram Heart Monitor

Ramsey Electronics ECG1C

Image removed due to copyright restrictions.
Please see: http://www.ramseyelectronics.com/images/largepics/ECG1C.gif

Skin Conductivity Monitor

The Galvactivator

Courtesy Rosalind Picard and Jocelyn Scheirer. Used with permission.

***Images from http://vismod.media.mit.edu/tech-reports/TR-542.pdf
with credit to Rosalind W. Picard and Jocelyn Scheirer**

The Digital Decision-Making Unit

To Memory
Interface Module

To Memory
Interface Module

User
Inputs

**User
Commands
Capture**

**Decision-
Making
Algorithm**

**Memory
Module**

**Data
Register**

**Display
Driver**

Screen Capture
Commands

Data to Be
Displayed on
Screen
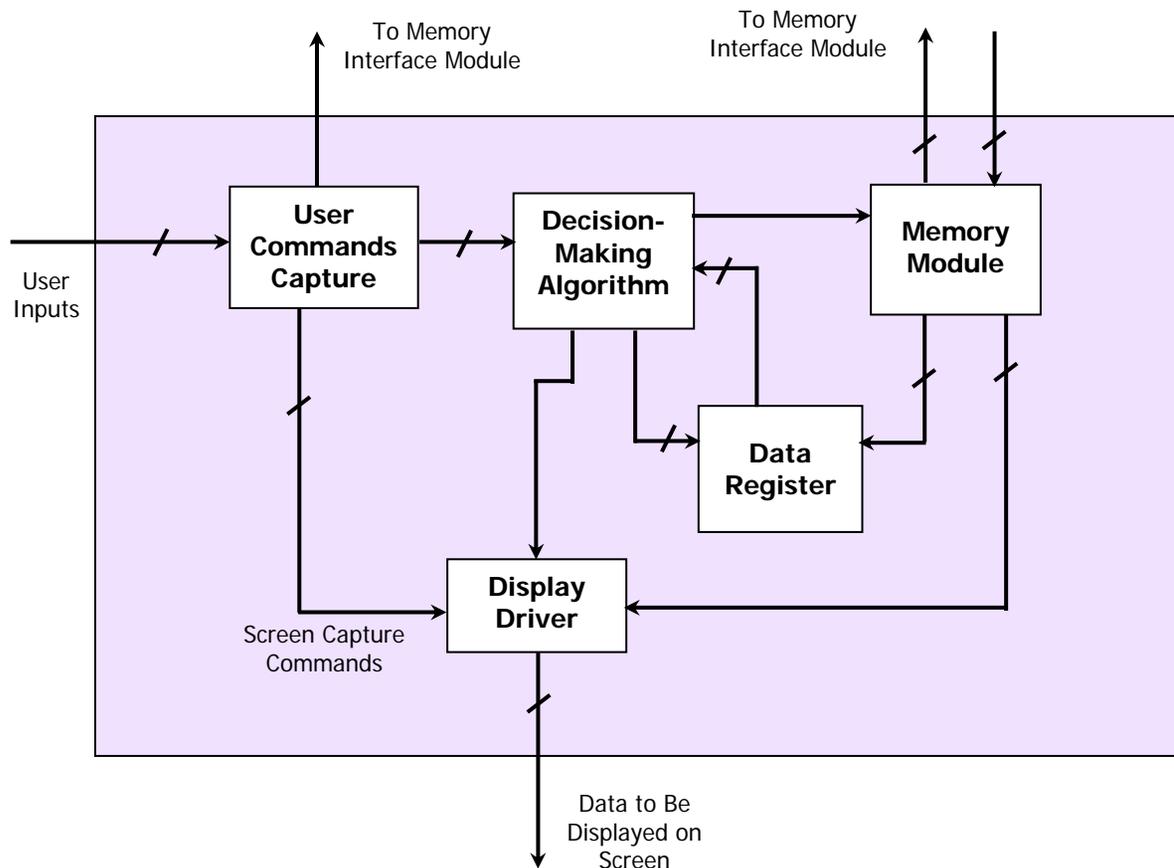
Design Overview

- User Interface
- Decision-Making Portion Based on Polygraph Data
- Additional Functions
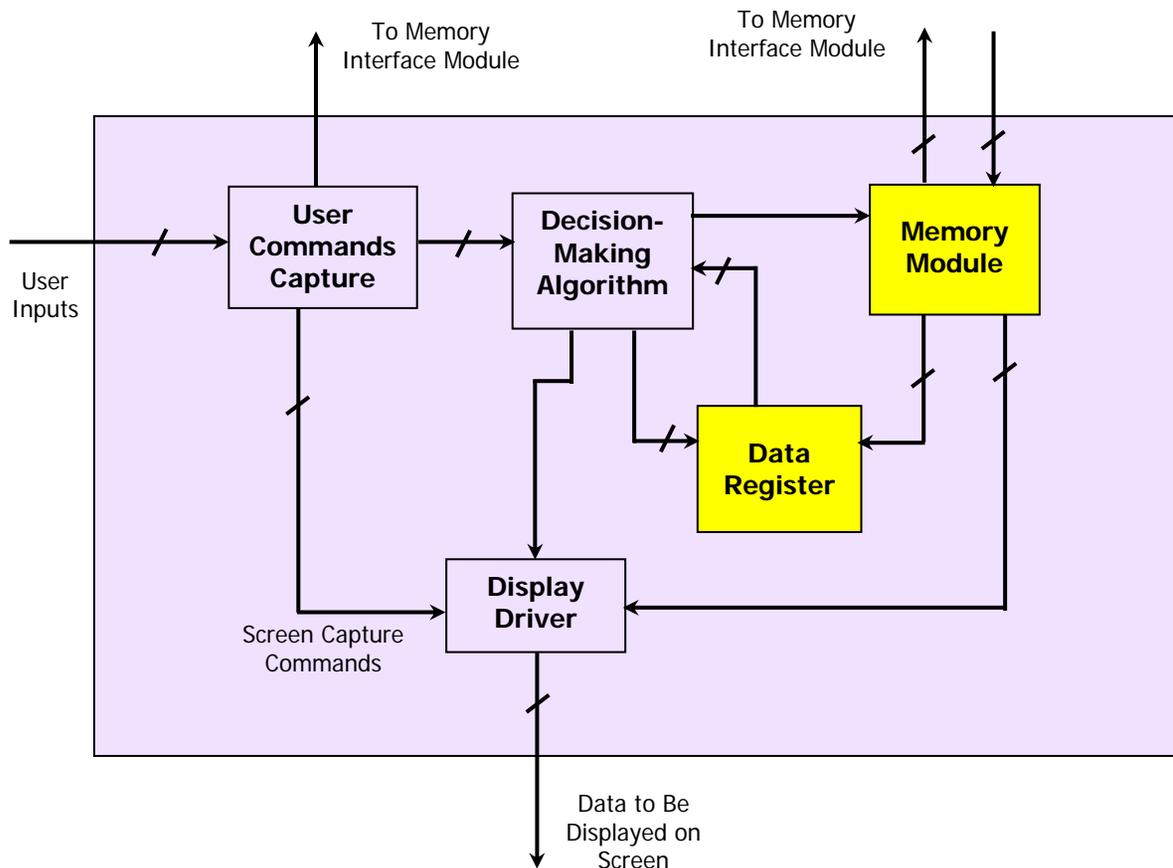 - Obtain Data Stored Externally in RAM
  - Prepare/Send Data to Display Unit

Capturing User Commands

To Memory
Interface Module

To Memory
Interface Module

User
Inputs

**User
Commands
Capture**

**Decision-
Making
Algorithm**

**Memory
Module**

**Data
Register**

Screen Capture
Commands

**Display
Driver**

Data to Be
Displayed on
Screen
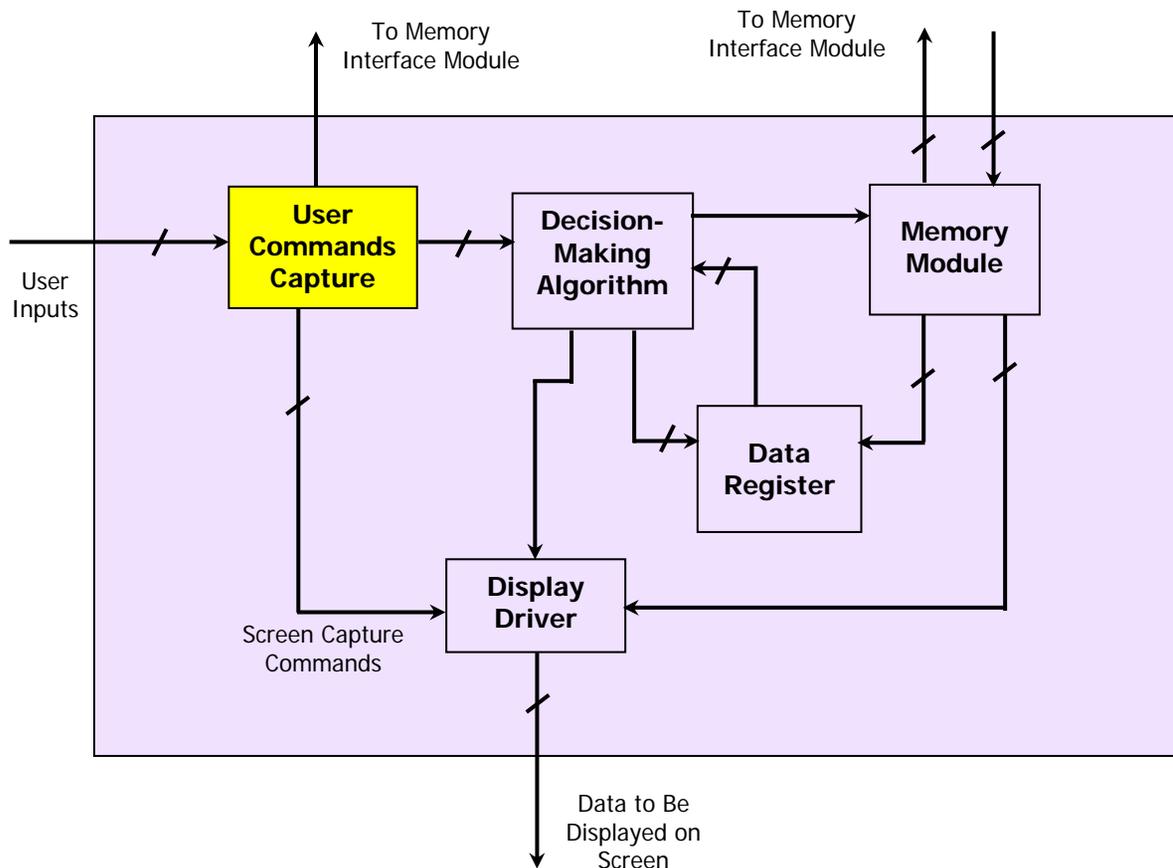
- Module registers all user inputs and passes them to appropriate module
- User Commands:
  - Type of Question
  - Analyze Results
  - Display Data
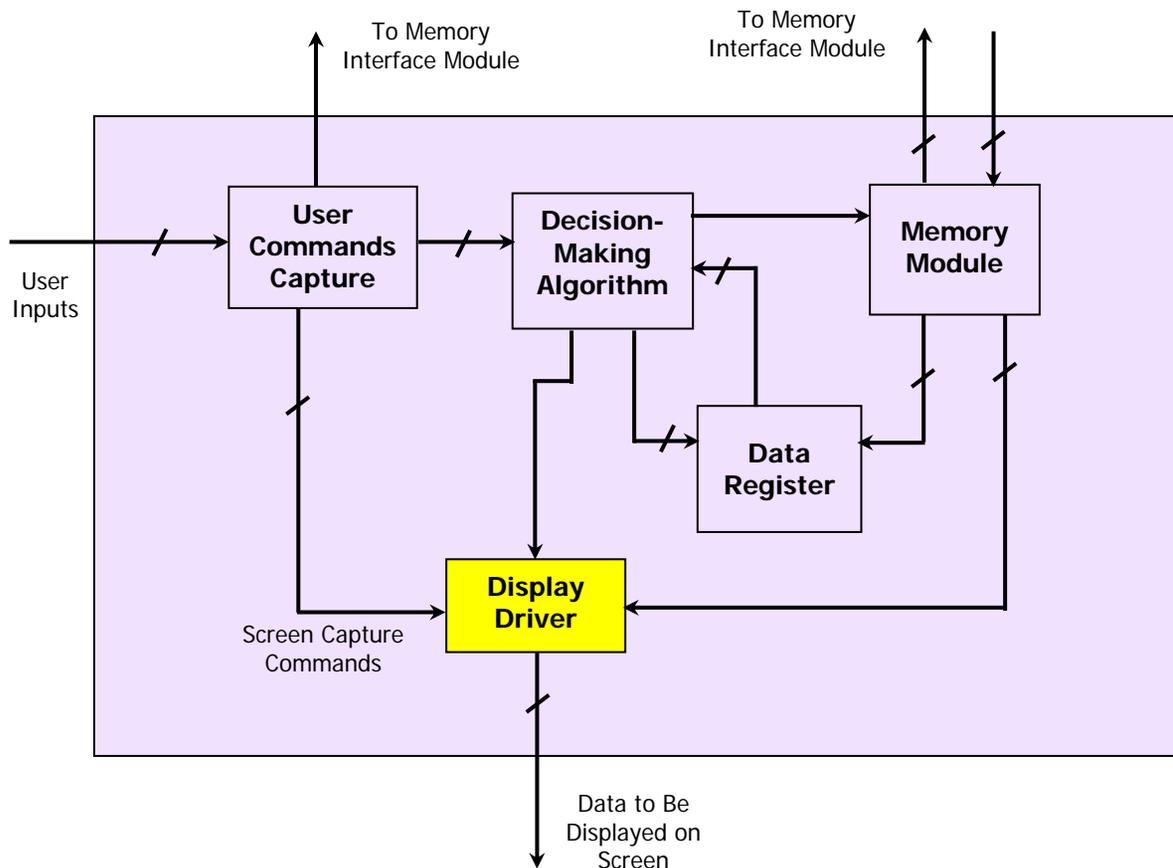 - Store Data
  - Screen Capture

Decision-Making Algorithms

To Memory Interface Module

To Memory Interface Module

User Commands Capture

Decision-Making Algorithm

Memory Module

Data Register

Display Driver

User Inputs

Screen Capture Commands

Data to Be Displayed on Screen
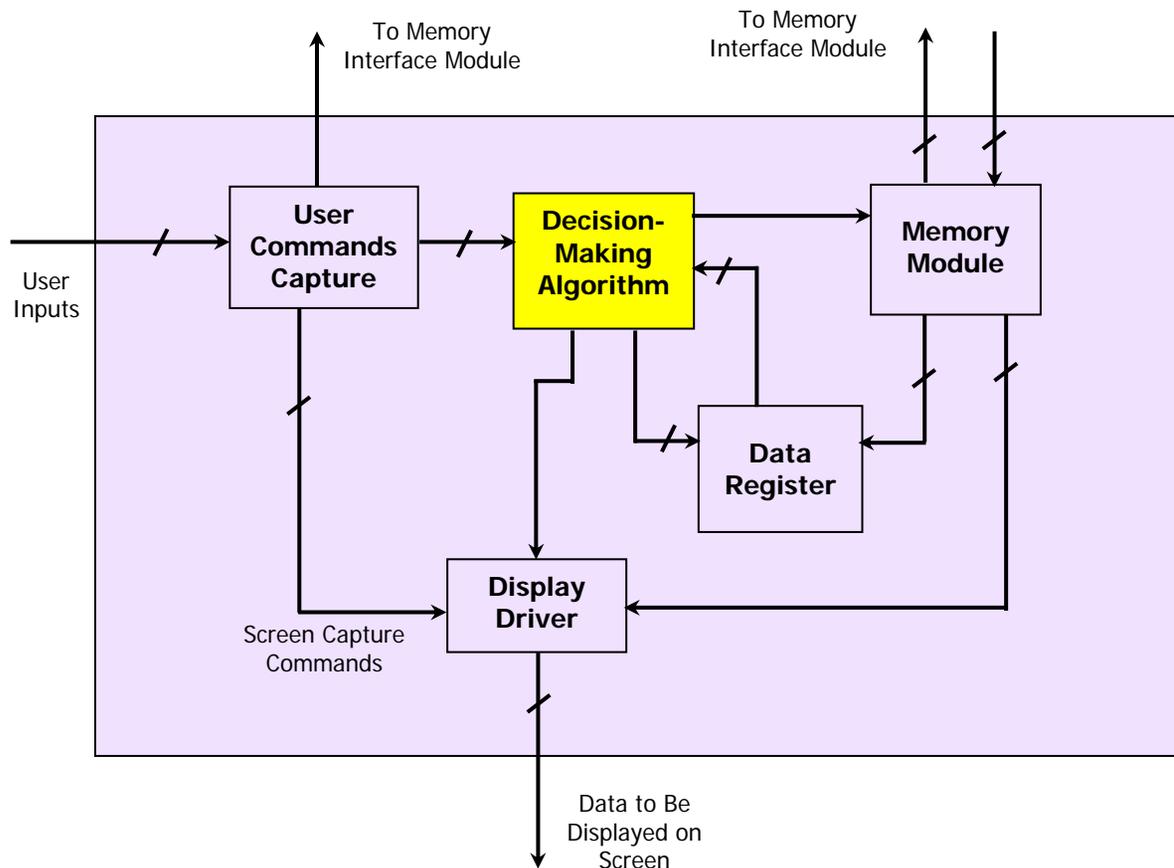
- Main Module of the DDMU – Analyzes sensor data and outputs binary "TRUTH/LIE" decision
- Digital Pre-Processing on data to remove extraneous, environmental factors
  - Average incoming data
  - Highpass Filter
- Implement one or more of following algorithms:
  - Compare statistics of time signal
  - Convert to frequency domain and compare
  - Hypothesis Testing

The Memory Module and Data Register

To Memory Interface Module

To Memory Interface Module

User Commands Capture

Decision-Making Algorithm

Memory Module

Data Register

Display Driver

User Inputs

Screen Capture Commands

Data to Be Displayed on Screen

- The Memory Module signals Memory Interface to Read from and Write to RAM by asserting a "request" signal
- Data Register holds critical values for the Decision-Making Algorithm:
  - Time sequences to be compared
  - Computed Statistics

Display Driver

To Memory
Interface Module

To Memory
Interface Module

User
Commands
Capture

Decision-
Making
Algorithm

Memory
Module

Data
Register

User
Inputs

Screen Capture
Commands

Display
Driver

Data to Be
Displayed on
Screen

- Gathers data to be
  sent to Display Unit
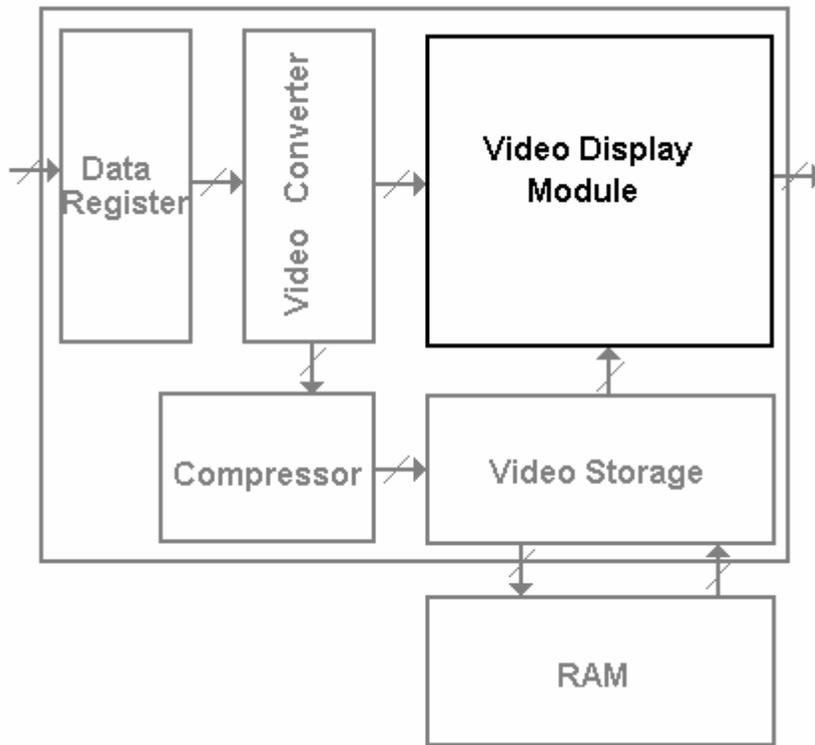 - Sensor Data
  - Decision (T/F)
  - Screen Capture
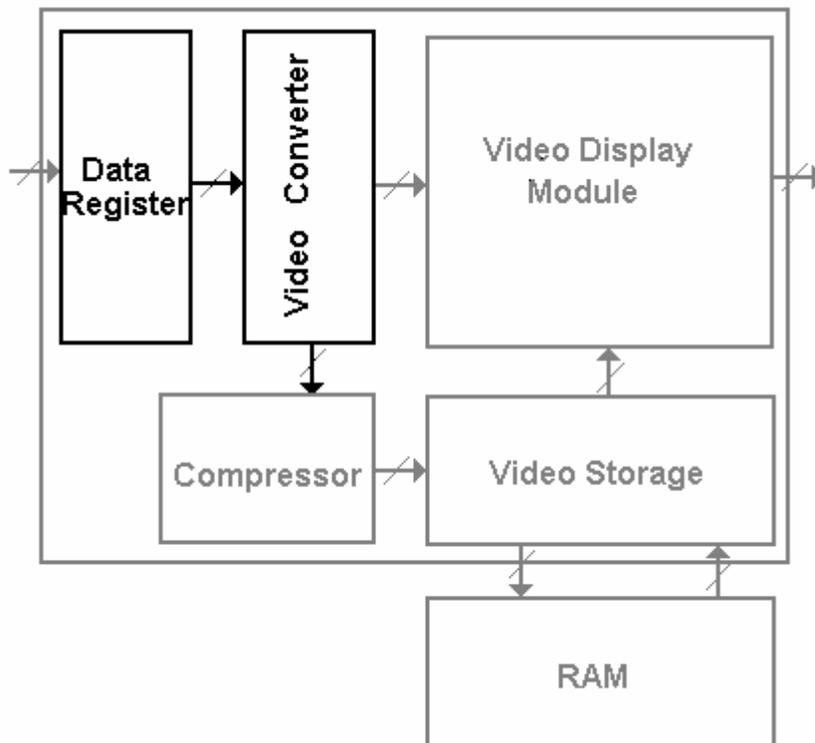   Command

Video Display
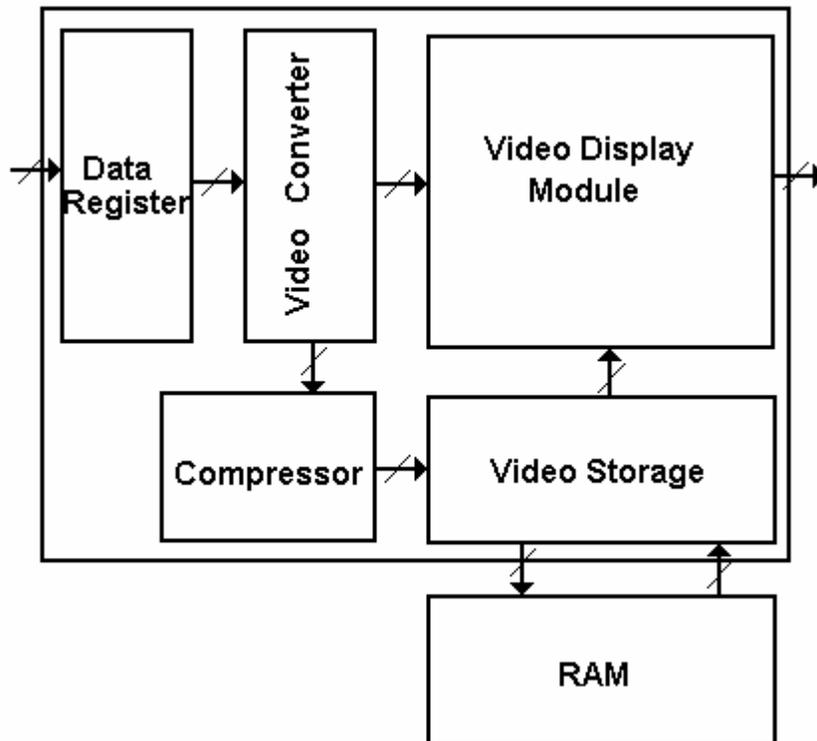
Job of the Video Display

- Take in data and convert to a visually appealing format
- Display data
- Save previous data for reference
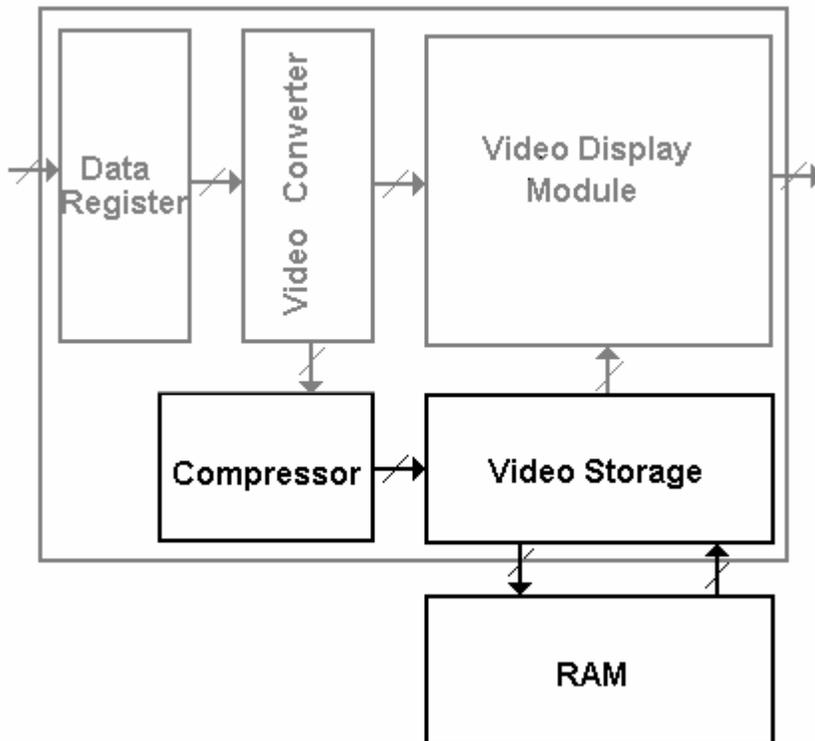
Video Output

- On computer monitor
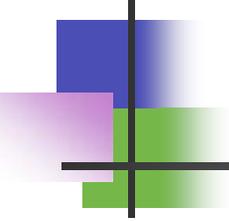- Like PS3/Lab 4
- Higher Resolution

Data Inputs

- Register data on vsync refresh
- Convert data into an eye-pleasing format

Video Storage

- Compresses data to save
- Displays previous data
- Interacts with onboard RAM
- Changes based on user input

Conclusion

- Design is modular
- Project is good extension to material presented in class
- Polygraph is an interesting real-world application