Display for Crew Station of Next Generation Main Battle Tank

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Abstract - *Battlefield surveillance is one of the most important force multipliers which are essential for winning the future battles and also for saving lives of army personnel. Systematic observation of the battle area for the purpose of providing timely information and combat intelligence to the crew is an absolute necessity as it is not only their duty to protect us, even its our highest duty to protect them. So in order to exercise it we have developed this display interface using Smart Display Unit for battlefield surveillance. This project is developed with Raspberry PI using Python as its development platform. The idea of unmanned turret in the combat vehicles is implemented by installing multiple digital camera on the turret for video acquisition and it is relayed to the Raspberry PI which acts as a client. This data is relayed to the Smart Display Unit(server) via Ethernet using the Gigabit Ethernet feature of the Raspberry PI. The crux of using the Ethernet cable is not only to provide high degree of network security and high speed transmission by neglecting the external interference to the maximum but also to eliminate multiple display devices and replace them with SDU(SD8010) to reduce the space constraint. The video signal is captured and partitioned into frames on the client side and it is transmitted to the server by applying the Transmission Control Protocol and socket programming in python. The server then eventually reconstructs the frames as video and displays it to the end user in the hull. In addition to this the Smart Display Unit acts as a display device to multiple controllers that communicates the data using I2C and CAN bus of SDU providing a better solution to space constrain in tanker.*

1. INTRODUCTION

As several areas/zones have become vulnerable to aerial attacks, it has become a necessity for the concealment of turret portion of the combat vehicle. In order that the tanker has to be concealed this proposed system replaces the crew members in the turret region with surveillance camera to monitor the battlefield. The implementation of this project to resolve the problem of replacing humans, because of this we reduce harm of human resource. The SDU 8010 is the armed vehicle's display unit to view the clarified and unclarified information on a single display instantaneously and eliminating the need for separate processor units and improving overall access to information when and where its needed. The idea of unmanned turret is achieved by installing multiple camera and all the video information captured by a camera is decoded by raspberry pi and it is sent through a gigabit Ethernet.

2. EXISTING SYSTEM

The existing system consists of four army personnel in the tank, of them two are assigned for controlling the hull (the lower portion of the tank) and the other two for turret (the upper portion of the tank). Among the two army personnel in the turret one of the army personnel is for surveilling the battlefield (Commander) and the other army personnel is for firing the target on the command of the commander. The commander surveills the battlefield using a high-resolutional telescopic device through which even long range could be surveilled easily the gunner also has a similar setup to fire upon the targets accurately. During intense combat situations these two person are highly prone even to rifle attacks by the enemies very easily which would ultimately result in the loss of control of the tank.

3. PROPOSED SYSTEM

In order to overcome the drawback of the existing system we have planned to install high profile cameras at various directions on the turret that would ultimately help in surveilling the battleground. The output of the multiple cameras are streamed to the Smart Display Unit positioned in the hull through gigabit Ethernet cable, using the same information the gunner can aim at the target and fire. This method ultimately eliminates the need of army personnel at the turret, which could be regarded as a preliminary step to an unmanned ammunition vehicle. In addition to it this Smart Display Unit has a special feature of integrating various controllers intended for specific functionality under one roof using Smart Display Unit. The main objective of "Display for crew station of NGMBT" is to reduce the space constraint by replacing multiple display devices which are connected to various controllers with a single display unit SDU8010.This is accomplished by interfacing raspberry Pi to the SDU by means of gigabit ethernet. Ethernet is the well established standard for military and other rugged application due to proven interoperability, security, reliability and speed. In order to save lives of military personnel, during aerial attacks, this project proposes the idea of unmanned turret in the armed vehicles.

Fig 1. EXISTING SYSTEM

Fig 2. PROPOSED SYSTEM

4. COMPONENT DETAILS

4.1 SMART DISPLAY UNIT

The SDU20-5 Smart Display Unit is a rugged display and computing system developed specifically for Combat Vehicle platforms. It consists of an Intel Core i7™ Applications Processor (AP) integrated with a high performance 10.4" Liquid Crystal Display (LCD) and video processing subsystemThe Core i7 application processor subsystem provides open-standard interfaces for Ethernet, Universal Serial Bus (USB), Controller Area Network (CAN) Bus, RSxxx serial, and analog audio enabling the SDU to host a diverse suite of Command, Control, Communications and Computing (C4) software applications for Situation Awareness (SA), Battle Management (BMA) and Intelligence-Surveillance-Reconnaissance (ISR) as required on a typical modern combat vehicle platform. Video-over-Ethernet Encoder/Decoder (VoE CODEC) Supports simultaneous encode of the four (4) SD and one (1) XGA inputs and decode and display of up to 4 SD independently of the Core i7 Central Processor Unit (CPU). System controller controls and status of embedded hardware functions are controlled via firmware running on a dedicated System Controller (SC).

4.2 RASPBERRY PI

Raspberry Pi 4 Model B is the latest product in the popular Raspberry Pi range of computers. It offers ground-breaking increases in processor speed, multimedia performance, memory, and connectivity compared to the prior-generation Raspberry Pi 3 Model B+, while retaining backwards compatibility and similar power consumption. For the end user, Raspberry Pi 4 Model B provides desktop performance comparable to entry-level x86 PC systems. This product's key features include a high-performance 64-bit quad-core processor, dual-display support at resolutions up to 4K via a pair of micro-HDMI ports, hardware video decode at up to 4Kp60, up to 4GB of RAM, dual-band 2.4/5.0 GHz wireless LAN, Bluetooth 5.0, Gigabit Ethernet, USB 3.0, and PoE capability (via a separate PoE HAT add-on). It uses **arm cortex a72** processor which makes it to work lightning fast. It can act as media centers, file servers, routers, and network-level ad-blockers. With the Pi 4 being faster able to decode 4K video benefiting from faster storage via USB 3.0 faster network connections via true Gigabit Ethernet. It's also the first Pi that supports two screens at one up to dual 4K at 30 frames per second.

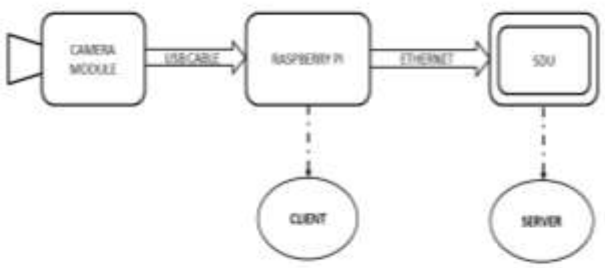
4.3 ETHERNET

Ethernet is the most widely installed local area network (LAN) technology. Ethernet is a link layer protocol in the TCP/IP stack, describing how networked devices can format data for transmission to other network devices on the same network segment, and how to put that data out on the network connection. Gigabit Ethernet, a transmission technology based on the Ethernet frame format and protocol used in local area networks (LANs), provides a data rate of 1 billion bits per second (one gigabit). Gigabit Ethernet is defined in the IEEE 802.3 standard and is currently being used as the backbone in many enterprise networks. Gigabit Ethernet is carried primarily on optical fiber (with very short distances possible on copper media). Existing Ethernet LANs with 10 and 100 Mbps cards can feed into a Gigabit Ethernet backbone. An alternative technology that competes with Gigabit Ethernet is ATM. A newer standard, 10-Gigabit Ethernet, is also becoming available.In computer networking, an Ethernet frame is a data link layer protocol data unit and uses the underlying Ethernet physical layer transport mechanisms. In other words, a data unit on an Ethernet link transports an Ethernet frame as its payload.

5. EXPERIMENTALSETUP

The proposed system has a Raspberry Pi, that basically functions as router that routes the data (video signal) from the client (raspberry pi) to the server (Smart Display Unit). This process is initiated and executed on a python platform by using certain additional modules that are intended for specific function like cv2(opencv2) for image processing, but here it is used for capturing the video from cameras connected to the raspberry pi. The videos that are captured by the cameras are transmitted to the raspberry pi it is stored under the variable 'cap' as an object of cv2. The socket connection is established by the socket library function defines the version of Internet Protocol applied (i.e) IPv4 and it also defines the type of transmission of data (i.e) serial transmission, to be precise it serialises and streams the data to the server. The IP address of the server necessary for establishing a connection along with its port number is mentioned in the client socket program that is executed by the Raspberry Pi. Similarly the IP address of the client and its port number is mentioned in the server program. The server socket program on the Smart Display Unit is initialised at first , the Socket connection is established using the bind and listen function when the mentioned IP address and the port address matches with the client's IP address and the port number the socket connection is accepted. Once all the above conditions are validated, (i.e) conditions are tested to be true the payload size of the data is verified with the value of the length of the data 'L' sent by the client, if it passes to be true the connection receives the data sent by the client. This process is carried until the payload size matches with the message size of the data on the client side, once it reaches the particular threshold value data packet gets terminated and the next data packet starts to stream from the client through the Ethernet to the server. The pickle function which is imported as a library function control and maintains the serializing of the data into a character stream on client side and equivalently on the server it de-serializes on the server side as this character stream contains all the information necessary to reconstruct the object on the server. The 'imshow' function reconstructs the frames and displays the video on the Smart Display Unit. The reception of the video is stopped once the wait-key is pressed. The client program that is run on the Raspberry Pi reads the data from the camera into the variable 'frame' and it is serialized, using pickle function. This serial data is constructed into a pack using the 'struct' function and the length of data is also eventually calculated and it is stored in the variable 'L', this value along with the data is sent transmitted to the server through the Ethernet cable. In the above process we use a CAT 6 Ethernet cable that has a bandwidth capacity of 250 MHz and it offers a speed up to 10 Gbps (i.e) 10 x10^9 bytes of information could be transmitted. So far this bitrate is considered to be the highest and our Smart Display Unit pertaining Ethernet cable with such capability makes it remarkable and at the same time makes this process feasible.

BLOCK DIAGRAM



6. CONCLUSIONS

From the proposed system we could make surveillance unmanned by integrating Raspberry Pi and Smart Display Unit and by establishing a secured connection we can transmit the video signal seamlessly to the end user in the hull. In addition to this we could synchronize various controllers intended for specific function like inertial navigation unit and GPS module and replace multiple display unit for various controllers with SD8010 thereby providing a better solution to the space constraint in the army tankers. For this special issue, our aim is to bring together researchers designing or developing advanced image processing techniques/systems, with a particular emphasis on defence and security applications. In near future this approach of battlefield surveillance can be implemented in Unmanned Ground Vehicles (UGV). These UGVs would be used for weapon platforms, logistic carriers and reconnaissance, surveillance and target acquisitions.

ACKNOWLEDGEMENT

We strongly record our deep sense of gratitude and thankfulness with utmost respect to our project guide **Mrs.V.Jayasri Scientist-F (FCS)** of CVRDE, for giving us this wonderful opportunity to work on the project **"Display for Crew Station of NGMBT"**.

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