SAVE-U

SENSORS AND SYSTEM ARCHITECTURE FOR VULNERABLE ROAD USERS PROTECTION

Information Society Technologies: Systems and Services for the Citizen

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Deliverable 23: Report on Rig Design

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Revision chart and history log

Version	Date	Reason
1.0	**23/06/2004**	First complete version to SAVE-U partners for review.
2.0	**27/10/04**	Updated to include comments from P Marchal
2.1	**15/11/04**	Amendments from partner feedback

Contents

1. EXECUTIVE SUMMARY

The work of MIRA Limited, described within this report, forms part of the evaluation of the sensor systems within the Sensors and system Architecture for VulnerablE road Users protection (acronym SAVE-U) European Community project.

The purpose of this document is to present an overview of the short range Test Rig Design for the SAVE-U project.

Work package 11 requires the development of a test rig to provide development data and to evaluate the sensor performance dynamically using real Vulnerable Road Users (VRU's) for true, combined correct characteristics using a dedicated test site. The test rig carries the SAVE-U sensor systems that are in operation as the test rig approaches the VRU at a speed of 40km/hr. The test rig is then brought to rest extremely rapidly in close proximity to the VRU.

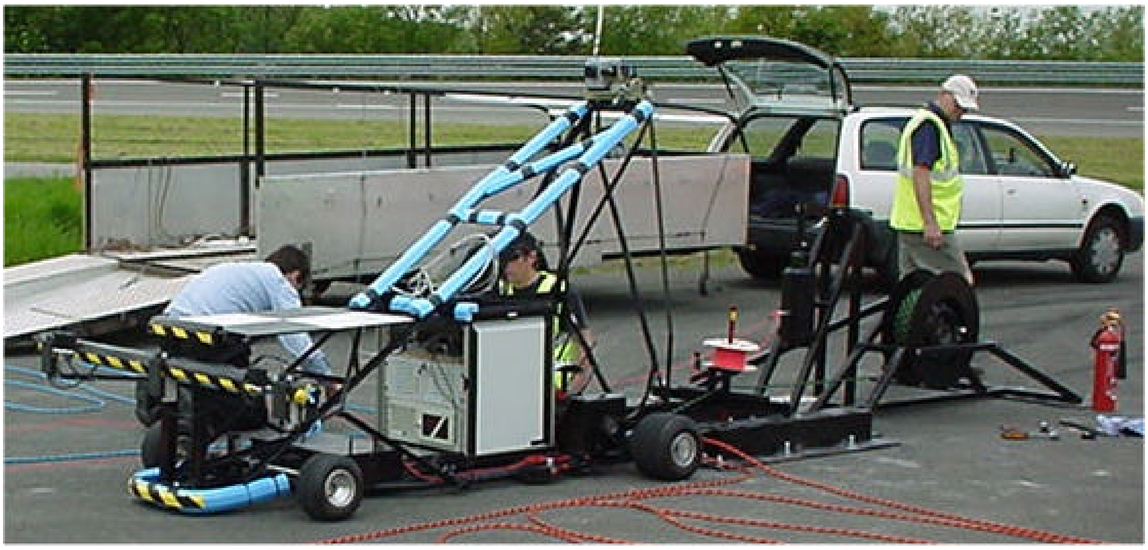

Figure 1 The Test Rig And Stopping Devices On The Test Site

In this document an overview of test rig design is given. The chassis is pictured, electrical schematics and components such as the power source and electric motor are explained. The remote control device is detailed and the vehicle sensor CAN interface given. The system used to decelerate the test rig is described and also the emergency energy absorber tether devices. Velocity and yaw data from a speed run are shown and the test site layout is given. An example of the recorded data is shown although this information will be discussed fully in a separate report. Finally the MIRA Safety Case is included in the appendices.

2. INTRODUCTION

The initial concept for the test rig was for a vehicle that would run on tracks buried in the road surface. This Test Rig, equipped with sensor equipment, would approach a pedestrian at speed and be rapidly brought to rest. Figure 2 shows this initial test rig concept.

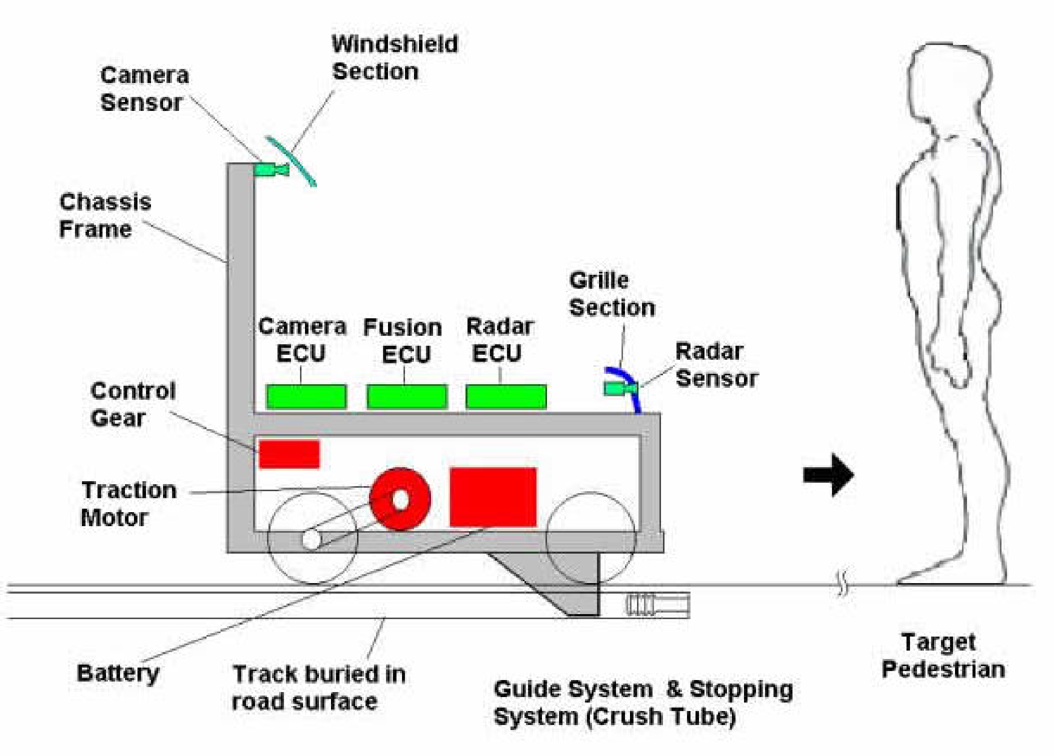

Figure 2 Initial Test Rig Concept

This design quickly evolved from a track-guided system to a tethered rig design. The benefits of this new tethererd system included eliminating the rail in the sensors field of view and also greater control of the stopping distance and final stopping position.

The evolved design concept of the revised tethered rig is shown in Figure 3

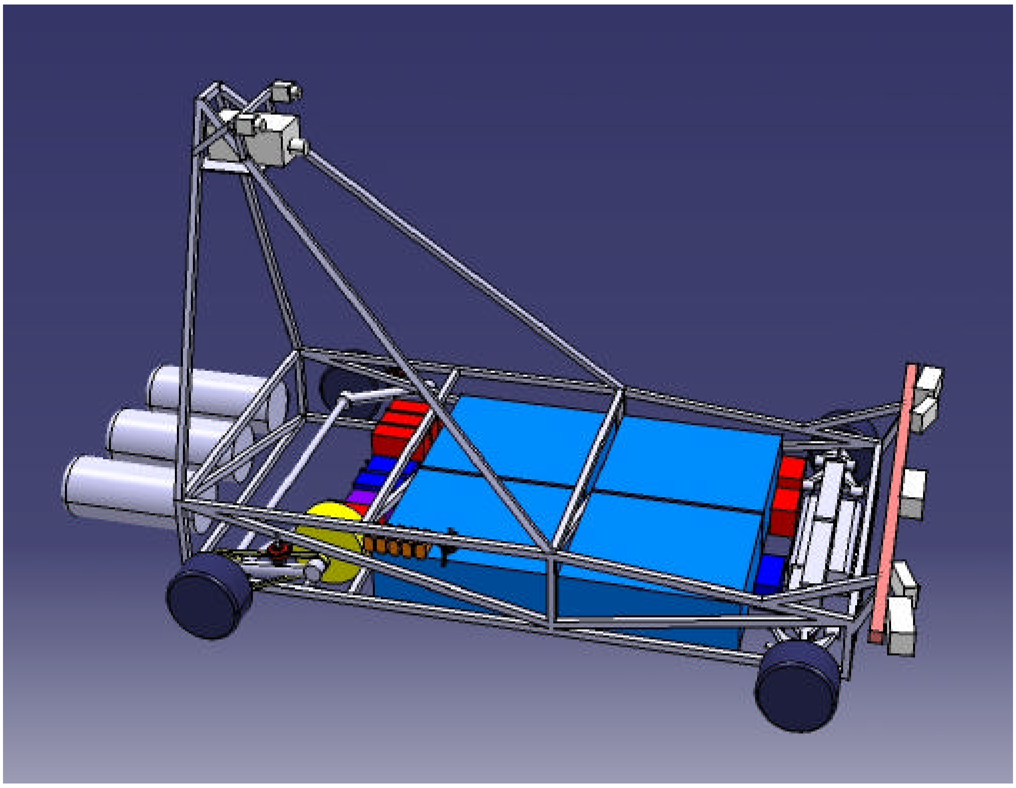

Figure 3 Initial Tethered Rig Design Concept

This new rig design concept allowed for three tethers to decelerate the rig, one operational and two more as emergency backup. Figure 3 shows the design concept with the computers, radar sensors and cameras clearly visible. The three cylinders at the rear of the rig were originally there to spool the high strength Dyneema tether rope.

The stopping of the test rig during the tests was a crucial consideration of the design. The tether point must be in line with the vehicle center of gravity else there would be a tendency for the vehicle to twist violently when stopped. The safety of the system during the stopping process was also essential. The structure of the vehicle must not fail and the onboard components (PC's and sensors) must remain secured. Failure of either of these factors could cause injury to the pedestrian.

3. TEST RIG CHASSIS

The chassis of the test rig is made from high strength tubular steel. An essential function of the test rig is that the test rig is decelerated to rest by means of a rope tether. Should this tether fail in operation, two additional emergency tethers are provided. Figure 4 shows the test rig chassis and indicates the tether positions used for stopping the Test Rig during the tests.

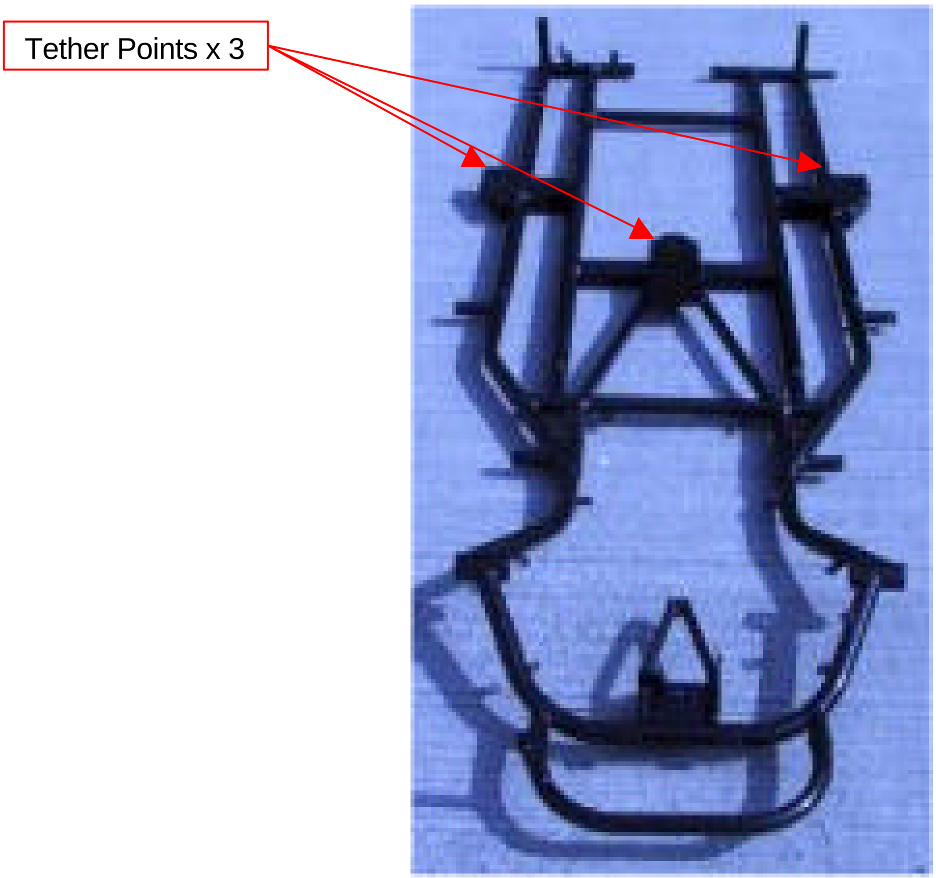

Figure 4 Test Rig Chassis

4. THE TEST RIG

The Test Rig is driven by an electric motor through a chain sprocket drive to the rear axle. Four Hawker Siddeley SBS 15 batteries provide the power source. The steering is contolled by an actuator. A control box houses all of the electronic equipment that is responsible for the motor control, steering control, CAN signal generation and the charging of both the drive battery and the PC power battery. Figure 5 shows the bare Test Rig without the pc and sensor equipment.

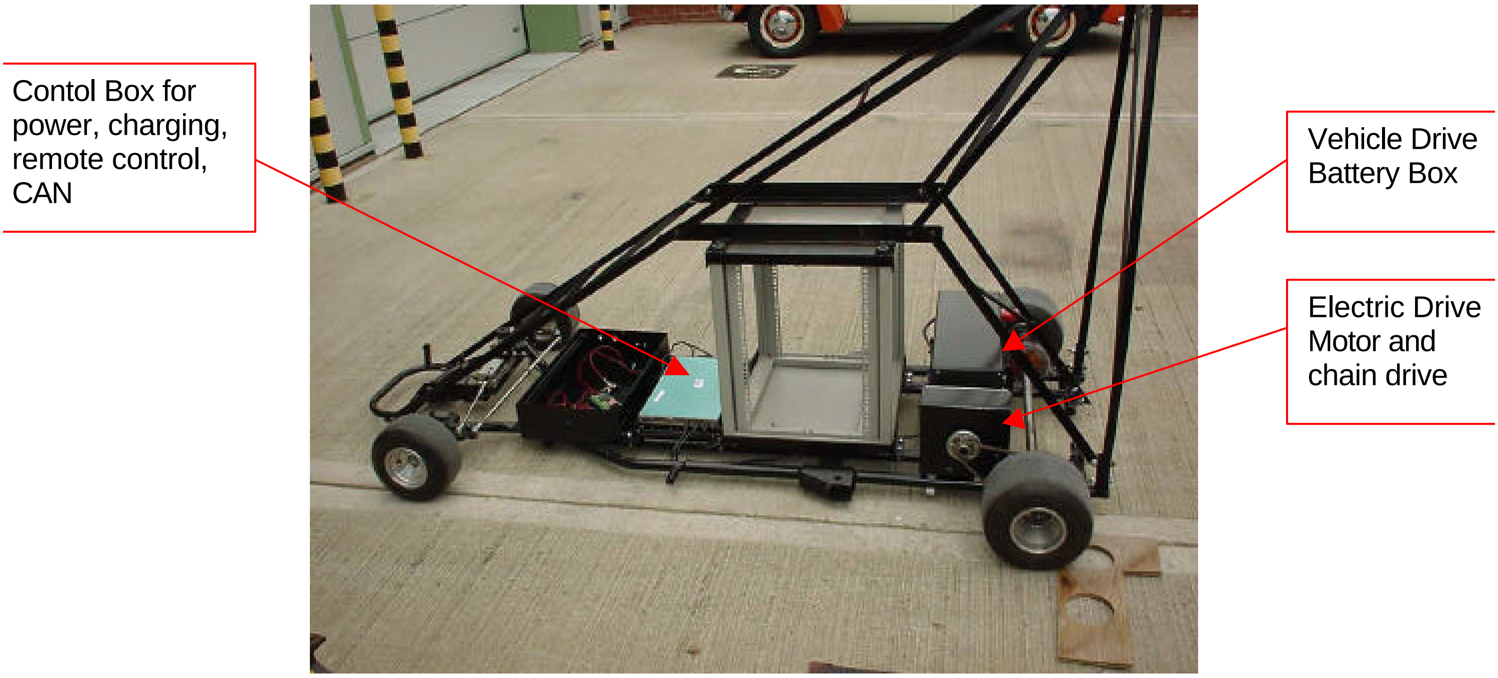

Figure 5 Test Rig 'bare' system

5. Test Rig Electrical Schematic

The electrical design of the test rig is shown in schematic form in Figure 6.

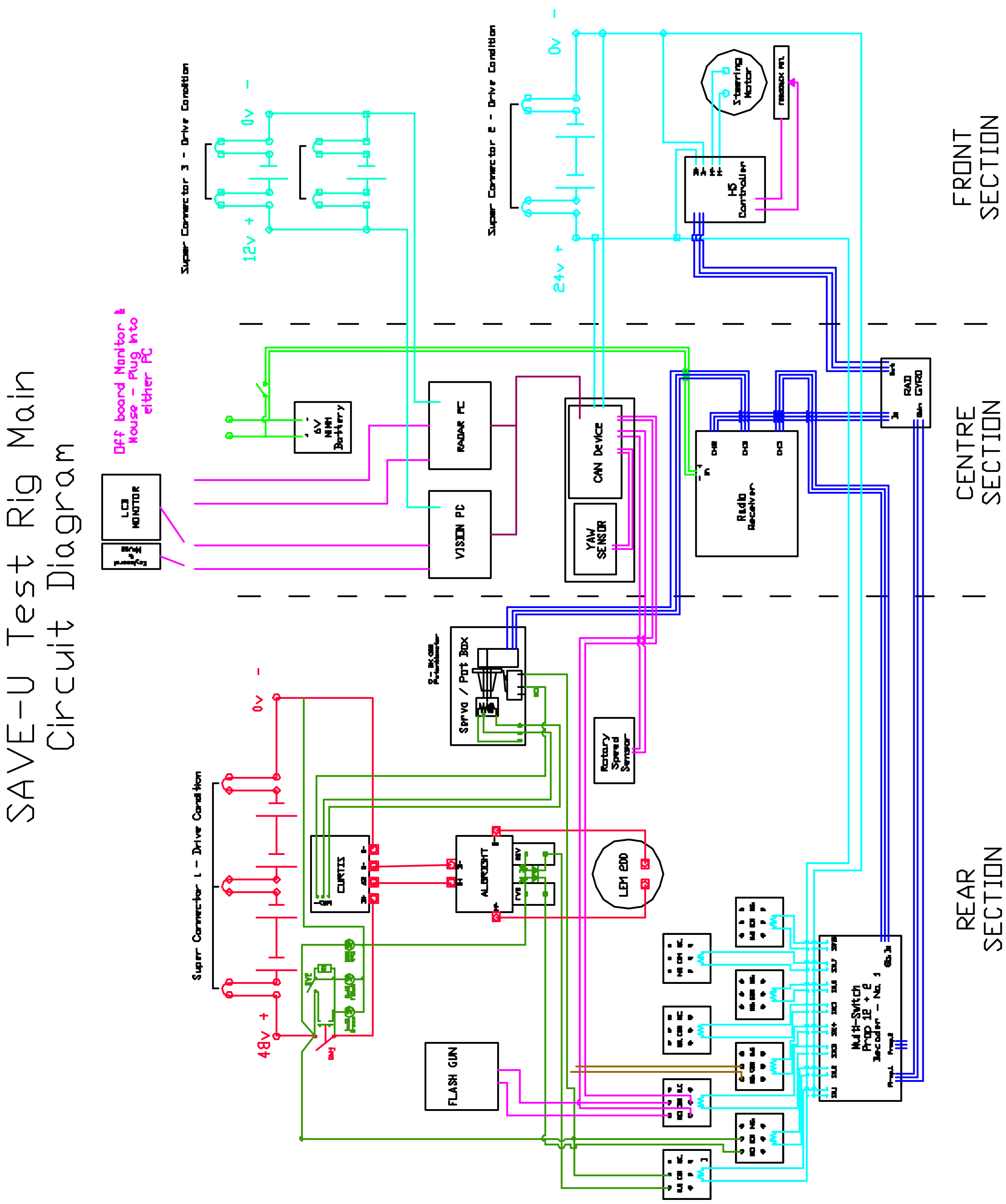

Figure 6 Electrical Schematic of the Test Rig

6. Power Source

A battery power source was used to provide energy for the traction of the test rig and to power the PC's and sensor equipment. These batteries were Hawker SBS provided by DMS Technologies Ltd. Hawker batteries utilise pure lead, thin plate technology and offer a wide operating temperature: -40°C to +50°C and are classified as non-spillable battery with no land or air transport restrictions. The *batteries used for the traction were four SBS15 batteries* that are 12V, 14Ah capacity. *The batteries used to power the sensors and PC's were two SBS30 batteries* that are 12V, 26Ah capacity.

7. The Electric Motor Drive

The electric motor that drives the test rig is manufactured by the LMC Ltd (Lynch Motor Company). The LMC 200 is an Axial Gap D.C brush motor suitable for traction and industrial applications. This motor has a high efficiency of around 91% and is comparitively light in weight (11 kg). The overall dimensions of the motor are shown in Figure 7.

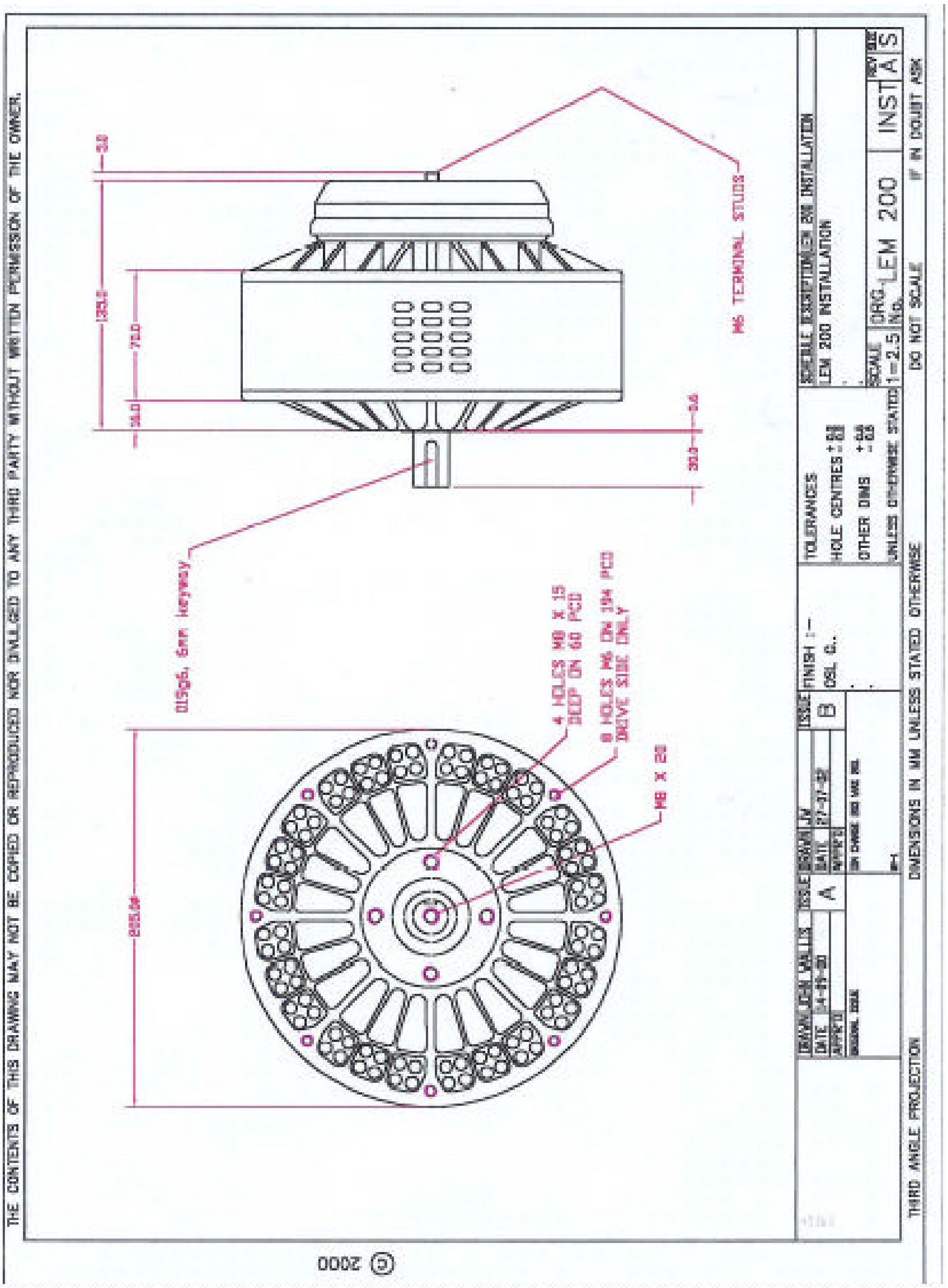

Figure 7 LMC 200 Electric Motor

8. Remote Control

The device used for the remote control of the test rig is a Futaba Skysport 6 FP6EXAN/40L. The Futaba device was chosen because of its leading reputation in the remote control field. The device was known to be reliable immune to interference from rogue radio transmissions.from external sources. The programmable nature of the device enabled all of the channels to have EPA (End Point Adjustments). For example the limits of travel for the steering could be programmed along with the steering central position. The T zero signal signal was programmed to one of the devices programmable buttons. Figure 8 shows the remote control.

Figure 8 Futaba Skysport 6 FP6EXAN/40L

9. Vehicle Sensor/CAN Interface system

The Vehicle Sensor/CAN Interface system essentially provides the vehicle CAN bus with messages containing information about the velocity and yaw rate of the vehicle, timestamp values and data logging start/stop indication. The velocity of the vehicle is determined using a toothed wheel attached to the vehicle's driveshaft. A tiny infrared light beam is continuously broken by the teeth and the frequency at which this occurs is translated by the micro-controller into a velocity value. The yaw rate of the vehicle is measured using a highly sensitive yaw rate sensor that provides an analogue voltage output proportional to the rate of yaw. This analogue voltage is converted into a digital number and then fed into the micro-controller.

The micro-controller has an internal timer that counts in 1 millisecond increments. The microcontroller resets this timer to zero at the instant the 'Time Zero' switch is closed. This 'Time Zero' switch is closed remotely using the remote control transmitter module used to steer and accelerate the vehicle. The micro-controller signals to the other devices connected to the same CAN bus when to start and stop data logging. A 'Log Switch' is connected to the micro-controller which the operator can use to start and stop logging. At the same time the micro-controller is sampling the vehicle velocity, reading the digital result of the converted yaw rate signal and incrementing the internal timer it is also sending CAN messages to the other devices on the CAN bus every 50 milliseconds. The information within the CAN messages is updated just before the messages are sent, therefore ensuring the recipients receive the most up to date information. Figure 9 shows a schematic of the interface system.

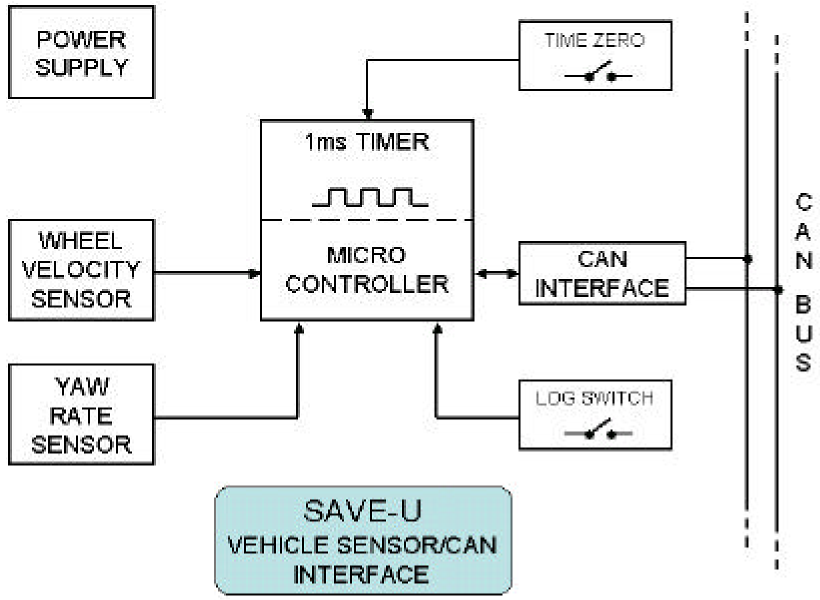

Figure 9 Vehicle Sensor/CAN Interface system

10. THE STOPPING RIG

The deceleration of the rig is achieved by a braking drum system known as the stopping rig. A rope tether (high strength Dyneema rope) is connected to the Test Rig and at its other end, wound around a drum. At a particular point in the travel of the test rig a pin is pulled that releases a falling weight that in turn applies braking force to the drum thus stopping the Test Rig. Figure 10 shows the Test Rig next to the Stopping Rig.

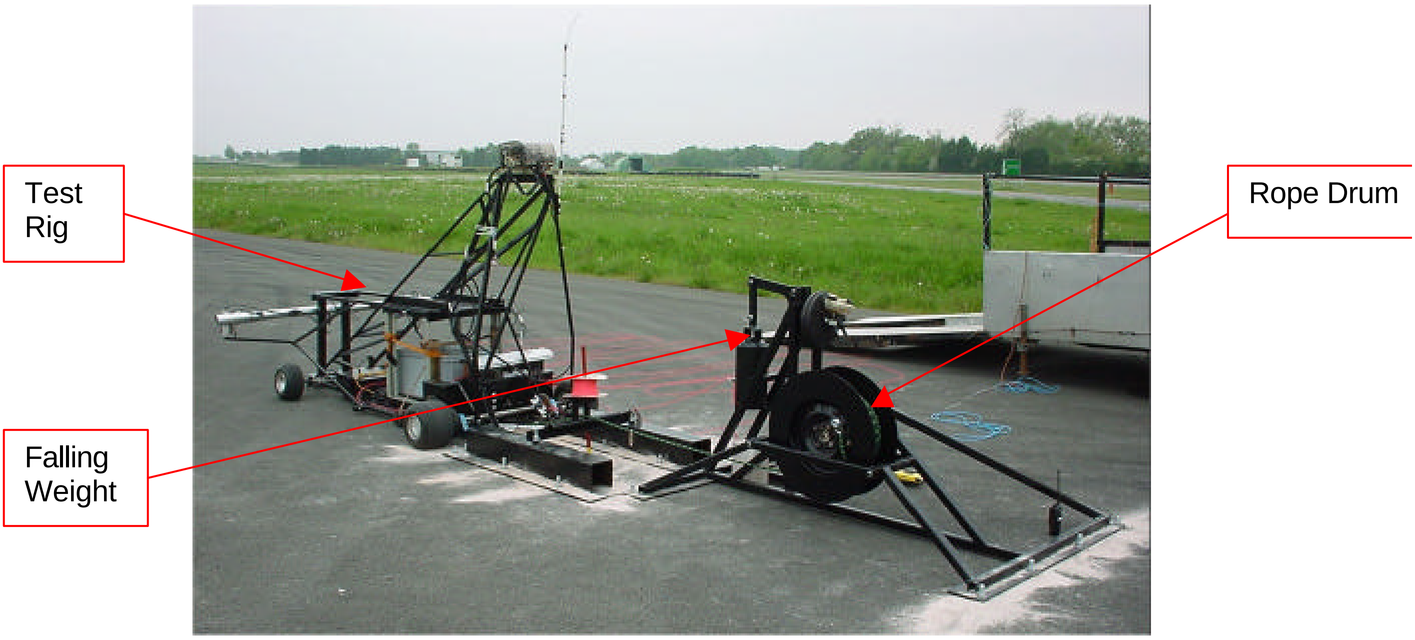

Figure 10 Test Rig and Stopping Rig

11. Emergency Energy Absorber Tether

In the event that the Stopping Rig fails to operate or the rope is severed, an emergency tether system will operate to stop the Test Rig. This Emergency Energy Absorbing Tether functions by deforming a steel bar within a steel box. The dimesions, grade of the steel etc have been designed to absorb the kinetic energy of the fully laden Test Rig at full speed. One of the units is sufficient to stop the rig; a second is provided for further safety. Figure 11 shows the two Emergency Energy Absorbing Tether units positioned adjacent to the stopping rig

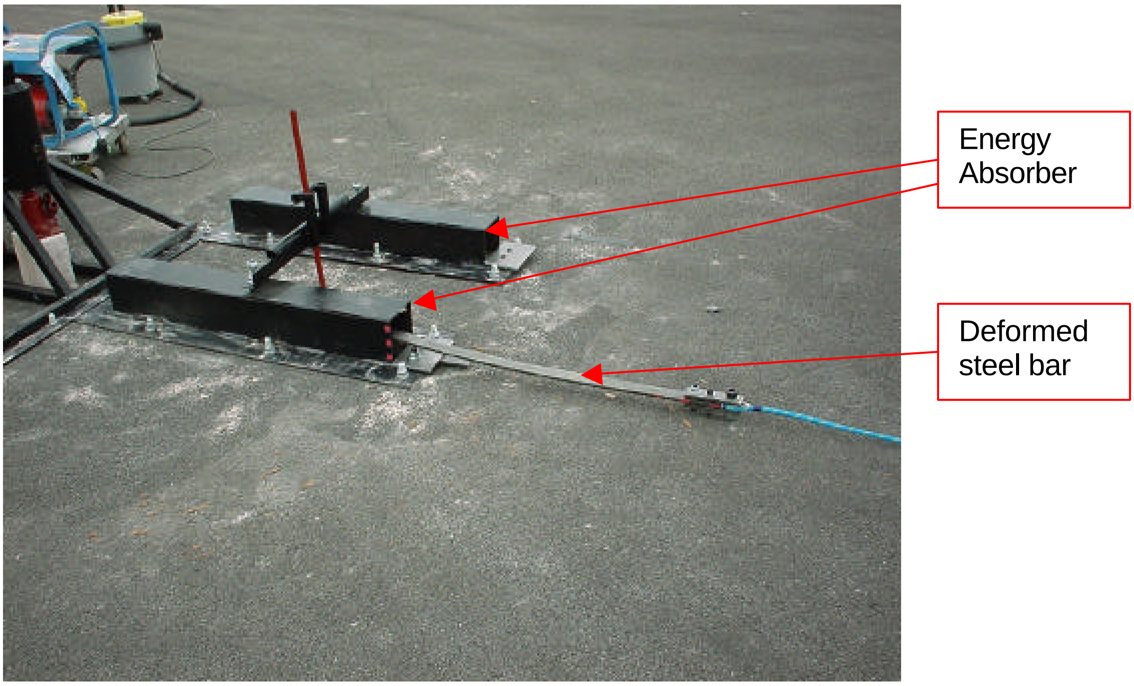

Figure 11 Emergency Energy Absorbing Tether

12. Speed Run

Figure 12 shows a graph for the Test Rig as it is accelerated and stopped during commissioning trials. The speed is shown approaching 10 m/s and then the test rig decelerates to 5 m/s, and then accelerates before being brought to rest. The Yaw rate values are also shown.

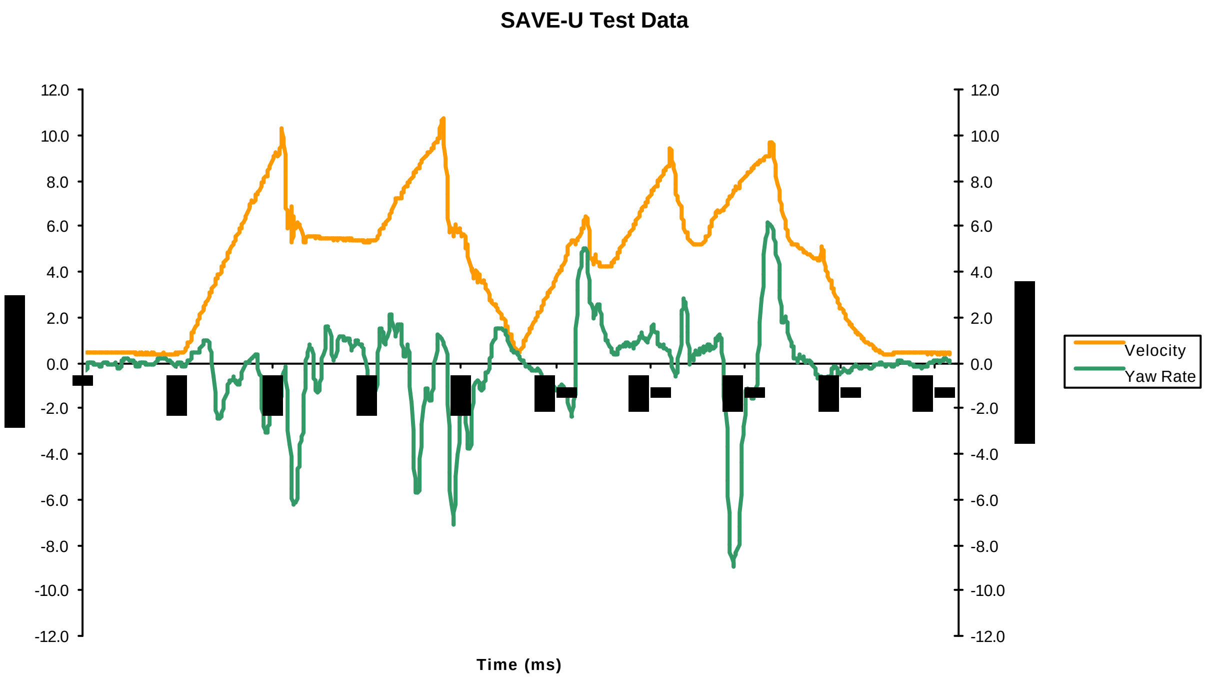

Figure 12 Velocity and Yaw Against time

13. The Test Area

The test area was a smooth tarmac surface on the ‘proving ground’ at MIRA Ltd’s site. The Stopping Rig was secured to the ground using commercial rawbolts and then trial runs conducted to confirm the actual stop position of the Test Rig. The road surface was then marked out with lines that would appear in the overhead camera used for establishing Ground Truth. Figure 13 shows the layout of the test site.

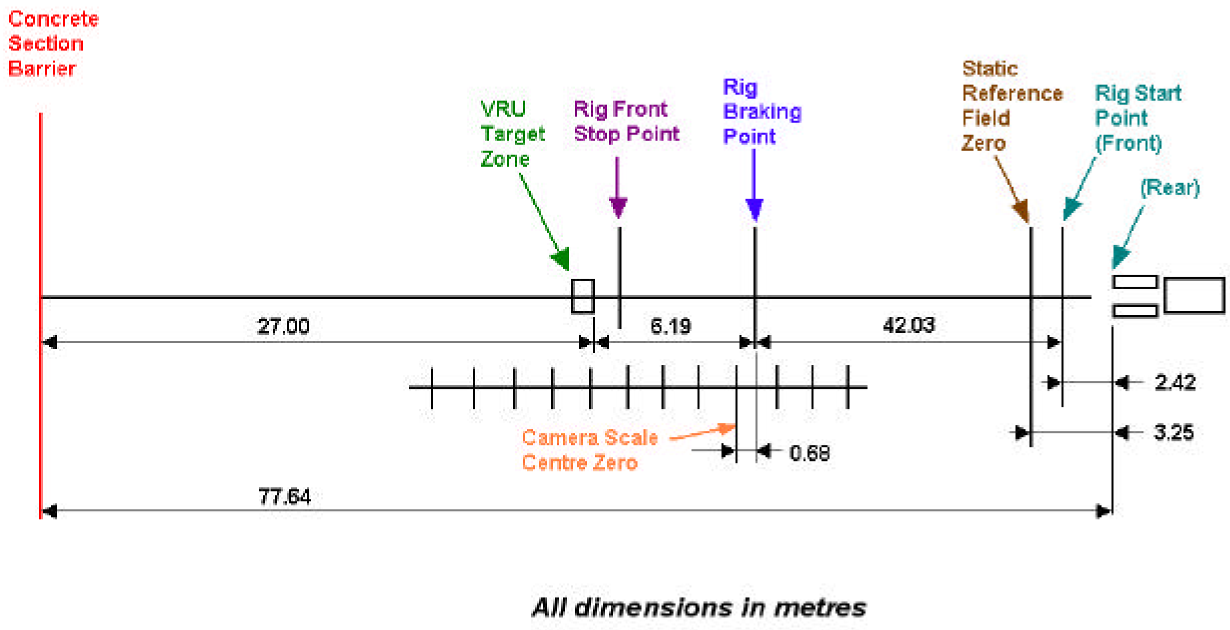

Figure 13 Test Site Layout

14. Example of Recorded Data

In the Test 21b three pedestrians were walking from left to right across the path of the test rig. This particular scenario evaluated the ability of the system to recognise multiple VRU targets. Figure 14 shows a screenshot from the CEA captured data. Figure 15 shows a screenshot from the overhead camera that is used for Ground Truth Analysis.

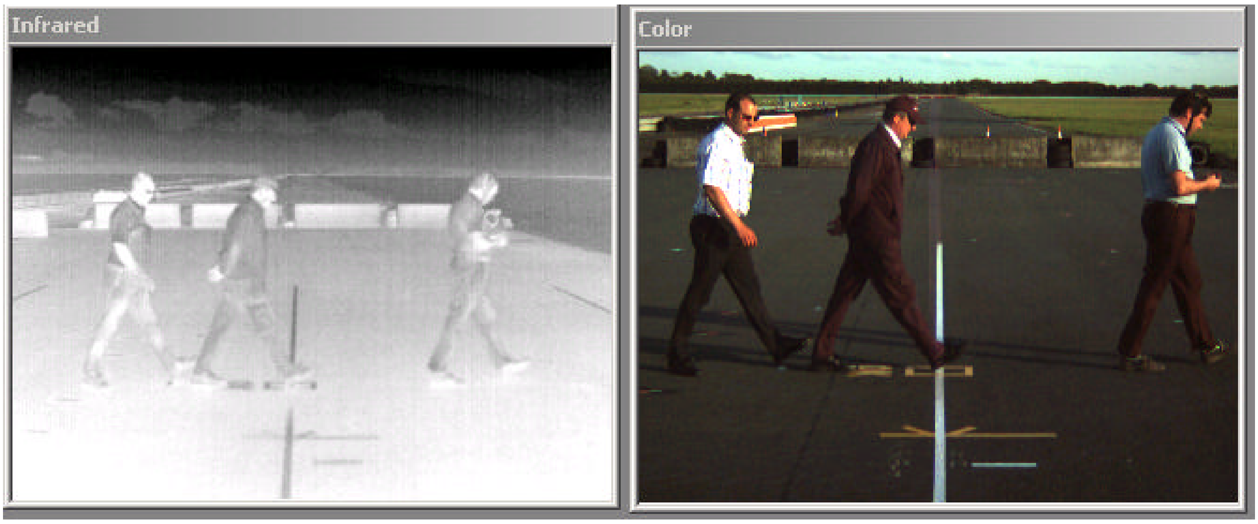

Figure 14 CEA Software Screen Capture of Test 21b

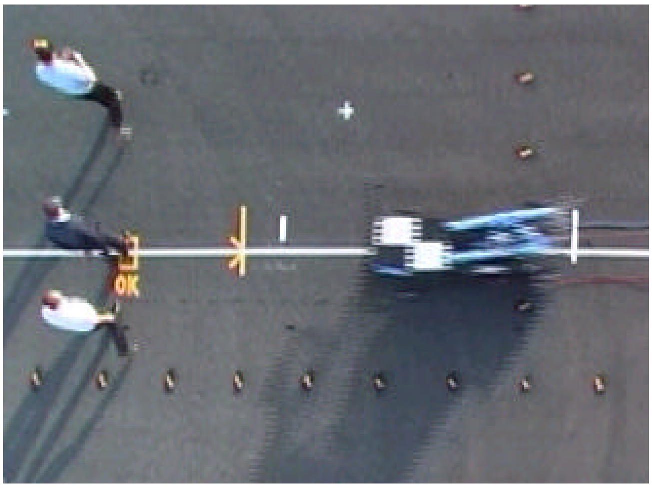

Figure 15 Overhead Camera Screen Capture

15. Experience From the First Test Phase

The tests undertaken in this programme were of a unique nature. To ensure the complete safety of the VRU's in the tests meant that a thorough safety review of any of the associated risks was required. The integration of these technical prototype systems did raise some problems that caused time delays in the test programme. The language used on the PC's was French and German, this meant that any error messages generated were difficult to understand for the English user. There were installation and voltage supply issues for the PC's. A problem with CAN communication was traced to a simple connection problem. The data capture software for the CEA and Siemens software proved difficult to use when the PC's were mounted onto the test rig. The speed and yaw signal generation from the test rig gave a noisy signal because of interference from the electric motor. A number of technical difficulties became apparent in producing the 'ground truth' data. The detailed camera settings and the subject target markers were not optimum. The generation of the ground truth data was not costed for in the original submission. The amount of work that was required for this task was not appreciated.
For the next test phase these experiences have been addressed. For example a common operating system language will be used to ensure a better use of the software and the test rig speed sensor has been updated to an optical sensor to avoid any noisy signal issues.

16. Conclusion

Test rig design within the SAVE-U project was succesfully completed. Some problems were encountered but these were finally overcome so that a series of nineteen tests were conducted and data was captured for the Siemens radar system and the CEA/DC vision system. The overhead camera filmings enabled data to be collected that would enable ground truth analysis to be calculated, although the latter is still work in progress.

In the next test phase the full SAVE-U sensing system will be evaluated for performance. Lessons learnt from the first test phase experience (data collection for algorithms optimization) have led to improved rig operation and test procedures.

The corrections brought on the system will allow to perform the test plan for evaluation in a more confident way in terms of test duration and quality of data recordings.

Appendix A

Test Procedure & Sensor Positioning

Appendix B

SAVE-U Safety Plan

Appendix C

SAVE-U Safety Appraisal