TECHNICAL SERVICES

NAKAMBALA MILL

SUGAR BAG IDENTIFICATION AND COUNTING

DECEMBER 07 SHIFT TEST

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CONTENTS PAGE

CONTENTS **PAGE**

ABSTRACT **4**

INTRODUCTION **5**

OVERVIEW **5**

COUNTING PROCEDURE **6**

1. MILL COUNT **6**

2. IMAGE RECOGNITION COUNT **6**

3. MANUAL COUNT **9**

RESULTS **10**

4. 8 AM TO 9 AM **11**

5. 9 AM TO 10 AM **13**

6. 10 AM TO 11 AM **18**

7. 11 AM TO 12 PM **20**

8. 12 PM TO 1 PM **21**

9. 12 PM TO 1 PM **22**

11. 3 PM TO 4 PM **25**

12. TOTAL SHIFT COUNT: 8 AM TO 4 PM **26**

CONCLUSIONS **28**

LIST OF FIGURES

Figure 1 - Lane used for counting only on the right 5
Figure 2 - Two imaging solutions counted a single lane 6
Figure 3 - All damaged products were recorded 7
Figure 4 – DVR Verification of the Counted Bags 8
Figure 5 – 4 Products were counted: 1Kg bale white & brown, 2kg white and 10kg cane sugar. 9
Figure 6 – Daily Report showing hourly totals 10
Figure 7 - Lane 1 compared to Lane 2 automatic counts compared to the Manual Counts 11
Figure 8 - A 2 KG bag was incorrectly classified as a 10 KG bag, the only error during this hour 13
Figure 9 - 1 KG poly bag was touching a 2 KG product. This was manually classified. 14
Figure 10 - 50kg EU bags were not classified as these bags only started being produced during the test period 15
Figure 11 - Ghosting on the Image – camera issue? 15
Figure 12 – Non Classified fields? 16
Figure 13 – Good template examples 17
Figure 14 - Examples of product not identified from lane 1: Note the large boundary box in each image 18
Figure 15 - Touching bags captured during 10 am and 11 am 19
Figure 16 - An image from the Digital Video Recorder showing bags counted in the 1st 7 seconds of the hour 19
Figure 17 - Touching products during the period 11 and 12 20
Figure 18 – Time difference between the PCs was 7 seconds 21
Figure 19 - People movement affecting lighting resulting in a bad classification 22
Figure 20 - Cause of light changes on the conveyor belt 23
Figure 21 - Bags which cannot be classified due to human interference 24
Figure 22 - Two one KG pre-packs were incorrectly classified as two KG Pre-Packs 25
Figure 23 – Graphical representation of classification and totals in 8 hours 26
Figure 24 - Damaged bags were detected by imaging system which were not allocated in the manual count 27
Figure 25 - 53s - Poly 1 KG Brown 4:06:53 29
Figure 26 - 54s - One KG White Sugar 4:06:54 29
Figure 27 - 55s - One KG White Sugar 4:06:55 30
Figure 28 - 56s - One KG White Sugar 4:06:56 30
Figure 29 - 57s - One KG White Sugar 4:06:57 30
Figure 30 - 58s - One KG White Sugar 4:06:58 30
Figure 31 - 59s - Poly 1 KG Brown 4:06:59 30
Figure 32 - 00s – 2KG Bale 4:07:00 30
Figure 33 - 01s - 2 KG Bale right way up at 4:07:01 31
Figure 34 - 01s (2) - 2 KG Bale on side 4:07:00 31
Figure 35 - 02s - 2 KG Bale right way up at 4:07:02 31

ABSTRACT

Automatic sugar bag counting offers tremendous advantages over traditional means of determining what product has been received at the warehouse. It is possible to monitor the production process and verify the production volumes, providing an accurate method of determining volumes. Additional benefits include productivity ratios, operational analysis and general human resource assessment. Manual counting is a very tedious process, prone to mistakes due to human error, distraction and pilfering. Using the MT500 Software, it is possible to classify and count each product passing the CCTV camera. When there is uncertainty with the classification of a product, it is set aside for manual confirmation and classification. The MT500 Software provides the means of counting products and recording production volumes automatically and accurately. A statistical image recognition algorithm is used and a very good classification accuracy of the products is obtained, even though the products are severely distorted and deformed on the conveyor belt. The classification accuracy is dependent on the quality of the image from the camera, uniform lighting, templates selected to identify the product as well as sufficient spacing between products.

A percentage capture rate of 100% (not a single bag missed) and a 99.986% classification accuracy rate against over 7,500 products during an 8 hour shift were achieved.

INTRODUCTION

This document outlines a comparison between 3 different counting techniques undertaken at the ISL NAKAMBALA MILL in Zambia. ISL Technical Services performed a bag by bag manual count, the mill provided an end of shift count (compiled from the number of bags passing through the cages) and the Motion Track software provided a count from each counting system.

Figure 1 - Lane used for counting only on the right

OVERVIEW

The accuracy of the cameras and computer systems to identify and count the various products that leave the packing station and are then transferred to the warehouse is crucial. If the I-Cube software is to be linked to the Bag Counting module of CaneLab system, which will then transfer the information to the various financial systems, it is important that the imaging system should provide accurate information. This series of tests has been conducted to verify the accuracy of automatically counting the products. A comparison of the automatic and manual counting processes was undertaken.

COUNTING PROCEDURE

1. MILL COUNT

1.1 The packing conveyor was stopped at 07:59.

1.2 A defined start bag was identified and allowed to proceed past the cameras on the transfer conveyor at 08:01.

1.3 This bag was walked through from packaging to the warehouse in order to ensure the start of the shift was clearly communicated and known to the packing staff.

1.4 At 15:59 the packing conveyor was stopped, no longer feeding the transfer conveyor.

1.5 A defined end bag was identified and walked through from packaging to the warehouse in order to ensure the end of the shift was clearly communicated and known to the packing staff.

1.6 All bags which passed the camera were included in the count.

2. IMAGE RECOGNITION COUNT

2.1 IMAGE RECOGNITION HARDWARE AND SOFTWARE COUNT

2.1.1 The cameras were cleaned, the lens focused, all set up operations completed and the database trained. Once the imaging system was turned on at 8 AM, the system was not touched again until after 4 PM.

2.1.2 Two imaging systems were utilised as a single lane was being counted, called Lane 1 PC and Lane 2 PC results.

All correctly identified products were captured in a folder called CLASSIFIED. All these images are available.

Figure 2 - Two imaging solutions counted a single lane

2.1.3 All unknown products, such as cardboard, paper, broken bags, sugar, etc was recorded in a folder called NOT CLASSIFIED. All these images are available.

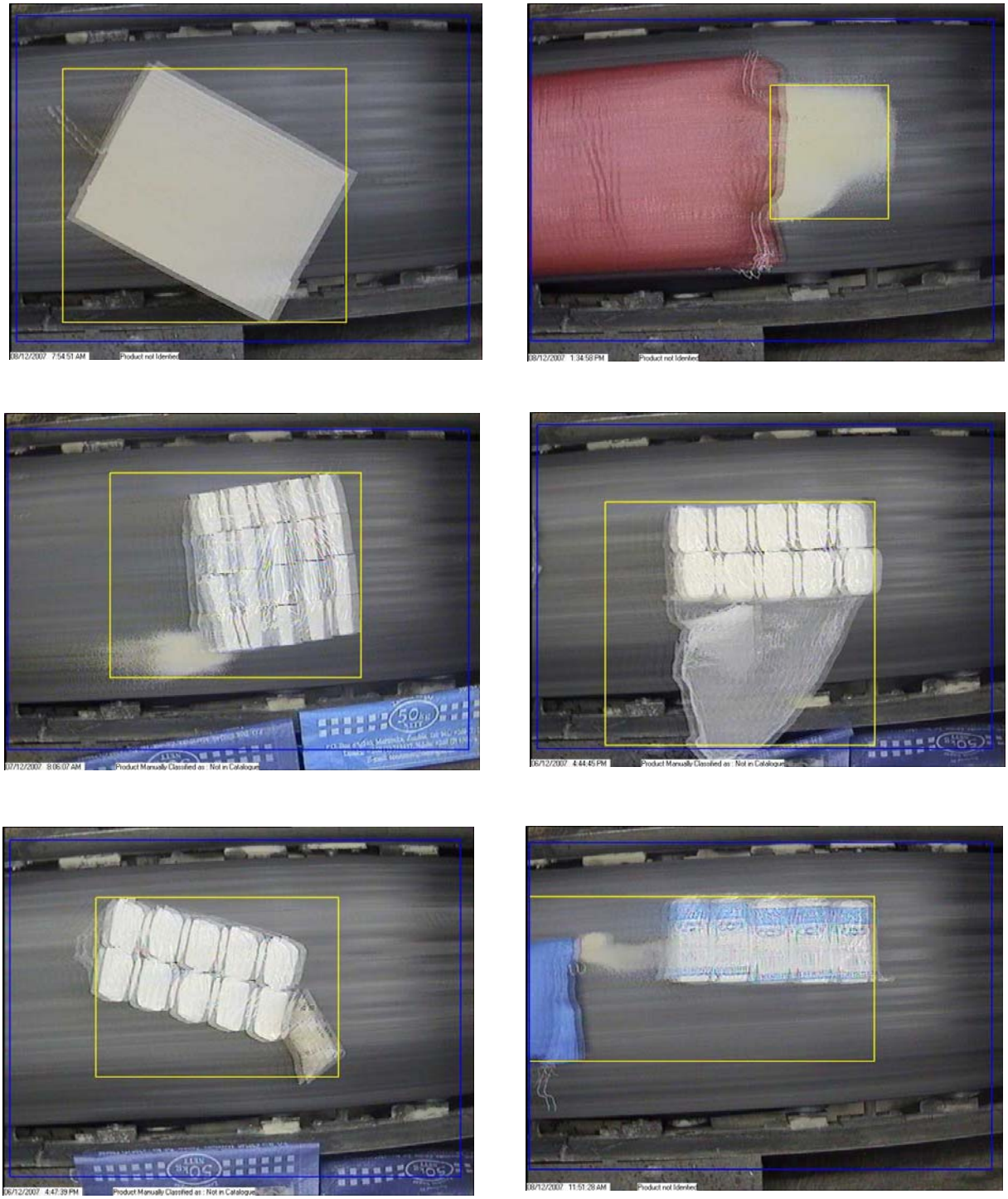


Figure 3 - All damaged products were recorded

2.1.4 A digital recorder covers the counting lane plus two overview cameras, which recorded at 25 frames per second the approach of the bag, the bag passing the counting camera and moving on to the warehouse. All eight hours of recording from all 3 cameras is available.

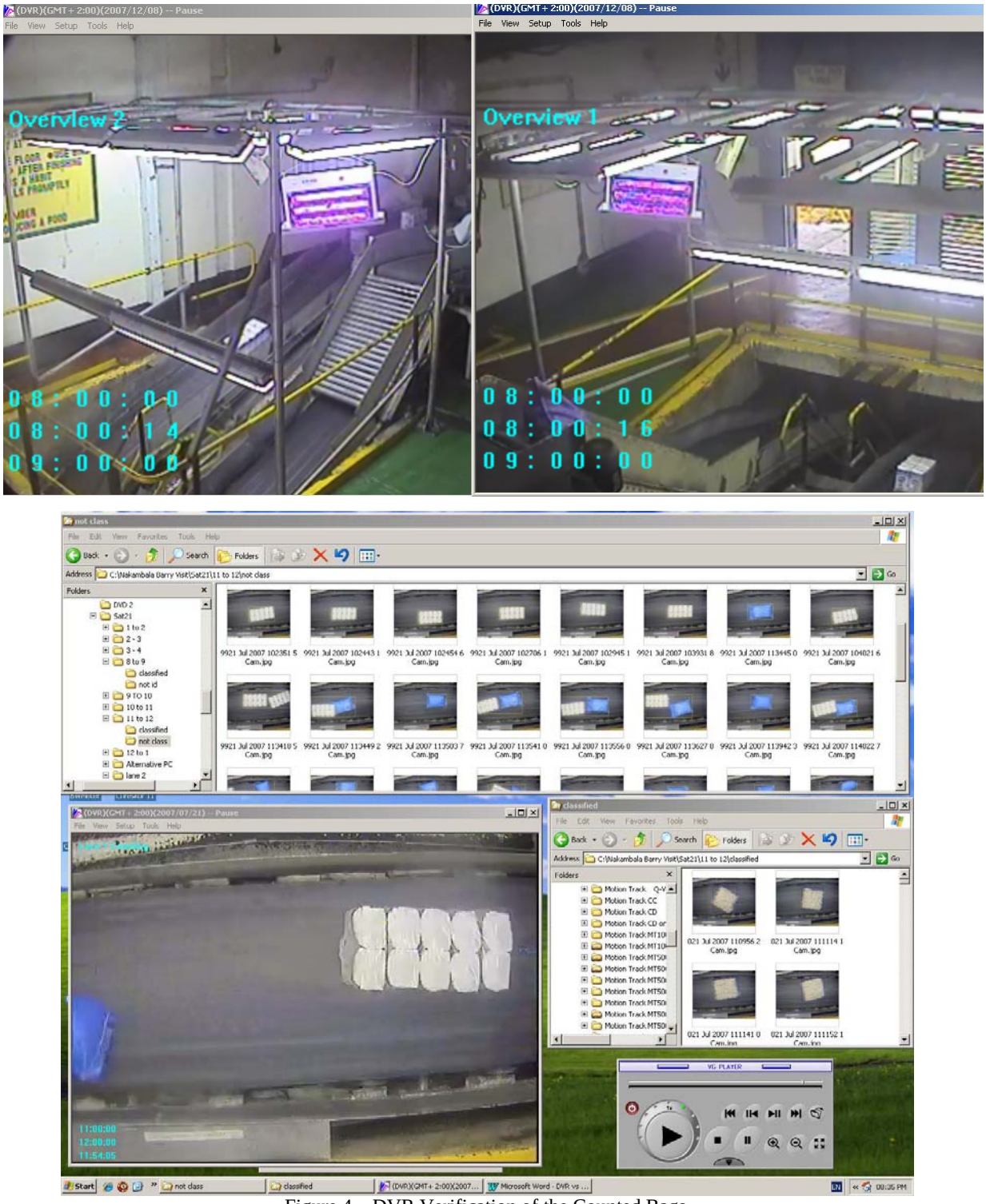


Figure 4 – DVR Verification of the Counted Bags

3. MANUAL COUNT

3.1 Four columns were created in a note book, one for each of the products.

3.2 As the product passed a set point at the end of the transfer conveyor, a mark was made in the appropriate column.

3.3 A counting shift lasted one hour, with a slight break in the flow of products to allow a change over in counters.

3.4 The marks were counted after the shift, creating the number of different products which passed the counting point from 8 AM to 4 PM.

3.5 All bags which passed the camera were included in the count.

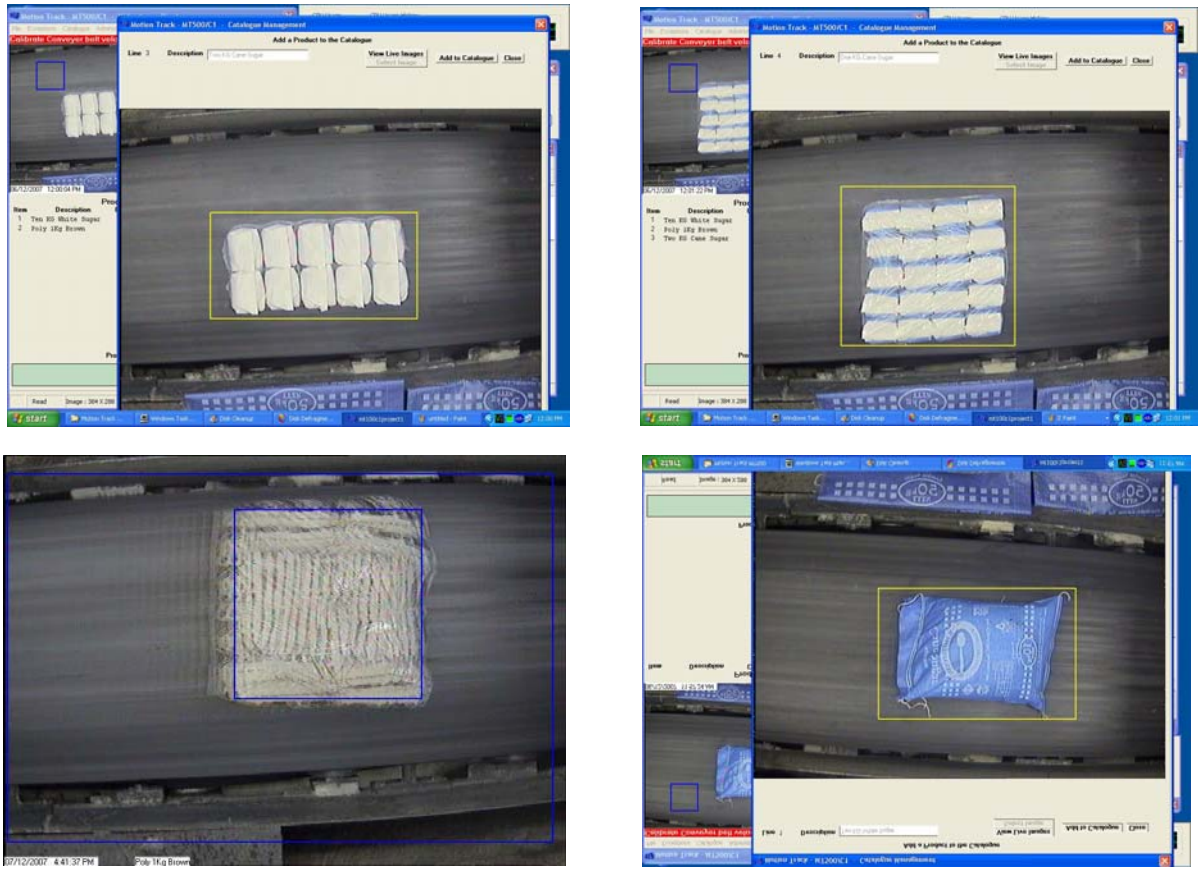
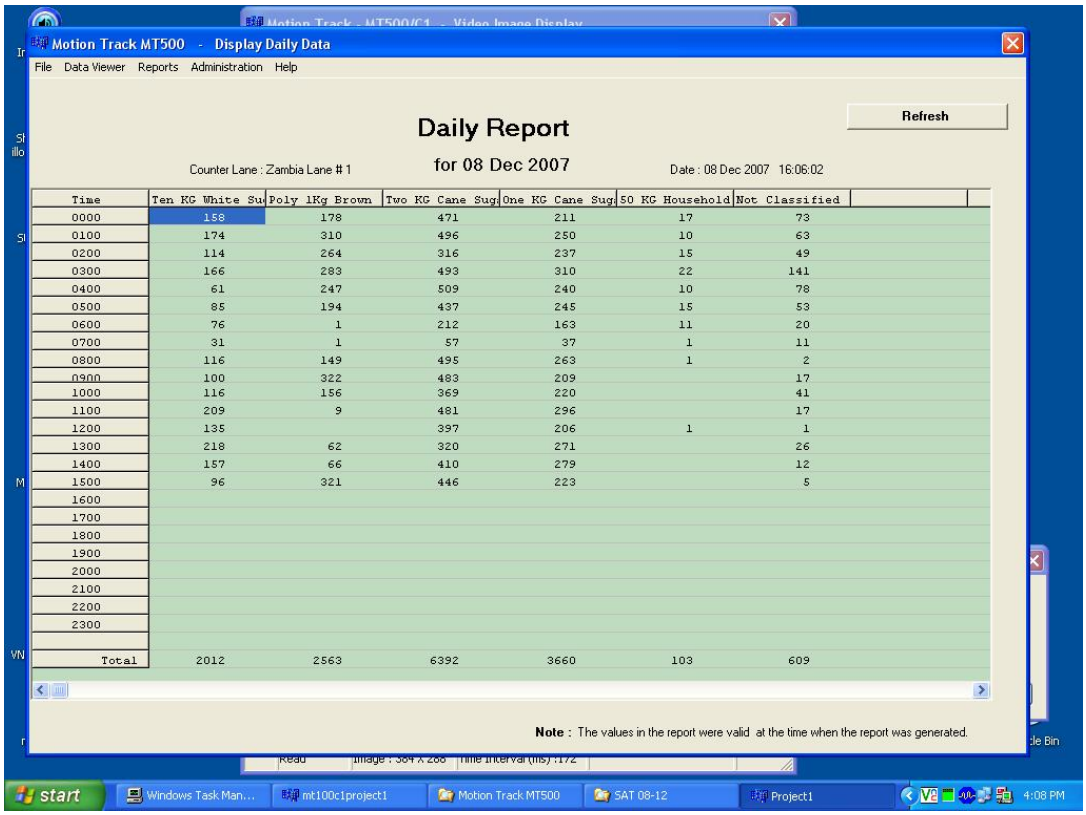


Figure 5 – 4 Products were counted: 1Kg bale white & brown, 2kg white and 10kg cane sugar.

RESULTS

Only Manual Count VS Automatic Count 1 & 2 could be compared per hour as the Mill only produces a count per shift.



Time	Ten KG White Su	Poly 1Kg Brown	Two KG Cane Sug	One KG Cane Sug	50 KG Household	Not Classified
0000	158	178	471	211	17	73
0100	174	310	496	250	10	63
0200	114	264	316	237	15	49
0300	166	283	493	310	22	141
0400	61	247	509	240	10	78
0500	85	194	437	245	15	53
0600	76	1	212	163	11	20
0700	31	1	57	37	1	11
0800	116	149	495	263	1	2
0900	100	322	483	209		17
1000	116	156	369	220		41
1100	209	9	481	296		17
1200	135		397	206	1	1
1300	218	62	320	271		26
1400	157	66	410	279		12
1500	96	321	446	223		5
1600						
1700						
1800						
1900						
2000						
2100						
2200						
2300						
Total	2012	2563	6392	3660	103	609

Figure 6 – Daily Report showing hourly totals

4. 8 AM to 9 AM

Product	Lane 1	Lane 2	Diff 1-2	% Capture	% Class (Lane 1 Lane 2)	Manual Count
10kg Cane sugar	118	118	0	100%	100% 100%	118
Poly brown	150	150	0	100%	100% 100%	150
2kg pre-pack	490	496	6	100%	99.987% 100%	496
1kg pre-pack	269	263	-6	100%	99.98% 100%	263
Not classified	4	2	-2			-

The counts are 100% correct for 10 KG on both lane 1 and 2, ploy brown lane 1 and 2 and for lane 2 both 2 KG and 1 KG, as verified against the images captured and the video recorded. On lane 1 six of the 2kg pre-pack bags were classified as 1 kg pre-pack. This would have been as a result of the incomplete database for lane 1.

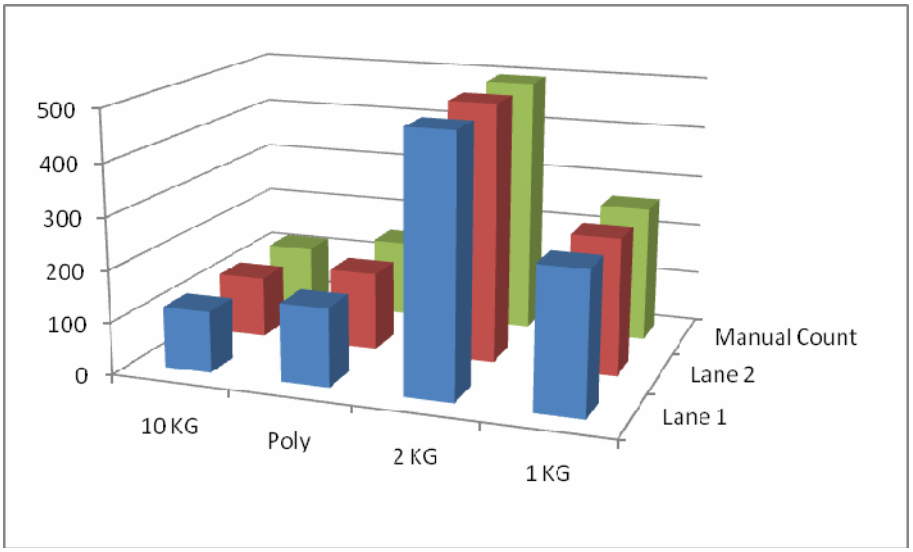


Figure 7 - Lane 1 compared to Lane 2 automatic counts compared to the Manual Counts

The counts in the table have already been adjusted to compensate for the products that were not classified automatically but were manually reviewed and classified. Lane 1 had 4 products which were not correctly classified and lane 2 had 2 products. The counts between the two lanes can differ even if both lanes are using the same camera, due to:

- The two PCs were set up with different training databases. Therefore the same image might be classified differently by the two PCs. Analysis of the training databases revealed that particularly lane 1 had been trained with too few templates. The training database contained 100 valid templates, whereas databases previously used had in the region of 300 templates. This would have a negative impact on classification performance.
- By inspecting the timestamps for the same bags seen by the two different lanes it was established that there is a time difference of approximately 7 seconds between the two lanes. While this doesn't cause a different classification of products, it does cause the hourly counts to differ since products passing by around the end of the hour are counted into different hours for the different lanes.
- The PCs do not process every frame received from the camera. The cameras produce frames at a rate of 25 Hz, whereas the PC process images at a rate of between 3 Hz and 10 Hz. Therefore the PCs only process a subset of all of the images, and generally do not process exactly the same set of images.
- There will be slight differences in the noise levels on the images seen by the two PCs since the cabling routes for the image streams to the two PCs differ.

During this period care was taken to ensure that the products are properly separated, manually attempting to keep at least 1m between bags. It can be seen from these results that this has a positive impact on the performance of the MT500 software, with no bags missed by the system and very few bags not counted due to touching. The touching bags were stored in a folder for later manual classification.

5. 9 AM to 10 AM

Product	Lane 1	Lane 2	Diff 1- 2	% Capture	% Class (Lane 1 Lane 2)	Manual Count
10kg Cane sugar	103	102	-1	100%	100% 99.0%	103
Poly brown	326	326	0	100%	100% 100%	312
2kg pre-pack	494	495	1	100%	100% 99.998%	488
1kg pre-pack	209	209	0	100%	100% 100%	202
Not classified	26	28	2			-

The counts between the two PCs are exact for poly brown and 1 kg pre-pack. A single 2 KG bag was incorrectly classified as a 10 KG bag. The manual counts were only the same for lane 1, 10 kg cane sugar with all other counts being very similar.

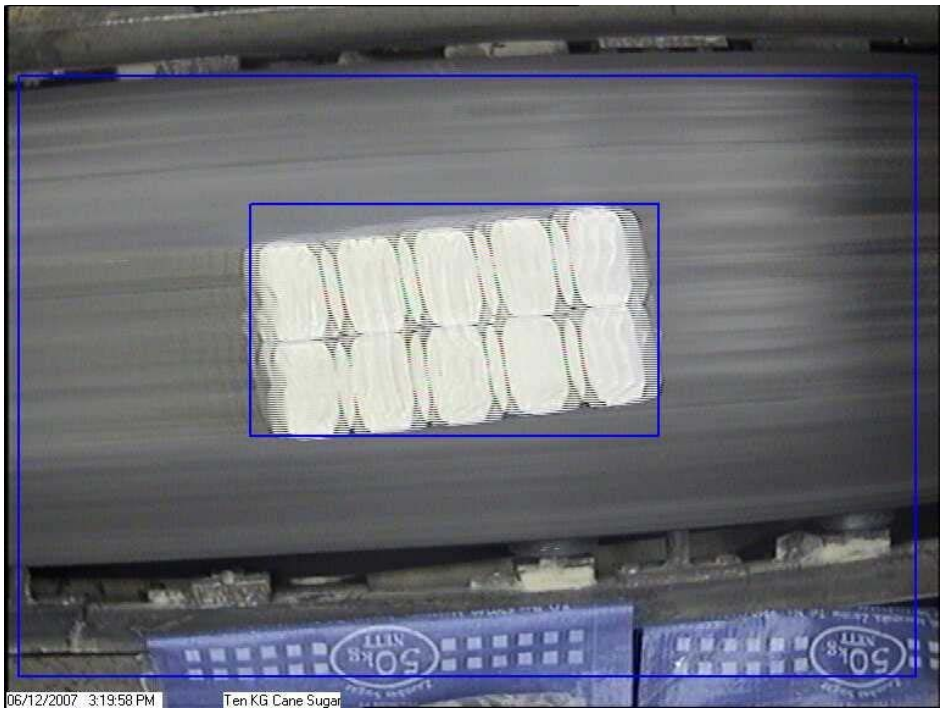


Figure 8 A 2 KG bag was incorrectly classified as a 10 KG bag, the only error during this hour

The accuracy of the manual count is questionable. Counting bags manually as they pass a certain point is an extremely difficult task. It is hard to keep concentrating, and to keep track of which bags have already been counted and which haven't. The DVR recording was used to perform a manual count where different counts were obtained in order to confirm which was the correct number. Based on previous manual counts from the DVR and the fact that the figures for the two lanes are very similar, we would suggest that the automated count is in fact more trustworthy.

The images that are not classified during this hour and others are a result of the following mechanisms:

- The majority of the unclassified products result from products that are too close together. An example of this is shown below. While in development (static environment) it was possible to classify products which were touching and where parts were not visible, in practice, at speed, with a number of products it is not possible for the software to accurately classify products which are touching, whilst moving at 1 meter per second. For proper operation a minimum spacing of 30cm needs to be maintained between products, which will result in the stated accuracy of 98% captured and 95% of these classified, although a much higher accuracy is currently being obtained. 50cm is the Mill prescribed minimum which we can achieve but suggest from the results obtained that you should conclude a minimum spacing of 100cm.

Figure 9 - 1 KG poly bag was touching a 2 KG product. This was manually classified.

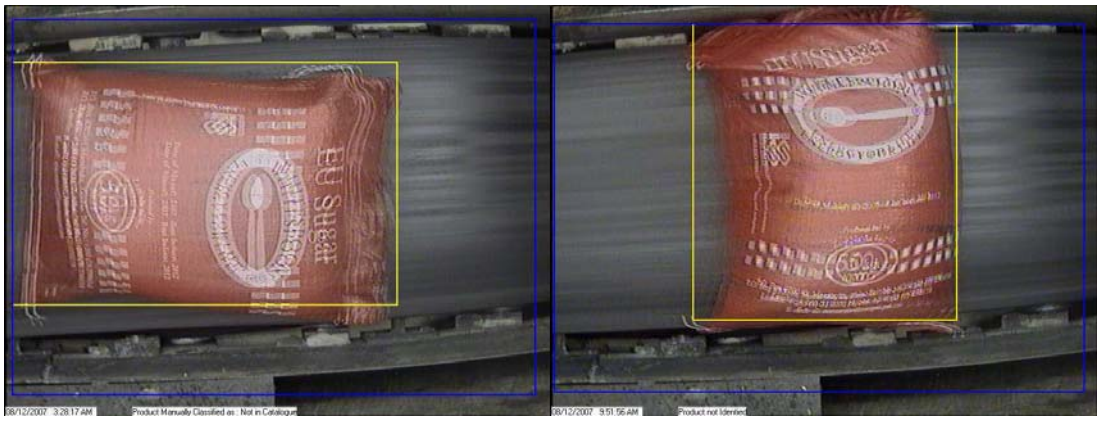


Figure 10 - 50kg EU bags were not classified as these bags only started being produced during the test period

- Many of the 50kg EU bags were not classified. There are no templates in the training database to handle these bags. Due to the fact that the size of these bags can vary a lot depending on whether the bag is presented facedown or standing on one end, a large number of templates is necessary to fully describe this class.
- There appears to be a problem with the camera setup. The figure below illustrates this:

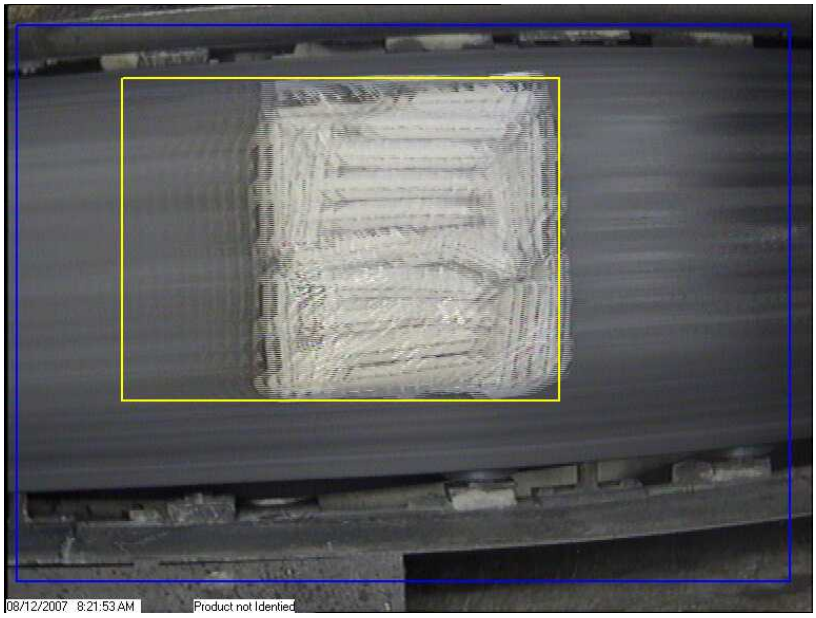
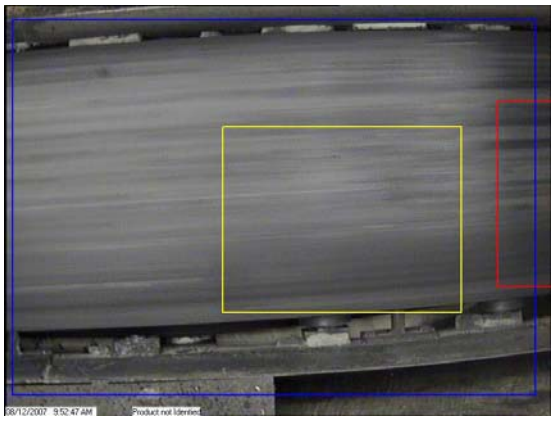


Figure 11 - Ghosting on the Image – camera issue?

From this image it can be seen that the product leaves a ghost trail behind it. Each of the ghost edges corresponds to the location of the product during a previous frame captured at the 25Hz camera frame rate. The likely cause of this is the shutter speed or aperture setting giving a blurred image with the speed of movement. We need to run a separate configuration test to ensure that the ½" camera is correctly calibrated for the speed of the conveyor. This particular high end camera has three automatic settings to allow for

basic setup and a manual override. From the location of the yellow frame on the image it is apparent that the software thinks that the bag and its ghost trail together form a single product. The size of this product doesn't match with the templates that have been trained, and hence the product isn't classified. This is simply resolved by amending the setup details for the camera.

- A sequence of not classified images was the result of the conveyor belt stopping and restarting with a product in the field of view. This sequence is shown below.



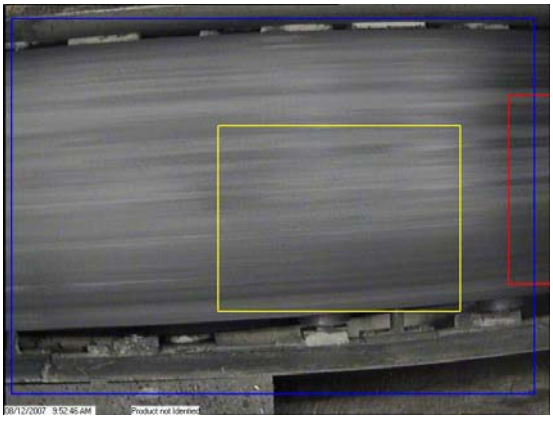


Figure 12 – Non Classified fields?

- There are insufficient training templates in the database. Products that are not classified but appear to be good templates for a specific product class can be added to the training database. Examples of such products are shown below.

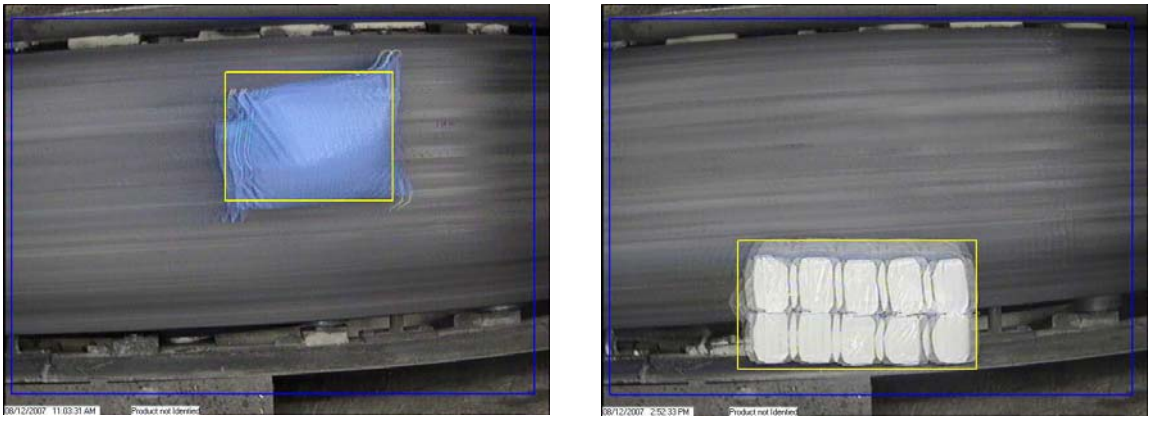


Figure 13 – Good template examples

As more templates are added fewer products will not be classified.

6. 10 AM to 11 AM

Product	Lane 1	Lane 2	Diff 1 -2	% Capture	% Class (Lane 1 Lane 2)	Manual Count
10kg Cane sugar	114	116	2	100%	100% 99.982%	114
Poly brown	153	158	5	100%	96.8% 100%	157
2kg pre-pack	374	369	-5	100%	98.6% 100%	370
1kg pre-pack	221	222	1	100%	99.995% 100%	220
Not classified	53	43	-10			-

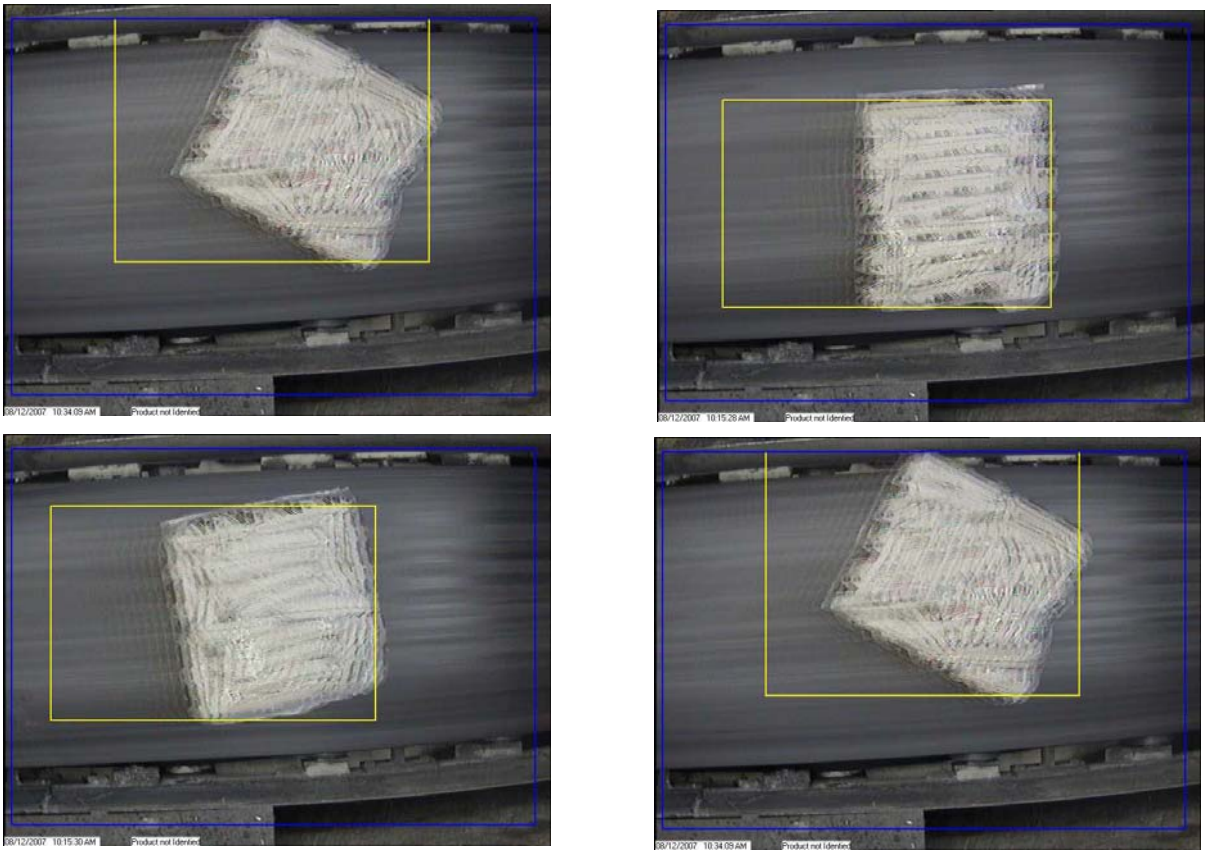


Figure 14 - Examples of product not identified from lane 1: Note the large boundary box in each image

The number of not classified products for lane 1 is more than that for lane 2 since the database for lane 2 contained more templates.

For lane 2 there were 5 less poly brown bags. The 5 EU bags were incorrectly classified as poly brown bags, hence were reduced.

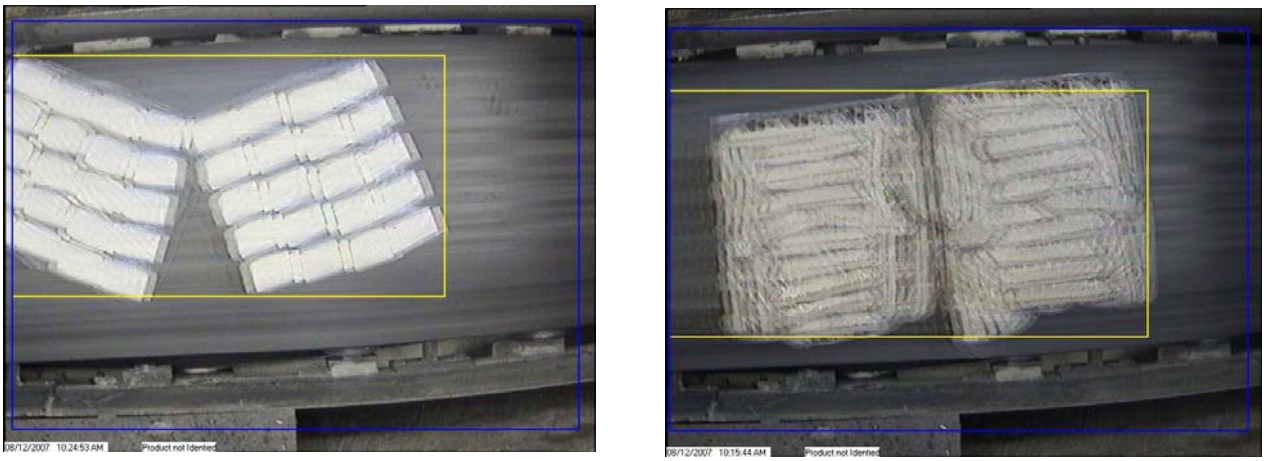


Figure 15 - Touching bags captured during 10 am and 11 am

The reason for the difference in 2kg pre-pack counts is the time difference between the two lanes, as described in section 5. In the next hour lane 2 has 5 2kg pre-pack bags more than lane 1 because these bags were entered into a different hour bracket than was the case for lane 1.

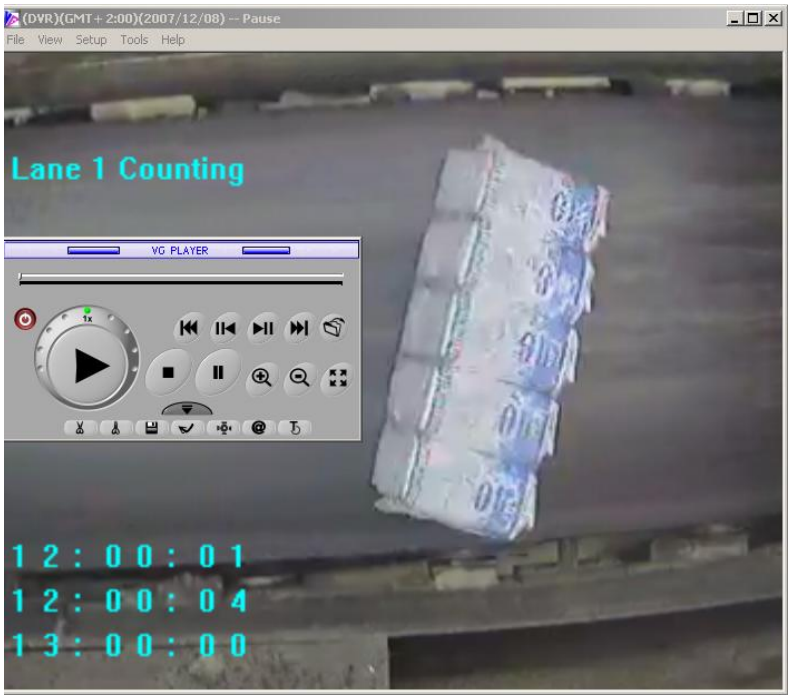


Figure 16 - An image from the Digital Video Recorder showing bags counted in the 1st 7 seconds of the hour

7. 11 AM to 12 PM

Product	Lane 1	Lane 2	Diff 1-2	% Capture	% Class (Lane 1 Lane 2)	Manual Count
10kg Cane sugar	211	214	3	100%	98.6% 100%	213
Poly brown	10	9	-1	100%	100% 90%	9
2kg pre-pack	480	485	5 (0)	100%	100% 100%	482
1kg pre-pack	296	296	0	100%	100% 100%	292
Not classified	19	20	1			-

Small differences exist between the two lanes, 3 10 kg cane sugars and a single poly brown. These can be explained as a result of training database differences. The 1 and 2 KG pre-packs were 100% the same.

The images that are not classified during this hour are as a result of the mechanisms described in section 5.

The manual count as verified by the DVR recording was only correct for the poly browns.

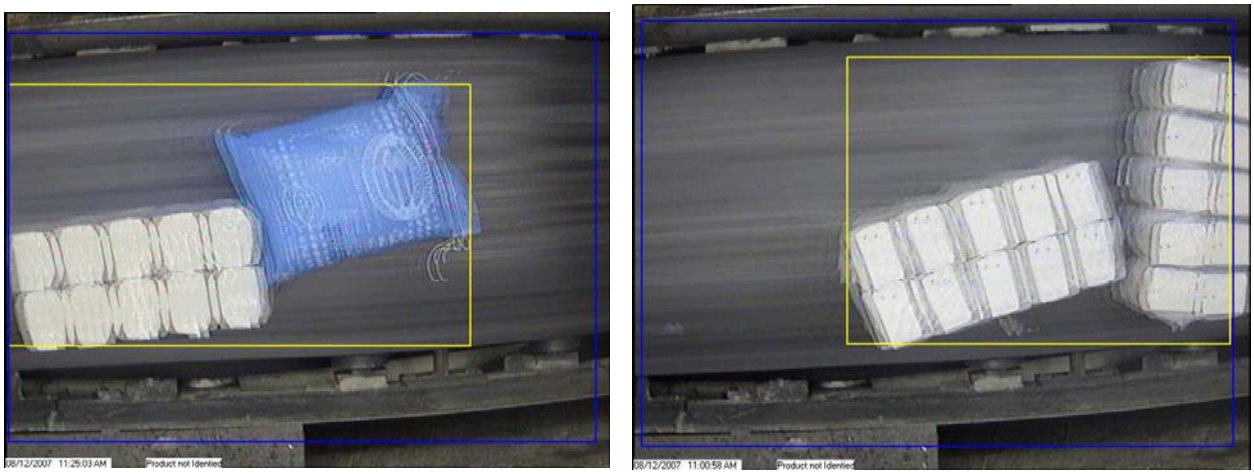


Figure 17 - Touching products during the period 11 and 12

In this hour the 5 extra 2kg pre-pack bags are present on lane 2 that flowed over from the previous hour due to a difference of about 10 seconds in the time reference for the 2 PCs.

8. 12 PM to 1 PM

Product	Lane 1	Lane 2	Diff 1 - 2	% Capture	% Class (Lane 1 Lane 2)	Manual Count
10kg Cane sugar	136	136	0	100%	100%	129
Poly brown	0	0	0	100%	100%	0
2kg pre-pack	402	397	-5	100%	98.7%	359
1kg pre-pack	208	206	-2	100%	99%	183
Not classified	1	1	0			0

During this hour the counting software on lane 2 was stopped and restarted. Without a camera in the control room the reason for this is not clear. The event can be verified from the snippet of the security log shown below.

08 Dec 2007 12:16:17 Status - System Shut down,
08 Dec 2007 12:16:26 Status - System Start Up,

The result of this was twofold

- Due to the fact that the counting software on lane 2 was not operational for a period of approximately 7 seconds (49 - 42 seconds) a number of bags were not seen on lane 2. This is reflected in the fact that the counts for lane 2 are lower than the counts for lane 1.

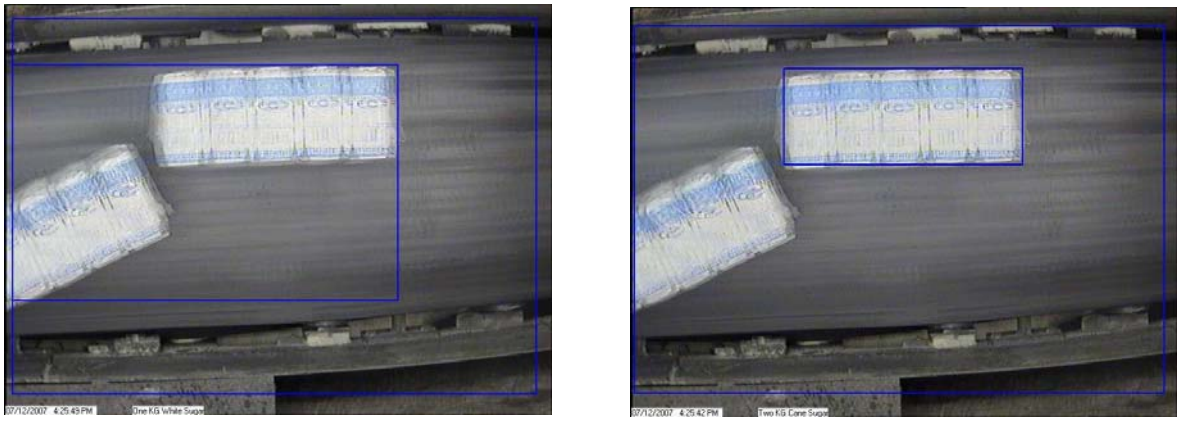
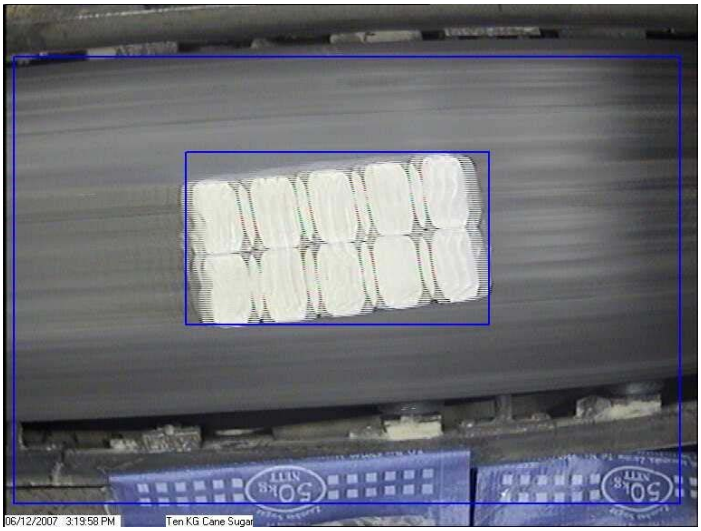


Figure 18 – Time difference between the PCs was 7 seconds

- Two separate count files exist for this hour: one from the start of the hour to the stoppage, and the other from start-up to the end of the hour. The counts in these two files have to be combined to give the true counts for the hour.

Recorded : ,08 Dec 2007 115959,
Sequence Number ,55, 0,
Not Classified : ,17,
Ten KG White Sugar,209,
Poly 1Kg Brown,9,
Two KG Cane Sugar,481,
One KG Cane Sugar,296,
50 KG Household VEA,0,
1197108000,

Recorded : ,08 Dec 2007 121617,
Sequence Number ,56, 0,
Not Classified : ,0,
Ten KG White Sugar,37,
Poly 1Kg Brown,0,
Two KG Cane Sugar,83,
One KG Cane Sugar,66,
50 KG Household VEA,0,
1197108977,
Reset : ,08 Dec 2007 121617,
Sequence Number ,56, 1,
Last Reset : ,08 Dec 2007 080120,
Totals since Last Reset,
Not Classified : ,77,
Ten KG White Sugar,578,
Poly 1Kg Brown,636,
Two KG Cane Sugar,1911,
One KG Cane Sugar,1054,
50 KG Household VEA,1,
Last Hour,
Not Classified : ,0,
Ten KG White Sugar,37,
Poly 1Kg Brown,0,
Two KG Cane Sugar,83,
One KG Cane Sugar,66,
50 KG Household VEA,0,
1197108977,
Recorded : ,08 Dec 2007 125959,
Sequence Number ,56, 1,
Not Classified : ,1,
Ten KG White Sugar,98,
Poly 1Kg Brown,0,
Two KG Cane Sugar,314,
One KG Cane Sugar,140,
50 KG Household VEA,1,
Empty,0,
1197111600,
Recorded : ,08 Dec 2007 135959,
Sequence Number ,56, 0,
Not Classified : ,26,
Ten KG White Sugar,218,
Poly 1Kg Brown,62,
Two KG Cane Sugar,320,
One KG Cane Sugar,271,
50 KG Household VEA,0,
1197115200,



9. 12 PM to 1 PM

Product	Lane 1	Lane 2	Diff 1 - 2	% Capture	% Class (Lane 1 Lane 2)	Manual Count
10kg Cane sugar	220	220	0	100%	100% 100%	234
Poly brown	63	63	0	100%	100% 100%	63
2kg pre-pack	324	325	1	100%	99.9969% 100%	368
1kg pre-pack	271	271	0	100%	100% 100%	288
Not classified	29	29	0			

The only difference between the two counting systems was a single 2 kg bag not identified in lane 1, created from the smaller template in use on Lane 1.

A number of not classified images are captured similar to the one shown below.

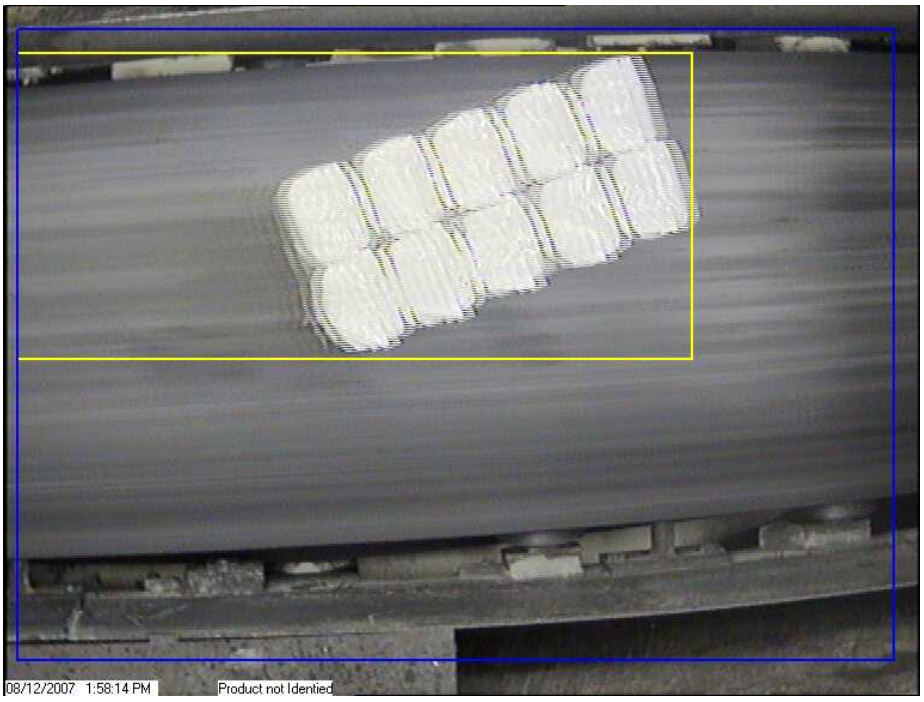


Figure 19 - People movement affecting lighting resulting in a bad classification

At a first glance the cause of this condition is not clear. From the size of the yellow block it is apparent that it is a segmentation error causing a part of the conveyor to be grouped with the identified product.

In order to find an answer the DVR recordings for this time were investigated. It can be seen that during this window a number of people are moving up and down the narrow central corridor between the two conveyors. This would cause a change in the light levels observed by the camera, which would cause the exact symptoms shown in the figure.
The solution to this problem is to keep people away from the conveyors in the region where the counting is taking place while the conveyor is operational.

Figure 20 - Cause of light changes on the conveyor belt

10. 2 PM to 3 PM

Product	Lane 1	Lane 2	Diff 1 - 2	% Capture	% Class (Lane 1 Lane 2)	Manual Count
10kg Cane sugar	164	164	0	100%	100% 100%	164
Poly brown	67	67	0	100%	100% 100%	67
2kg pre-pack	416	418	2	100%	99.5% 100%	419
1kg pre-pack	282	281	-1	100%	99.6% 100%	281
Not classified	15	18	3			

The three counts were the same for 10 KG and Poly Brown while a single 1 kg was incorrectly classified on lane 1 and two 2 kg pre-packs were incorrectly classified on lane 1. All 3 of these items could have been resolved if the lane 1 template was far better.

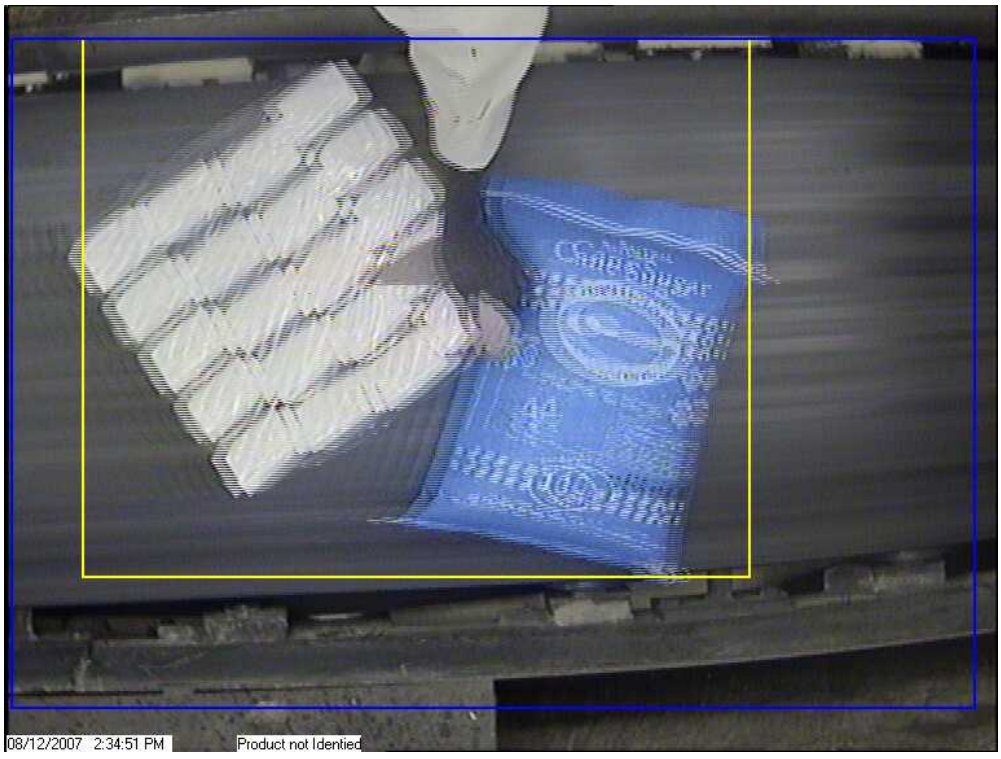


Figure 21 - Bags which cannot be classified due to human interference

11. 3 PM to 4 PM

Product	Lane 1	Lane 2	Diff 1 - 2	% Capture	% Class (Lane 1 Lane 2)	Manual Count
10kg Cane sugar	98	98	0	100%	100% 100%	97
Poly brown	324	324	0	100%	100%	327
2kg pre-pack	446	448	2	100%	100% 99.96%	445
1kg pre-pack	225	223	-2	100%	99.1% 100%	222
Not classified	7	7	0			

The imaging systems were the same for both 10 KG cane and poly brown, with 2 misclassifications between 2 kg and 1 kg bags.

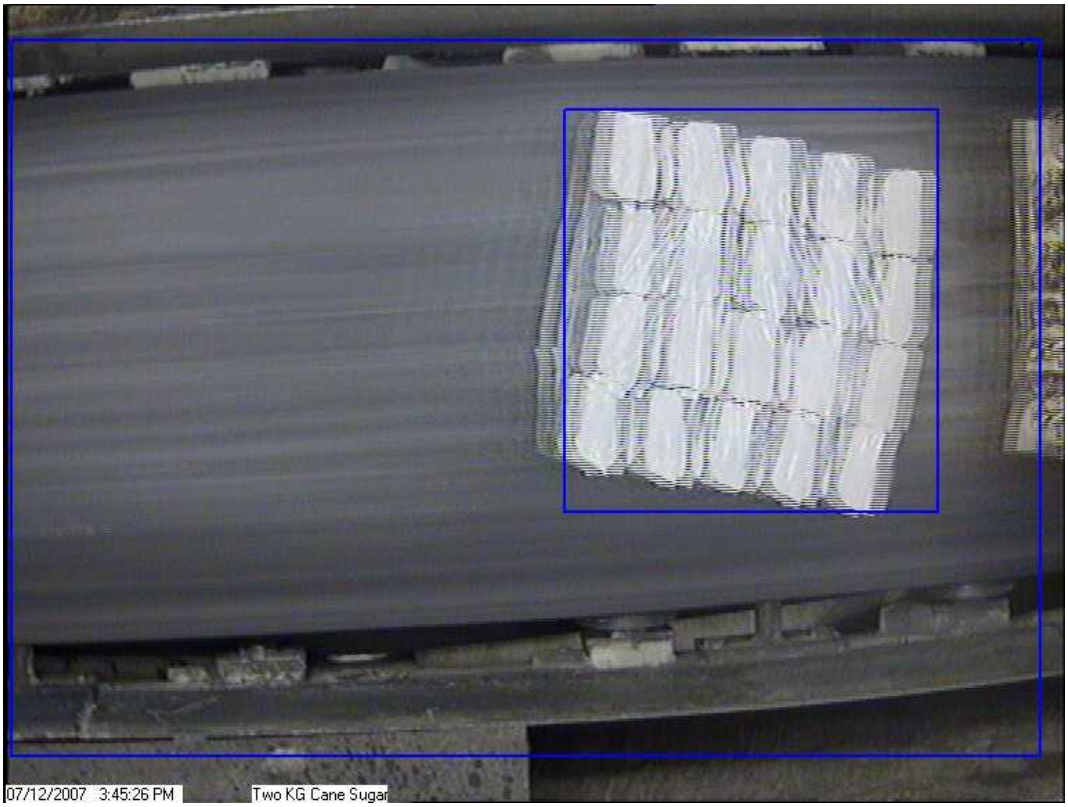
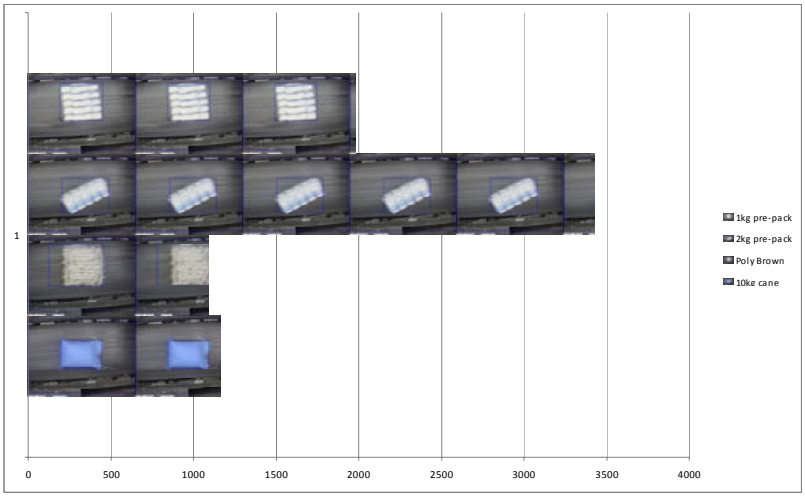


Figure 22 - Two one KG pre-packs were incorrectly classified as two KG Pre-Packs

12. TOTAL SHIFT COUNT: 8 am TO 4 pm



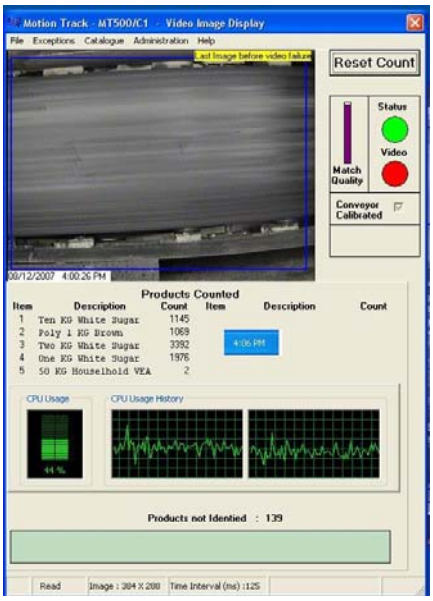


Figure 23 – Graphical representation of classification and totals in 8 hours

i.	The mill count for 10 KG bags was:	1 192
ii.	No of 10 KG bags counted by Lane 1 PC =	1 164 (+5)
iii.	No of 10 KG bags counted by Lane 2 PC =	1 168 (+1)
iv.	No of 10 KG bags counted manually =	1 172

The high mill count (20 bags more than any of the other counts) can only be explained by deliberate over counting and fudging of the results upwards to ensure no bags are missing. It is not possible for bags to be manually carried to the cages, the over view cameras prevent this. All bags passing the counting camera have been accurately counted by the imaging system, which suggests that the manual count was over by 3 bags. The lower count for PC 1 compared to PC 2 was due to incorrect classification at:

- 9 & 10 when a single 2 KG bag was classified as a 10 KG;
- 10 & 11 when 2 bags were incorrectly classified;
- 11 & 12 when 3 bags were incorrectly classified.

v.	The mill count for Poly Brown bags was:	1 094
vi.	No of Poly Brown bags counted by Lane 1 PC =	1 093 (+5)
vii.	No of Poly Brown bags counted by Lane 2 PC =	1 097 (+1)
viii.	No of Poly Brown bags counted manually =	1 085

The imaging systems, after classification correction ( ), had the same count while the mill count was slightly lower with 4 bags and the manual count was 9 bags out.

ix.	The mill count for 2 KG Pre-pack bags was:	3 545
x.	No of 2 KG Pre-pack bags counted by Lane 1 PC =	3 434
xi.	No of 2 KG Pre-pack bags counted by Lane 2 PC =	3 434
xii.	No of 2 KG Pre-pack bags counted manually =	3 427

The automatic and manual counts were very similar, while the mill count was over 110 pre-pack bags over these counts. In previous attempts to correlate the automatic system with the mill count similar huge discrepancies were observed, suggesting that this is not an isolated practice and occurs on a regular basis.

A number of broken bags were detected by the imaging system which were not removed and subtracted from the mil count or fixed and remained in the count. It is suggested that any product not identified / classified by the imaging system be moved off the conveyor to a holding area and then either fixed and placed under the camera again or removed from the system.

Figure 24 - Damaged bags were detected by imaging system which were not allocated in the manual count

xiii.	The mill count for 1 KG Pre-pack bags was:	1 999
xiv.	No of 1 KG Pre-pack bags counted by Lane 1 PC =	1 981
xv.	No of 1 KG Pre-pack bags counted by Lane 2 PC =	1 981 (1905+76)
xvi.	No of 1 KG Pre-pack bags counted manually =	1 951

The manual (30 bags under) and mill (18 bags over) counts were not accurate when compared to the automatic count of 1 981, determined by both systems.

CONCLUSIONS

A percentage capture rate of 100% (not a single bag missed) and a 99.986% classification accuracy rate against over 7,500 products during an 8 hour shift were achieved.

A number of steps can be taken to ensure that a good counting accuracy is achieved and maintained. The following is a list of steps which should be taken:

Product training

In view of the severe deformation and distortion of the bags on the conveyor belt, it is necessary to provide multiple templates of the products to assist in the classification of the products. It is crucial that this training process be done accurately and effectively since it has a major impact on the accuracy of the classification of the bags. The low number of templates resulted in a higher number of incorrectly classified products. Having a higher number and wider range of templates would reduce the incorrect classifications.

Camera Images

The higher the quality of the images makes classification easier. It is thus important that the CCTV cameras should be in good working condition, rigidly mounted, well focused, shutter speed and aperture settings checked and with clean lenses. The camera is currently able to move and can be tightened down so no movement is possible. The shutter speed appears to have changed and needs to be checked. Suitable lens cleaning materials must be supplied on site and regular maintenance should be performed.

Lighting

The lighting of the products should be good and constant. Variations in lighting may cause the MT500 Software to segment an area of an image without any product being present. Shadows and reflections should thus be avoided. If personnel movement is unavoidable in an area, a shroud should be placed over the conveyor belt to prevent stray lighting from falling on the products. If this is not possible an alternative position could be explored? If all broken and unclassified products were automatically directed to a holding area these could

be suitably resolved. Very minor changes to the software would be required to facilitate this option.

Product spacing and orientation

Due to the severe deformation of the products to be counted, it is necessary to ensure that a good image is obtained of each product to be recognised. Overlapping or touching bags cause additional uncertainty in the classification process, and should thus be avoided.

We recommend that products should be spaced at least 100 centimetres apart (or one second, based upon a conveyor moving at 1m/s), and should present the same markings to the CCTV cameras as when the templates were collected to identify the products. This will allow for 18,000 plus products to be counted in an 8 hour shift per lane (or 32,000 per 8 hour shift, based on the current conveyor speed. This is substantially more than current and likely future production (less than 10,000 products per shift).

A speed test where products were placed at 20 centimetre intervals was conducted. No bags were missed, even after large numbers of bags had passed the camera rapidly. There were two incorrect reads due to the database templates being incorrectly trained. This gives a capture rate of 100% and a 99.996% accuracy rate.

Figure 25 - 53s - Poly 1 KG Brown 4:06:53

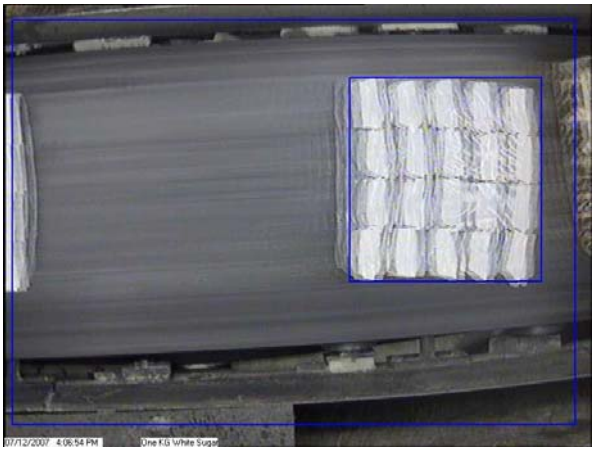


Figure 26 - 54s - One KG White Sugar 4:06:54

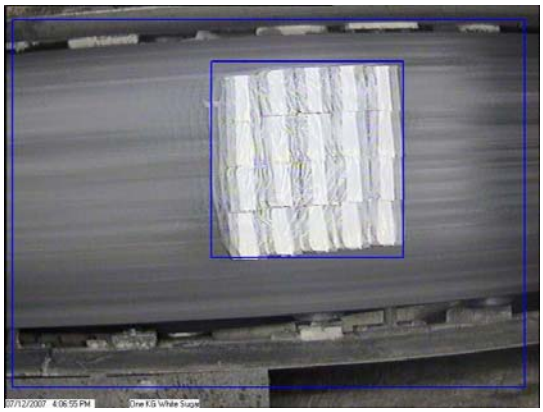


Figure 27 - 55s - One KG White Sugar 4:06:55

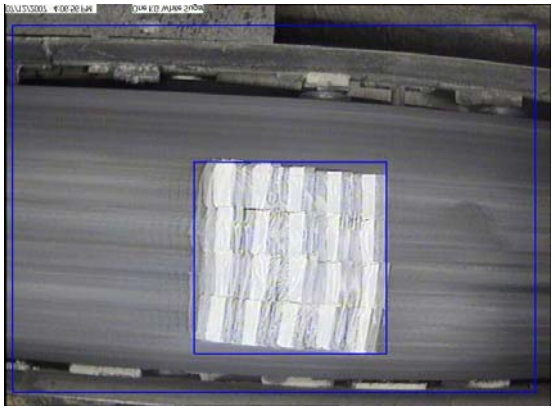


Figure 28 - 56s - One KG White Sugar 4:06:56

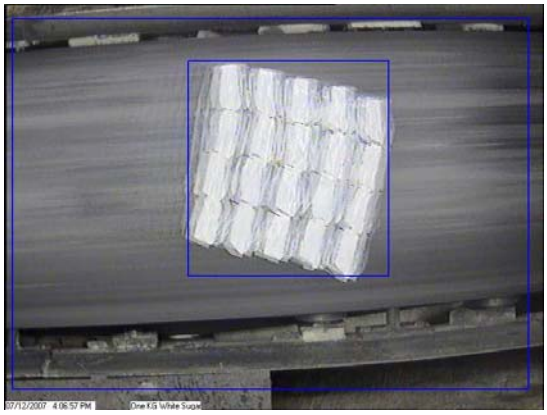


Figure 29 - 57s - One KG White Sugar 4:06:57

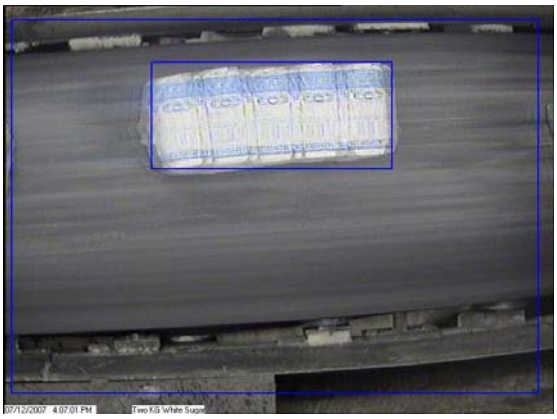


Figure 30 - 58s - One KG White Sugar 4:06:58

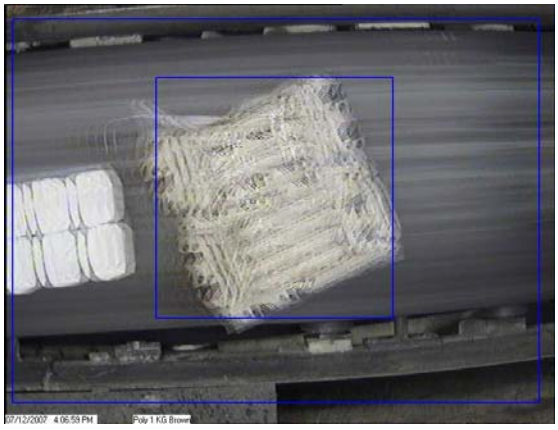


Figure 31 - 59s - Poly 1 KG Brown 4:06:59

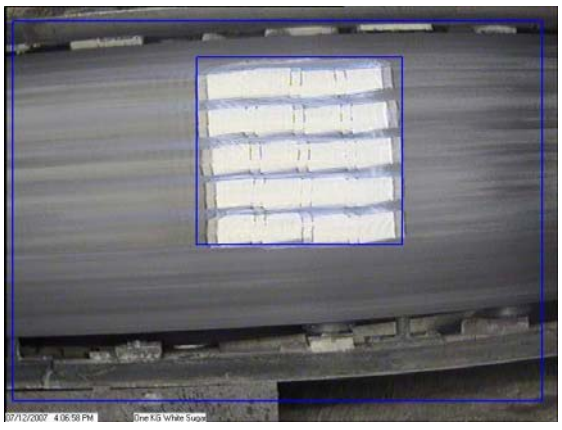


Figure 32 - 00s – 2KG Bale 4:07:00

Figure 33 - 01s - 2 KG Bale right way up at 4:07:01

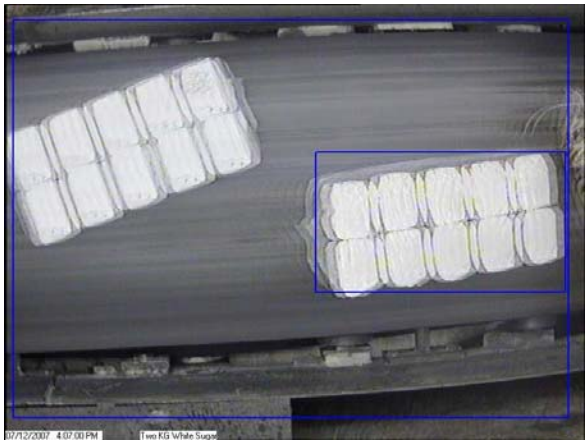


Figure 34 - 01s (2) - 2 KG Bale on side 4:07:00

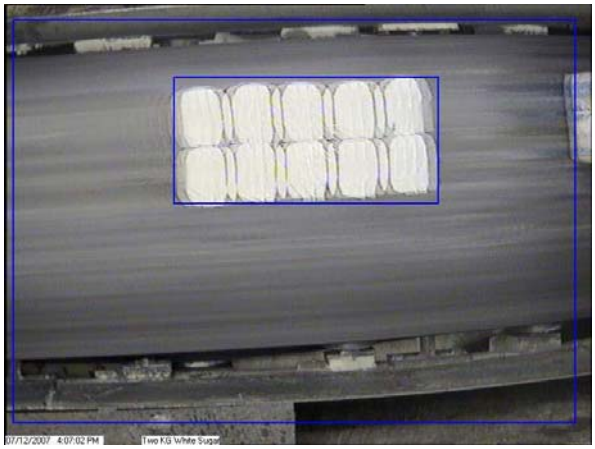


Figure 35 - 02s - 2 KG Bale right way up at 4:07:02

Bag designs

The selection of unambiguous bag designs, recognisable from all positions in which the bags can be placed on the conveyor belt will improve classification accuracy and reduce the template training requirements.

CPU loading

The PC loading issue is not dependent on the number of bags passing in front of the CCTV camera. The MT500 Software runs at regular intervals (you can see the cycle time at the bottom of the main window.) Each time the MT500 Software runs it captures an image of the conveyor belt and thus also of any bags present on the conveyor belt. When bags pass the capture point the time between successive image cycles of the MT500 Software

increase due to the increased processing load. The PC is quite capable of handling all the processing within acceptable times. If, however, another application runs, it runs after the MT500 Software has completed processing and thus delays the start of the next MT500 Software processing cycle. If the application takes say 5 seconds to perform its processing it causes a gap of 5 seconds between successive MT500 cycles. If a bag moves through the camera field of view during that 5 second period, it will not be seen by the MT500 Software, and hence not counted. (The MT500 Software will not have an image of the bag(s) passing through the field of view during the 5 second period.) Depending on the time interval between processing cycles, one or more bags could be missed. This situation can occur with only one bag on the conveyor belt or when there are many bags on the conveyor belt.

Increasing the PC processing power will not significantly improve the situation. If it is required to run another application on the PC, it should preferably be done at a time when there are no bags passing in front of the CCTV camera. This will ensure that the MT500 Software obtains an image of each bag passing in front of the camera and processes the image.

The load tests run at Nakambala confirm that the PC running the MT500 Software can readily accommodate all processing required without missing bags as a result of inadequate processing.

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